AUGUST 21, 1975

BERLIN EXHIBITS EUROPEAN TV DEVELOPMENTS/59

Electronics trims fat from food industry/86

Using phase-modulated signals to analyze PLLs/94

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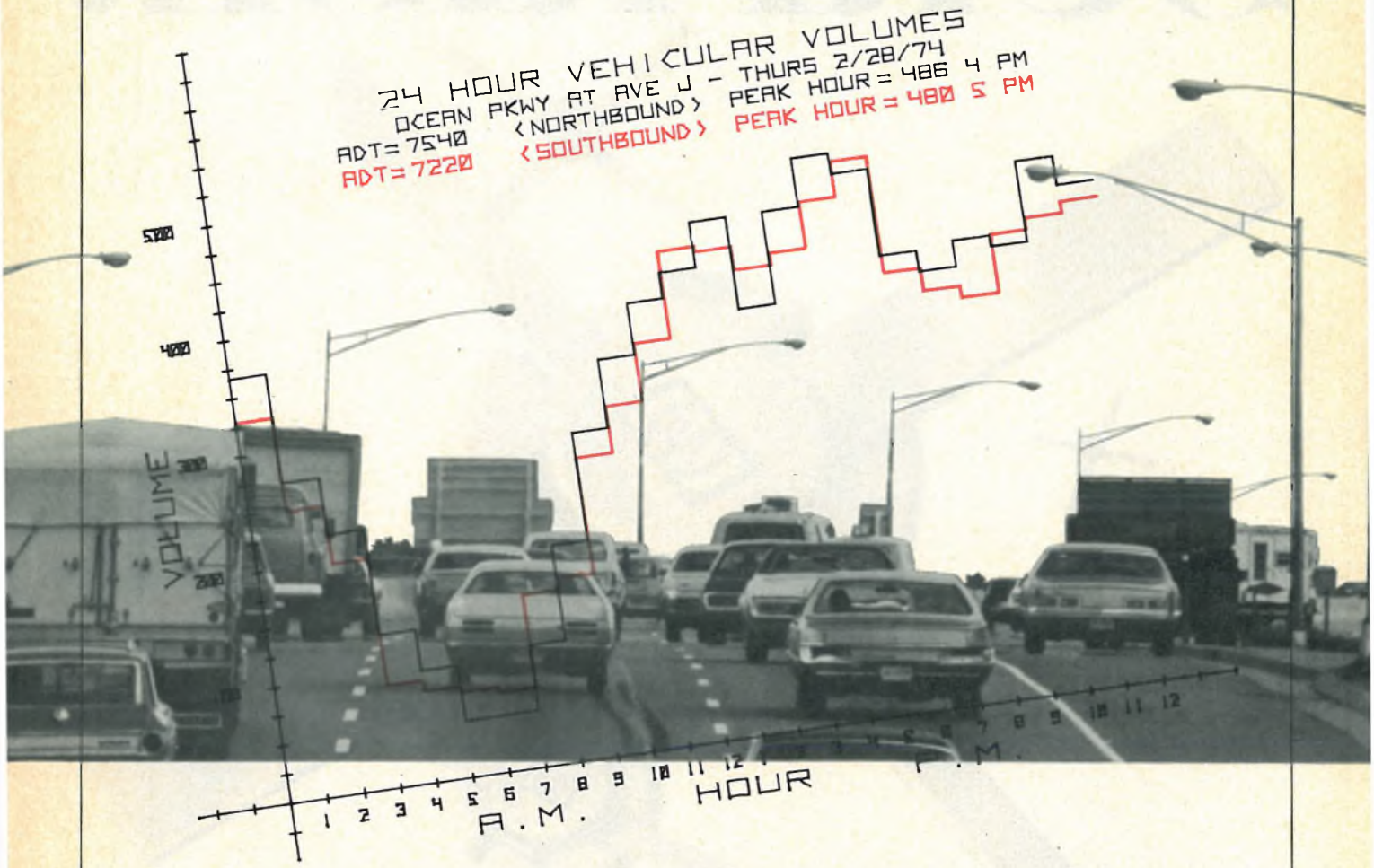
Just another algebra problem to the HP 9820A.



Algebra is the language of the HP 9820A Programmable Calculator. And that's one of the reasons the Research Division of New York City's Department of Traffic chose the 9820 to help them analyze traffic flow and density. Another important reason for choosing the 9820 over other computing systems was the 9820 adapted easily to their needs at a price that allowed them to dedicate the system to their dynamic applications. That means they can input their raw data as it's received and get results in minutes. The algebraic language, along with the interactive alpha display, allows them to write and edit programs so quickly that emergency situations and special reports can be handled as they occur. And because it's familiar and natural, researchers were able to use the system without any formal training.

From the variety of output options available for the 9820, the Research Division was able to choose just the right one for their needs – plotter generated 8½" x 11" charts for incorporation into reports. Finally, one of the staff adapted an HP interface card so the 9820 could acquire data directly from traffic counter-generated tapes – even though he had no previous interfacing experience.

If computing availability and quick turn-around are as important to your problem-solving activities as they are to New York City's Traffic Department, think about an HP Programmable Calculator. HP calculators provide you with an array of peripheral options, an easily learned programming language, interfacing capabilities and an optional library of general-purpose programs. Call your local HP sales office.

095/15

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Electronics

The International Magazine of Electronics Technology

Vol. 48, No. 17 • August 21, 1975

Highlights

Cover: Photography's a snap with electronics, 74
Of the 15 million cameras sold worldwide last year, barely one in three contained electronic controls. But that proportion will grow rapidly as ICs become more reliable and less expensive and as the more sophisticated equipment attracts an increasingly sophisticated public.

Art Director Fred Sklenar both posed for and shot the cover.

Raytheon head analyzes military success, 66
What enables Raytheon to win contracts like the one for the SAM-D missile and to triple Government sales to nearly $1 billion in about a decade? Luck, plus a heavy investment in independent R&D, says president Brainard Holmes in an interview.

Food processing refines its technology, 86
Responding to pressures from the Government, consumers, and lower profits, the food industry is starting to streamline its operations with electronic systems, some of them microprocessor-based. This is part 4 of the series on electronics and industry.

Three phase-modulation test methods for PLLs, 94
The availability of synthesized-signal generators makes it easy to test phase-locked loops with phase-modulation techniques, the most generally satisfactory approach to the closed-loop circuit.

And in the next issue . . .
Preview of Wescon . . . the benefits of testing assembled components automatically . . . what the arrival of bipolar LSI means to the digital designer, part 1.

Electronics

Publisher's letter

Just about every reader of *Electronics* will be aware of some of the things technology is doing these days for both still- and motion-picture cameras. But do you realize how far some designs are pushing beyond automatic exposure controls and the like? According to Ron Schneiderman, our New York bureau manager, who put together the report starting on page 74, one camera maker has a prototype lens that focuses automatically.

But, he hurriedly adds, that's a rarefied example of what may be coming. More important, in terms of its probable impact on the enormous photography market, is the gradual spread of multi-capability chips from cameras in the top third of the price range down into the mass-market types.

Before that can happen, however, the prices of ICs must drop, and reliability must rise. As one IC supplier observes: "Reliability must be fantastic. Everything has to work. Reputations are important in the photographic industry; it's one of the most heavily studied consumer markets there is."

The electronic takeover of so many camera functions is both helping and being helped by the boom in photography. Schneiderman was impressed enough, after surveying developments in Japan, West Germany, and the U.S., to start calling his own not-too-old single-lens reflex "a museum piece."

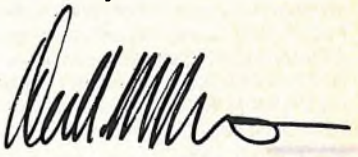
In the food industry, sturdy, simple-to-understand, easy-to-hose-down pneumatic equipment is the rule, and even well-known food-processing companies often have no electronics people on their staffs. This situation is forcing the would-be electronics supplier to go a good deal more than half way to meet his customer.

Still, these days, reports Industrial Editor Margaret Maas, food-processing firms are becoming much more receptive to sales talk about the precision of electronic process control and test and measuring equipment—and the economies it makes possible. For one thing, fines for underweight cans, bottles, or packages are heavy—but consistent overweight, however marginal, cuts into the industry's traditionally slim profit margins. For another, Government controls are proliferating, and consumers are at their most critical when it comes to food.

"Failure rates have to be extraordinarily low," comments Margaret, "since just one bad can may force the recall of an entire product line."

Luckily, besides the stick there is a carrot or two for the food industry—modular electronics equipment with an installed cost that has by now fallen below that of the pneumatic gear, plus newly available turnkey computer systems programed in process-control language the user can easily learn.

So little data is available on the interface between electronics and food processing that Margaret found no one willing or able to put a dollar figure on the size of the market. But for details of what she found starting to happen, turn to page 86 for part 4 of our Electronics and Industry series.



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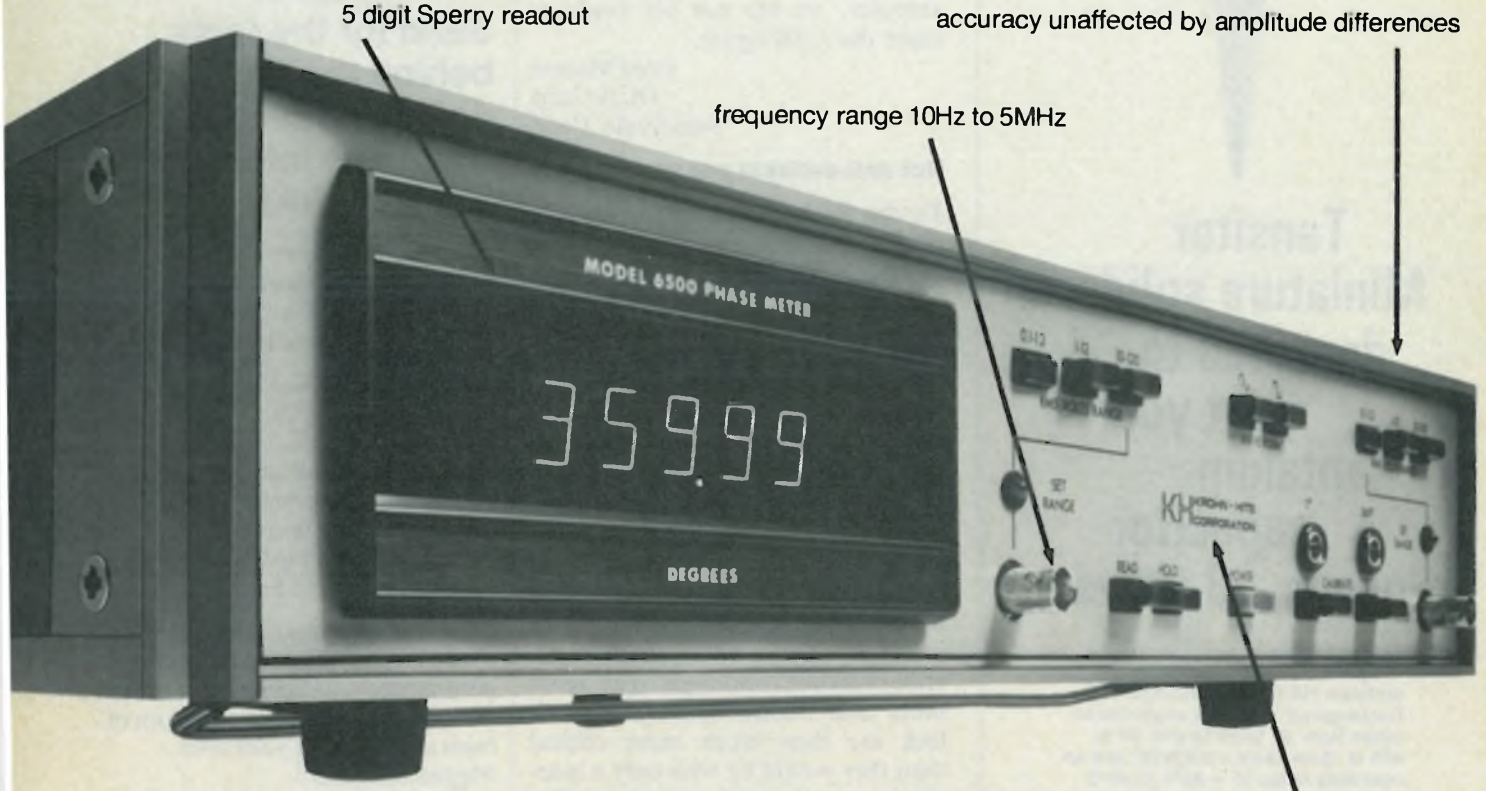

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Circle 4 on reader service card

Readers comment

Not ready yet

To the Editor: The New Products article dealing with our Model 8501 ion-implantation processor [July 24, p. 122] contains an error that may cause some confusion.

The current range of the Model 8501 is from a few nanoamperes to over 300 microamperes, not "to over 3,100 microamperes" as the article said. Although we have rated the 8501 conservatively, and typically attain currents to 500 microamperes, we are not yet ready to claim the 3,100 figure.

Fred Maurer
GCA Corp.
Sunnyvale, Calif.

Not anti-antiskid *per se*

To the Editor: I'd like to clarify a couple of minor issues raised in the article, "Antiskid testing upsets truckers" [July 24, p. 63]. When you state that "truckers opposed Federal regulation of their stopping capabilities" you are only partially correct. Responsible trucking companies sought to improve air brake systems long before FMVSS 121 was proposed. What they *do* object to is the severity of the brakes the law mandates. Antilock is thus relied upon to harness extremely powerful brakes which would otherwise be prone to locking under many moderate braking conditions. The reliability and maintainability of antilock are thus much more critical than they would be with only a marginal increase of the stopping distance as now required.

The Technical Advisory Group of the American Trucking Associations has never opposed the use of antilock itself.

Richard MacMillan
American Trucking
Associations Inc.
Washington, D.C.

Correction

The company that developed a new gallium arsenide production process (Aug. 7, p. 54) was incorrectly identified. Its name is Metals Research Ltd., not Materials Research Ltd., and is not affiliated with an American company bearing that name.

HiNIL Interface

Prevent CMOS latch-ups and failures with a high noise immunity logic I/O.

CMOS systems are subject to latch-ups and failures in the field because of high voltage transients, static charge and improper field maintenance procedures. Moreover, due to their increased output impedance, CMOS is more susceptible to transient errors than corresponding bipolar logic.

A simple solution to these problems is to use Teledyne's bipolar High Noise Immunity Logic (HiNIL) as the system I/O interface. The I/O design approach shown in Figure 1 has solved these problems in applications such as business equipment, industrial controls and electronic games. The HiNIL interfaces protect the delicate CMOS inputs with a rugged bipolar "front end" not susceptible to CMOS failure modes. Also system noise immunity is maximized, and the HiNIL output devices provide direct, high current logic drive of relays, displays and long lines.

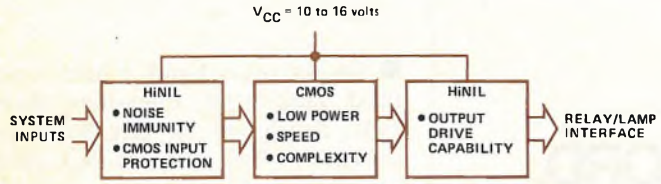

Figure 1. HiNIL input interface protects CMOS inputs while HiNIL outputs directly drive long lines and peripheral devices

The two families are directly compatible at the 10 to 16 volts V_{cc} range. The designer can take full advantage both of HiNIL's capabilities and of CMOS' low power dissipation, supply voltage flexibility and improved noise margin at higher supply voltages.

Parasitic SCR latch-up is an all too common CMOS malfunction. Large noise transients and DC input levels below ground or above V_{cc} could force CMOS input diodes into forward conduction, causing SCR action in the four-layer diodes formed by the diode and parasitic p-n substrate junctions. This condition leads to device latch-up, increased I_{cc} current and, when current is not limited, to gate destruction. Maximum protection can be obtained by using

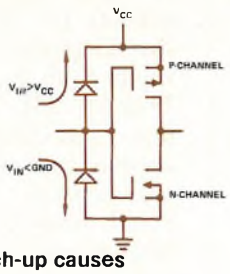

Figure 2A. CMOS latch-up causes

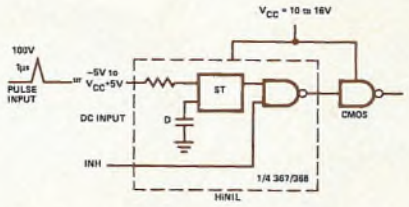

Figure 2B. HiNIL input protection

HiNIL Schmitt triggers. They prevent latch-up at DC input levels from −5 volts to V_{cc} +5 volts and suppress 100 volts transients as wide as 1μsec (Figure 2).

HiNIL inputs on plug-in cards will protect a CMOS system from problems associated with "on power" fault isolation, a widely used TTL system maintenance method. Plugging CMOS into powered connectors has led to latch-up failures because it allows inputs to see logic "1" signals before V_{cc} rises on the card. The failure is frequently catastrophic if input current is not limited.

HiNIL's lower output impedance and DC noise margin of 3.5 volts ignore large voltage noise transients that can cause CMOS logic errors. Also, static charges large enough to rupture CMOS oxide regions are often generated in dry environments by movement of materials and users. A HiNIL input gives more immunity to static and maximizes noise protection.

Examples of HiNIL Interface Devices

301 Dual 5-Input Power Gate 302 Quad Power NAND Gate (OC)	65mA relay or lamp driver
323 Quad NAND Gate (OC) 332 Hex Inverter (OC) 334 Strobed Hex Inverter (OC)	Input noise protection plus open-collector pullup to other logic levels
350 8-Bit Multiplexer 351 Dual 4-Bit Multiplexer	Drive longer lines than TTL with 10X noise immunity (I_{OH}=12mA)
361 Dual Input Interface 362 Dual Output Interface 363 Quad Output Interface	361 directly connects HiNIL to DTL/RTL/TTL 362 and 363 connect DTL/RTL/TTL to HiNIL
367 Quad Schmitt Trigger 368 Quad Schmitt Trigger (OC)	Suppress 100V/1μs spikes, protect CMOS, decode switches, etc.
380 BCD to Decade Decoder 381 BCD to Decade Decoder (OC) 382 BCD to Decade Decoder 383 BCD to 7-Segment Decoder	Provide decode/drive for lamps, LEDs, gas discharge displays, etc.
390 Interface Buffer Series	250mA HiNIL driver series will be available soon.

HiNIL reliability insurance costs little since the I/O circuits—unlike filters and shielding—generally replace other logic and drive circuits. So, don't wait until your new CMOS system runs into costly problems in the field. We'll show you how to build foolproof low-power systems. Call or write today for HiNIL application notes and specifications.

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News update

■ When a new form of barium-titanate ceramic was developed last year in West Germany by Siemens AG and independently in the U.S. by Erie Technological Products of Erie, Pa., the American company said it was considering a large-scale marketing effort [May 16, 1974, p. 43]. The material promised a means to avoid the rapid price rises for precious-metal inks used in multilayer capacitors. Erie's plans never progressed because, says general sales manager Paul Snyder, "We are still refining this system. Even though we have made some products, there is a characteristic we are still not satisfied with." So while Erie has delayed release of this capacitor type, it is maintaining a concentrated engineering effort.

■ On the other hand, a line of air-fired base-metal thick-film materials, developed by Engelhard Industries of East Newark, N.J. [May 16, 1974, p. 42], has created sizable sales and interest, says the company. "Silver-platinum molecular bonding material has been the biggest seller of the new air-fired metalization as a replacement for standard silver plating in hybrid circuitry," says Sanford Cole, manager of Engelhard's thick-film group. In general, adds Cole, "the new materials have found a good market in the field of digital-watch manufacture."

■ Statek Corp. has found an eager market for its new tuning-fork-shaped quartz crystal, the tiniest developed up to that time [May 16, 1974, p. 31]. The Orange, Calif., firm is shipping well over 50,000 crystals per month, and is expanding capacity. And next month Statek plans to introduce an even thinner crystal—50 mils vs the 70 mils of last year's model. The part will occupy about half the space of the present one with equal performance. Litronix is a major customer, and has been licensed by Statek as a second source.

—Howard Wolff

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Circle 9 on reader service card

Editorial

IEEE election: Being above criticism

This year for the first time there will be a contest in the presidential election for the Institute of Electrical and Electronics Engineers. Joseph K. Dillard, selected by the institute's nominating committee, will be opposed by Irwin Feerst, who has collected the required number of signatures on a nominating petition to get on the ballot.

Because this election is unusual, extra care is necessary to assure that the balloting be conducted with honesty and fairness not only in substance, but in appearance. In this regard, Feerst has raised an issue concerning how the ballots are collected and counted at the IEEE facility in Piscataway, N.J. There is no reason to believe that the IEEE staff and the Tellers Committee responsible for handling and tabulating the votes in the past have been anything but completely honest.

Yet why create a situation that could cause questions about fairness after the balloting? The institute should make every effort to remove this distracting issue by arranging to have an impartial outside organization count the votes.

Although this move may require an unplanned appropriation from the budget, it will be money well spent. The system that was satisfactory before this year's election is not adequate in a contested race. By hiring an outside ballot-counting firm, the IEEE serves both candidates—and, more importantly, all its members. The institute has to be above criticism in this matter, so that the membership can concentrate on the real issues raised in this election.

The need for an EFTS lobby

Does the installation of a banking terminal turn a supermarket into a branch bank? Yes, according to a recent decision in a Washington, D.C., district court, which has thrown a big roadblock in the path of the big prospective market in electronic funds-transfer systems. No, according to the U.S. Comptroller of the Currency, who had exempted EFTS terminals from branch-banking regulations last December, and officials there refuse to reverse that ruling pending appeals of the district court decision.

The confusion that results from the lack of a firm national policy could hardly be better illustrated. Yet, strangely, no one seems much concerned. Hardware manufacturers, who have the most to gain, seem content to wait hopefully for a successful appeal. The American Bankers Association is divided, since EFTS will give those members who can afford it a competitive edge over those who cannot. The *ad hoc* committee on EFTS within the Computer and Business Equipment Manufacturers Association has been disbanded till the situation clears. Most disturbing of all is the attitude of President Gerald Ford who, in the nine months since he signed a bill authorizing a national commission on EFTS, has failed to appoint even one of its 32 commissioners.

It seems likely that EFTS will ultimately be accepted, but the orderly development of the systems can be accelerated by an early and thorough consideration of their implications for the banking industry and the public at large. And it looks like that won't begin to happen until those who favor the development of the EFTS market become much more active in presenting their point of view in Washington.

Bye bye, MSI.

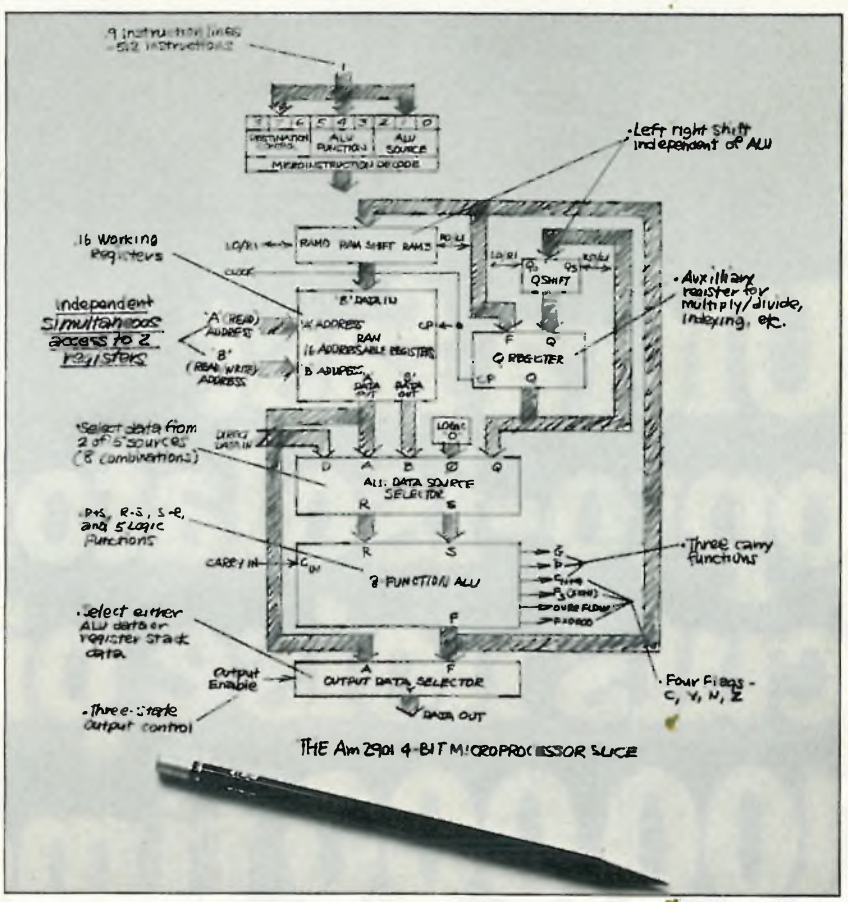
Now there's a microprocessor that gives you the best of LSI. Without giving up any speed. Without having to fight your way around registers you can't get at and ALU functions that aren't there.

Introducing the Am2901.
The Am2901 is a microprogrammable four-bit central processor slice using Advanced Micro Devices' high-performance, low-power Schottky TTL process. It's the first and foremost member of the Am2900 Family, a series of large-scale, low-power Schottky circuits for computation, control, communication and storage in microprogrammed computers. The Am2900 Family combines the architectural and functional flexibility of MSI with the performance and cost advantages only possible with LSI. The circuits can be used to emulate existing hardware, so the software doesn't have to be changed; to build machines with specialized instruction sets; to construct high-performance processors with the entire program in efficient microcode.

Cycle-saving two-address architecture.
The Am2901 stores data in sixteen addressable working registers and an auxiliary register. The sixteen registers are arranged in a two-port RAM—two addresses are used to read data simultaneously from any two of the registers. Two source operands for the arithmetic logic unit are selected from the two addressed registers, the auxiliary register, external data, or logic zero, providing a total of 203 unique pairs of source operands for every ALU function.

The most powerful bipolar microprocessor ever made.
The Am2901 includes an eight-function Arithmetic Logic Unit that performs addition, subtraction both ways and five logic functions on two source operands. It also does single operand functions like increment, complement and force zero. On every operation it provides all four status outputs—carry, overflow, zero and negative. The output of the ALU can be shifted left or right prior to storage; the auxiliary register can be shifted at the same time. In one cycle the Am2901 can perform this multiplication algorithm: Examine the LSB of the multiplier; if it's a 1, add the multiplicand to the partial product; shift the partial product down one place; shift the multiplier down one place.

The world's fastest TTL microprocessor.
The typical cycle time for a register-to-register read-modify-write is 100ns. No other microprocessor is close. And most other bipolar microprocessors only have single address architectures—that usually means two cycles to do what the Am2901 can do in one. (If you don't need speed, use an 8080; if you do, then use the fastest microprocessor around—the Am2901.)



You can't afford to ignore it.
The Am2901 costs $30 in quantities of 100. Now. And in case you've forgotten how prices go in the semiconductor industry, we've projected the Am2901 to be priced under $10 within a few years. But component cost isn't your only savings. Look at the additional benefits you get: fewer components and interconnections, smaller PC boards, less power consumption, and the improved reliability that goes with these. If MSI were free, the Am2901 would still be a bargain.

Write for more information.
The Am2901 is going to be the industry standard. It's too good to be anything else. Write, right now, for the whole story, and say bye bye to MSI.

Hello, LSI.

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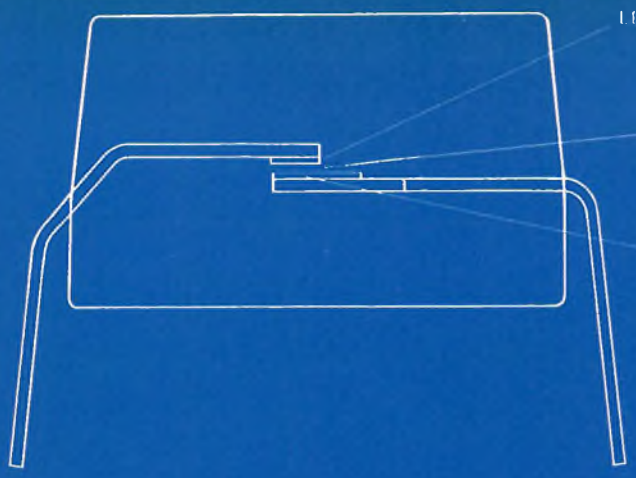
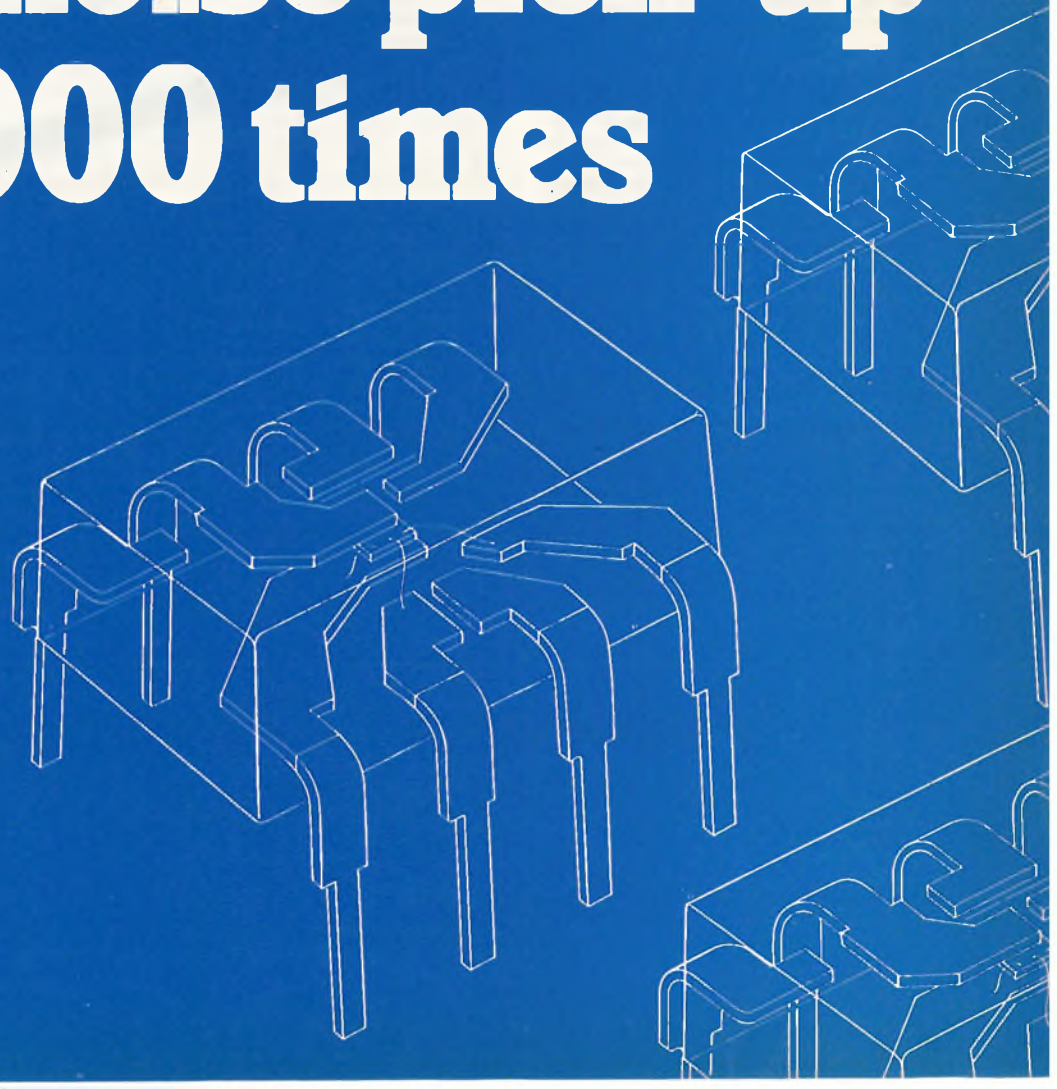


Ultra fast opto-isolator cuts noise pick-up 100,000 times



The specs are startling. Our IL-100 Isolite can transmit data at rates up to 5 megabits per second. And with common mode rejection of 50 db. That's better than any opto-isolator ever made, regardless of speed.

This performance is good enough to eliminate noise pick-up problems in nearly all hard-wired data transmission applications.

Such a state-of-the-art breakthrough means you can tie together computer and peripherals without resorting to brute force techniques for eliminating noise pick-up—such as laying in conduit and shielding systems, all of which are highly expensive.

And it means you save countless hours when a system is installed, modified or moved.

The IL-100 is a true solid-state device. It is DTL/TTL compatible, so it can be designed into your next solid-state system without the extra components required by pulse transformers.

It has an unusually versatile Schottky-clamped 3-state output that gives you built-in multiplexing capability without extra parts.

And its built-in Schmitt trigger virtually eliminates chance of oscillation, making your designs less critical and more reliable.

With propagation delay of only 75 nanoseconds, there is no opto-isolator made that offers comparable performance.

Don't use yesterday's technology to protect today's solid-state circuits. For details on the IL-100 ultra high-speed opto-isolator, contact Litronix, Inc., 19000 Homestead Road, Cupertino, Calif. 95014. Phone (408) 257-7910.

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Circle 13 on reader service card

People

Emergency monitoring is Pete Kreer's specialty

Now that he's got citizens' band radio operators working with the Ohio State Highway Patrol monitoring emergency calls along Ohio highways, Henry B. (Pete) Kreer is looking to formalize similar programs in the other 49 states. Kreer is counting on the on-going boom in sales of CB radio gear (see p. 62) to dramatically increase his base of volunteers.

His organization is called React, for Radio Emergency Associated Citizens Teams. "It's a nationwide group of CB operators organized into teams that monitor CB emergency channel 9 and report highway emergencies to the proper authorities," explains the 51-year-old Kreer, the group's founder and national director. As one of the original licensees of the class-D radio service and a past chairman of the citizen's radio subcommittee of the FCC's National Industry Advisory Committee Kreer came up with the idea more than 15 years ago after using his own CB mobile set to call for help while commuting to the Chicago office of the market-communications firm he heads.

Study. The Ohio network grew out of a study sponsored by General Motors Research Laboratories, which until early this year owned React. "But we've cut that umbilical cord," Kreer says, "and become an independent nonprofit corporation so that we can better seek funds from Government agencies and private foundations." However, GM continues to fund React at about the same level it has in the past.

Based on methods developed in the Ohio tests, "We're in a position to present a documented React program to a state for less than $25,000—and we've seen some interest by about 14 states," he says. Federal funds should begin to open up, too; earlier this summer, the Department of Transportation released a report that encourages state and local government participation in organized volunteer monitoring of channel 9 for highway safety.

Band man. Kreer's goal is to monitor emergencies in 50 states on citizen's band.

The React organization now numbers some 40,000 dues-paying "listeners" sprinkled across the U.S. and Canada. They are organized into about 1,000 teams that promise to monitor channel 9 24 hours a day, every day. Kreer himself has equipped his two cars and his home with CB sets and carries a spare to clamp on rented cars when he travels.

General Motors estimates that the Ohio program uses volunteered time valued at $10.2 million annually. "The benefit to the taxpayer is gigantic," Kreer says, "especially when you think that all the equipment is privately owned, and all the time is volunteered."

Carter wants Dumont to be a name again in scopes

"We're on a crash program," declares John Carter Jr., the new president of Dumont Oscilloscope Laboratories, who intends to put his company back into the commercial-scope business in the next six months. Four new scopes will be introduced this month (see p. 133), and two more are in development. The goal, says the 31-year-old Carter, is to serve the entire scope market, including either side of the 10-

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Semi-automatic panel wiring with .001″ accuracy

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The terminal locator handles panels up to 61 cm x 91.5 cm. Comes complete with solid state tape reader and N/C operated wire preparation unit which automatically delivers wire, cut to length, and stripped one end or both ends. See your Gardner-Denver International Electronic Product Specialist or write us. Gardner-Denver Company, International Division, Dallas, Texas 75247, U.S.A.

*Wire-Wrap is a registered Trademark of Gardner-Denver Company.

GARDNER·DENVER

to-100-megahertz range covered by the company's present scope line, which is sold almost exclusively to the military.

Three of the new scopes are low-price units designed for general-purpose maintenance and repair applications. The fourth is a 100-MHz scope aimed at logic testing and other field service uses. But scopes with larger bandwidths are coming.

How will Dumont, which virtually stopped pushing commercial sales three years ago to concentrate on the military market, be able to compete head-on with the likes of Tektronix Inc. and Hewlett-Packard Co.?

"We'll have to offer more for the money," says the six-foot Carter, adding that his company will try to combine more features and lower prices. Color-coded controls and improved triggering, as well as a $200 lower price, are features of the 100-MHz scope that competes with the Tektronix model 465, Carter points out.

First introduction. Having introduced the first oscilloscope in the 1930s, the original Dumont merged with Fairchild Camera & Instrument in 1960. When the senior Carter bought the Fairchild scope division in 1968, sales had fallen below $2 million a year. Last year, according to industry estimates, Dumont sales were about $5 million. With the commercial-oscilloscope market estimated at $300 million annually, there's certainly room for Dumont to move.

Formerly director of marketing for Carter Semiconductor Inc., Carter served as interim president of the family-owned companies for a few months last year after his father's death. Now enjoying a one-year order backlog, Carter is also thinking of product ventures beyond oscilloscopes.

He regards his company as a supplier not merely of oscilloscopes, but of "waveform-testing equipment." And this means a future, not only for commercial scopes but also for products such as function generators, time-mark generators, and scope calibrators.

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Well take heart, pilgrim. Because thanks to the whatever-it-is NAKED MILLI millicomputer, your hardware hardships are over.

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Start with your price problem: $395 used to buy you a lot of grief in the form of an 8- or 12-bit microprocessor. Which was still a bunch of bucks away from anything you could call a computer.

Now, $395 buys you the NAKED MILLI LSI-3/05 with 256 16-bit words of RAM. A full-blown, full-scale computer with an amazingly powerful instruction set and two standard I/O systems including ComputerAutomation's new Distributed I/O System.™

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It also buys you membership in the NAKED MINI® LSI Family. Not just a casual relationship, but total hardware and software compatibility.

"Ah ha," you say, as you reach for a purchase order. "That means Maxi-Bus™ compatibility, too. Which means the NAKED MILLI is also compatible with ComputerAutomation's standard peripheral controllers and I/O interfaces. Which means..."

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Suppose, however, that you need more machine. Okay, how about a computer with 1K words of RAM for $489? Or...

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All prices shown are for quantities of 100.

Meetings

IFAC/75: International Federation of Automatic Control's Sixth Triennial World Congress, IFAC, Massachusetts Institute of Technology, Cambridge, Mass., Aug. 24–30.

NBS Seminar on Frequency Standards and Clocks: Characterization, Usage, and Problem Areas, NBS, Boulder, Colo., Aug. 25–27.

Fifth European Microwave Conference and Exhibition, Microwave Exhibitions & Publishers Ltd. (Sevenoaks, Kent, England), Congress Centrum, Hamburg, West Germany, Sept. 1–4.

European Solid State Circuits Conference, IEEE, University of Kent, Cambridge, England, Sept. 2–5.

Workshop on Computer Hardware Description Languages and Their Applications, IEEE, City University of New York, New York, Sept. 3–5.

National Postal Forum IX, U.S. Postal Service, Washington Hilton Hotel, Washington, D.C., Sept. 8–10.

Hybrid Technology Conference, IEEE, University of Technology, Loughborough, England, Sept. 9–11.

Compcon Fall, IEEE, Mayflower Hotel, Washington, D.C., Sept. 9–11.

First National Conference on Software Engineering, IEEE and NBS, Mayflower Hotel, Washington, D.C., Sept. 11–12.

International Conference on Environmental Sensing and Assessment, IEEE, Stardust Hotel, Las Vegas, Nev., Sept. 14–19.

Wescon, Western Electronic Show and Convention, Civic Auditorium and Brooks Hall, San Francisco, Calif., Sept. 16–19.

Optical Fiber Communication International Conference, IEEE, IEE Headquarters (Savoy Place), London, England, Sept. 16–19.

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All calculations can be performed on an on-line real time basis. The frequency analytical range can be selected in 25 different ways corresponding to the input data with sampling times of 0.5μ sec. to 50 sec. And the system offers the widest measuring frequency band in its class: from 0.0001 Hz. (almost DC) to 1 MHz.

TEAC is famous for building a highly sophisticated line of data recorders and magnetic tape transports. Recording technology is our specialty. And now we also offer you the means to analyze your data as well.

To explain all the options the TEAC C-120/F-120 system offers you in terms of computation, interpretation and display of data would take a book. So we've printed one. In a few pages it will explain the many ways in which our equipment can help you in your work. It's free from your TEAC representative. And we think you should read it.

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NORWAY: RODLAND & RELLSMO A.S., Enebakkveien 230, Oslo 11 Tel: (29) 3080 **SWEDEN**: SAVEN A.B., Strandgatan 3, S-185 00 Vaxholm Tel: 0764-316 80
SWITZERLAND: WENGER DATENTECHNIK, Bruderholz str. 45, 4053 Basel

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Unique Action Pins solve panel-production problems.

No more rupturing of plated-thru holes. Fewer rejects. Wide commercial tolerances on plated-thru hole diameters. Increased contact area. Higher production yields. Stable electrical properties. Highest reliability. Low cost. Now you can get them all with AMP ECONOMATE Panels loaded with new Action Pins. Or in your panels with our Action Pin Components.

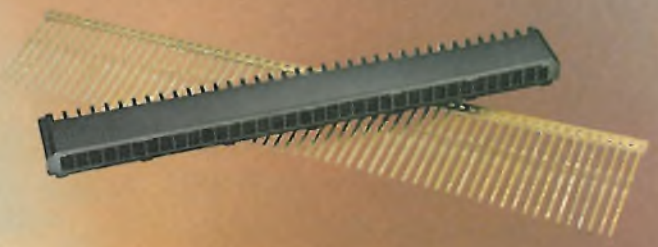
HOW ACTION PINS WORK. AMP Action Pins incorporate a spring section to give a higher degree of compliance than ever before possible. The diagonal measurement of the spring section —before insertion—is larger than the hole diameter (Fig. 1). When the Action Pin is inserted, the two opposing spring members readily compress, and after insertion, exert a force sufficient to effect a gas-tight interface with the plated-thru hole walls (Fig. 2). Yet their rounded corners prevent rupture of the plated-thru hole. They come with a variety of configurations: card-edge contacts, .025² feed-to and feed-thru posts, and SEM (NAFI-style) two-piece receptacle-and-blade contacts. All are compatible with wrap-type terminations or I/O connections.

Fig. 1

Fig. 2

AMP ECONOMATE panels are made to your specifications and consist of two elements: the pc board—either two-sided or multi-layer with plated-thru holes—and the AMP ECONOMATE Action Pin contacts.

ECONOMATE I card-edge contacts, and ECONOMATE II two-piece receptacle-and-blade, SEM (NAFI-style), contacts both feature snap-on housings for maximum maintainability of panels. Posted panels feature .025² feed-to and feed-thru posts for automatic, semi-automatic, or manual point-to-point wiring. All types hold costs to a minimum through AMP's high-speed automated assembly process.



MAKE OR BUY. AMP can supply all your panel requirements. Or, you can make them yourself using our reliable Action Pin components. Contacts come in strip for high-speed, low-cost gang insertion at rates up to 10,000 an hour with our high-productivity assembly tools.

Action Pins solve the problems that bother you most. They won't broach, rupture, tear, distort or damage the plated-thru hole—giving you the ultimate in reliability.

When it comes to panels, AMP is where the action is. Get the whole story. Call (717) 564-0100 or write AMP Incorporated, Harrisburg, PA 17105.

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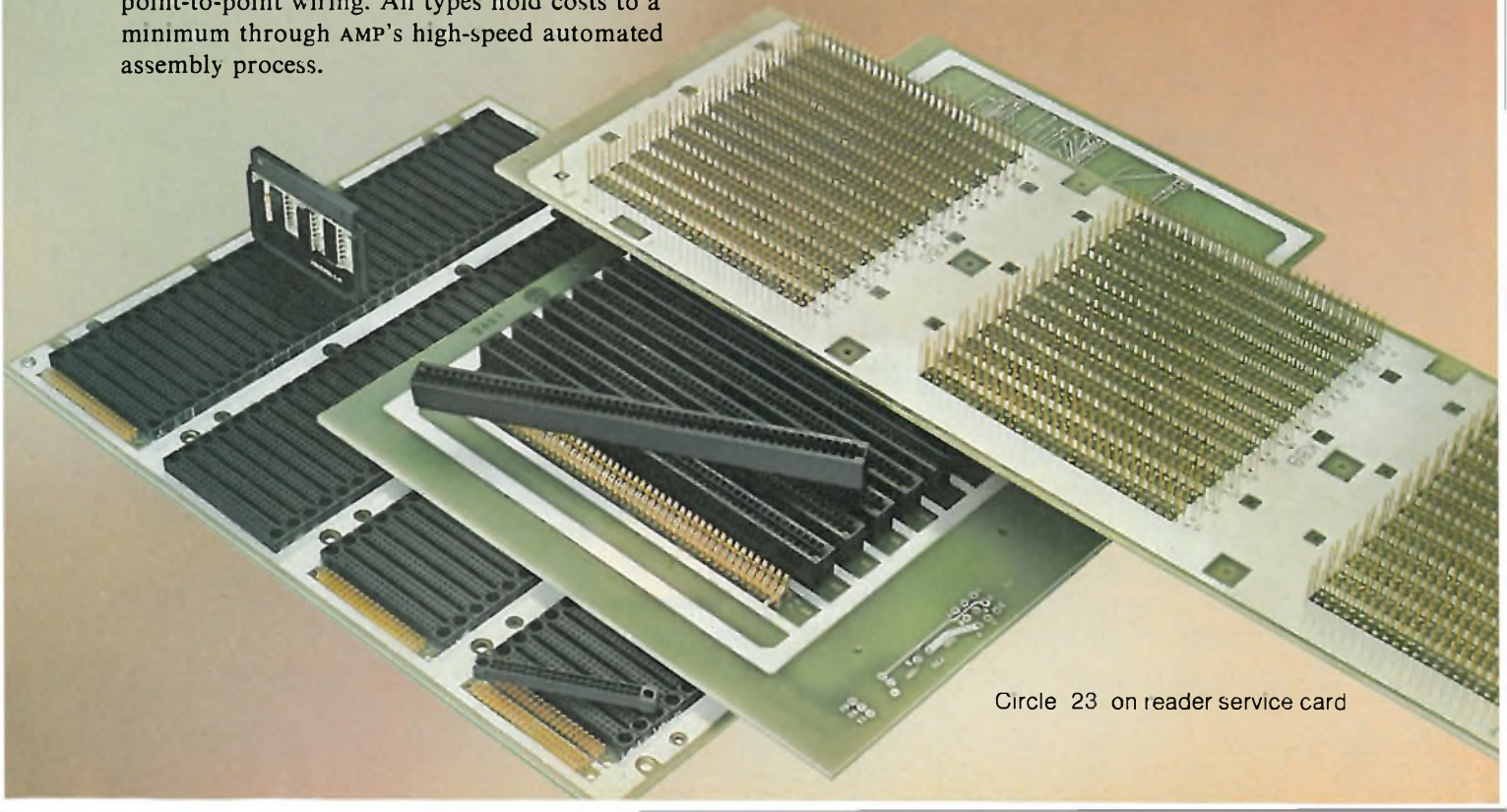
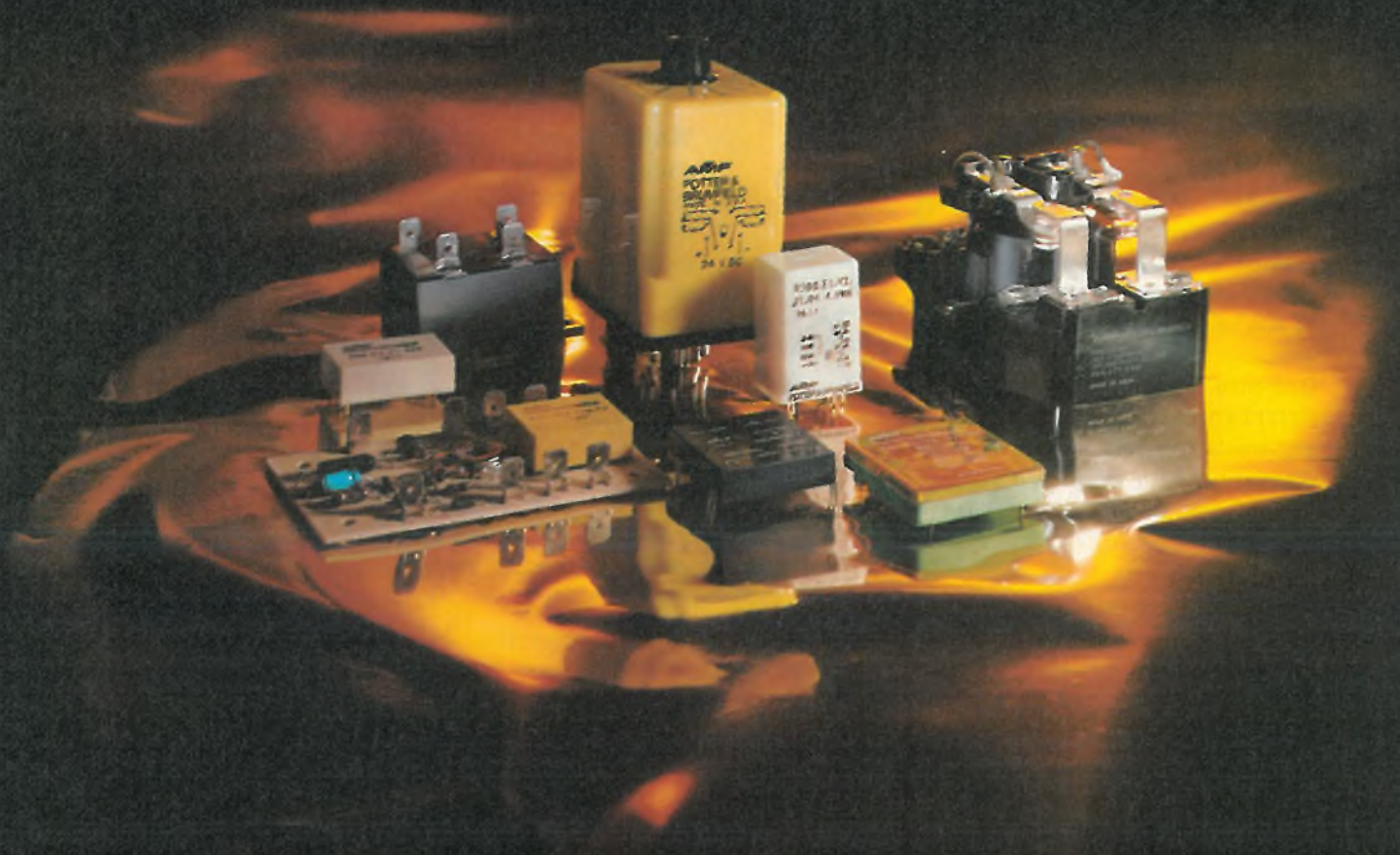


New from Potter & Brumfield



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1. R10S. Sensitivity to 5mW per pole. Available in 1, 2, and 4 Form C contacts. Ratings from dry circuit to 3 amps. Less than $3.00 in lots of 500.

2. R50 relays. Help you solve cost and space problems. Less than $2.00 in quantity, the R50 allows 0.6" center-to-center pc board spacing.

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4. R16 time delay module. Offers big savings at under $7.00 in quantities. Timing ranges, potentiometer adjustable, are 0.2 to 2, 2 to 30 and 10 to 100 seconds for delay on operate.

5. T10 series relays. Only 0.375" high. Ideal for high density applications—permit pc boards to be mounted on 0.5" centers. Two and 4 Form C contacts provide 0.1 to 3 amp switching @ 30 VDC. Coil ratings: 6, 12, 24 and 48 VDC.

6. JDO relays. Solid state switching with total opto-coupler isolation. Zero voltage turn on and zero current turn off minimizes EMI and RFI. Low profile permits pc board mounting on 0.5" centers. Coil ratings: 5, 6, 12 and 24 VDC. Shockproof.

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Solving switching problems is what we're all about.

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Electronics newsletter

Raytheon operates Impatt at C band with 25% efficiency

Researchers at Raytheon Co. have taken a significant step closer to the goal of getting maximum power and efficiency out of microwave and millimeter-wave solid-state sources. For Impatt diodes used at these high frequencies, the firm's Semiconductor Research Laboratories in Waltham, Mass., has set a power record: **11 watts at C band with an efficiency of 25% to 30%.** And by placing the diodes in a specially designed combiner, Raytheon has obtained a continuous-wave output power of 63 W—a combining efficiency of 92%.

That figure exceeds the 75% to 80% maximum efficiency obtainable with standard combiners, says Robert L. Bierig, manager of the lab. And that output of 11 to 12 W is roughly twice what had been achieved with 6-gigahertz (C-band) diodes in the past, he says.

Hitachi video disk uses holograms, spins at 6 rpm

Another optical approach to video disk players—this one using holograms—is being taken at the Tokyo central research laboratory of Hitachi Ltd. At the lab, a model of a disk 30 centimeters in diameter plays 30 minutes of color pictures and sound.

The disk contains 54,000 holograms, each of which stores luminance, chrominance, and sound information superimposed in an area that's only 1 millimeter in diameter. **This storage density is so high that the disk need turn only six times a minute.** The two other optical video disks, one developed by the team of Philips N.V. and MCA Disco-Vision Inc. and the other by Zenith Radio Corp. and Thomson CSF, require 1,800 rpm. And the RCA Corp. system stores picture information as a series of capacitance changes [*Electronics,* June 12, p. 30]. Hitachi has not yet announced whether it will market the system.

Reticon readies 1-k analog delay device for $10

Look for Reticon Corp. of Sunnyvale, Calif., a manufacturer of n-MOS image-sensing arrays and analog processing devices, to make its first leap into the consumer-oriented market. The means will be a 1,024-bit n-channel bucket-brigade analog delay device priced at under $10, or less than 1 cent per bit.

Designated the SAD (serial analog delay) 1024, the device is **designed primarily for variable or fixed delay of analog signals and general audio applications,** including speech compression, voice scrambling, reverberation, and echo and chorus effects in electronic organs and musical instruments. Containing two independent arrays of 512 storage elements in a 16-pin ceramic dual in-line package, the device features a dynamic range in excess of 75 decibels, signal bandwidth of greater than 100 kilohertz, sampling frequency from 1 to 2 megahertz, and less than 1% second harmonic distortion.

Engineers, public disagree over U.S. technical rank

Evidence that America's engineering and scientific community isn't getting its message through to the general public is provided by two new surveys measuring attitudes about American technological leadership. The surveys were performed by Opinion Research Corp. of Princeton, N.J.

The first study shows that **the bulk of the population thinks the Fed-**

eral Government is doing "about the right amount" to maintain a worldwide leadership position. It also concludes that this area is "of relatively little concern in comparison with other problems facing the nation." But the second survey, covering replies from a national cross section of 3,253 engineers, shows that they, by a 2 to 1 margin, think **American "scientific and technical leadership has deteriorated rather than improved in relation to other industrialized countries."**

Among EEs questioned, 44% agree that the U.S. position has weakened, 30% believe it has stayed the same, and 21% say that it has improved. However, U.S. electronics gets a high mark among all the engineers surveyed: 11% believe that U.S. electronics technology is lagging and 42% say it's holding its own. Some 40% believe that it is making "outstanding progress."

NEC to build Intel's 8080A microprocessor

Nippon Electric Co. in October will start sales in Japan and the United States of an 8-bit microprocessor that is pin-compatible with Intel's 8080A. For present users, NEC will also continue production of its independently designed CPU, which is the same electrically. NEC's first microprocessor has three levels of interrupt and direct transistor-transistor-logic drive. **However, Intel's model 8080A includes these features.**

Hitachi Ltd. is also contemplating expansion of its 8-bit microprocessor repertoire beyond its single independently designed CPU to include the 8080A or Motorola's 8-bit microprocessor. An Intel-compatible chip is also being made jointly by Mitsubishi Electric Corp. and Oki Electric Co.

Canada slaps dumping penalty on TV makers

The Canadian Government has found the major television set makers of the U.S. and Japan guilty of dumping **and has imposed provisional dumping duties of about $100 a set.** The penalty covers color sets with 16-inch screens and larger. The decision will prove a boon to Canadian set manufacturers, which have to charge more because of their smaller market, and are trying to regain their 70% market share.

Present import duties, which range from 15% to 30%, are temporary until Canada's Department of National Revenue reaches a final and binding decision. Most hurt by the new duties are Canadian catalog merchandisers committed to the previous price structure.

Addenda

Scientific Micro Systems, a Sunnyvale, Calif., subsidiary of Corning Glass Works, is entering the single-chip microprocessor market **by "unbundling" its MicroController system.** The bipolar unit has been offered as part of a controller on a printed-circuit board, which also holds 256 bytes of read/write memory and up to 4,096 bits of ROM program storage. Now, SMS will offer the Schottky TTL microprocessor as a separate part in a 48-pin dual in-line package. . . . A small Atlanta, Ga., company, Stop-Loss Inc., has come up with a shoplifting security system **using a tag that doesn't have to be removed at the time of sale.** The tag, made of magnetic material, is applied directly to the item. A salesperson must place the item into a bin where the tag is deactivated before the sale can be rung up.

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"We like them because they're easy and accurate to use.

You'll like them because of selection, features and price."

You'll also like Cherry quality. The kind of quality you always hope for . . . but that is only realized when a company (like Cherry) has total in-house manufacturing capabilities. To make sure the thumbwheel or leverwheel switch you order is the finest available. Anywhere. Combine this dedication to quality with the broadest line and lowest prices, and you'll understand why our customers say "thumbs up" to Cherry thumbwheels.

NEW! The smallest thumbwheel switch of them all.

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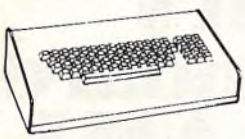
For complete data and specs: TWX 910-235-1572 . . . or PHONE 312-689-7700 . . . or circle reader service number.



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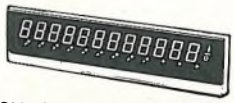

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Fiber-optic cable getting connector for use in field

Corning Glass and Deutsch team up to produce first single-fiber-per-channel unit; product coming by December

The great barrier to using fiber-optic cable has been the unavailability of an easy-to-use, low-loss method for connecting cables in the field without cumbersome splicing. Now, however, engineers at Corning Glass Works, Corning, N.Y., believe they have the kind of connector that's needed. Working with the Electronic Components division of connector manufacturer Deutsch Co., Banning, Calif., they've come up with a design that Deutsch may have available commercially by the end of the year. A preproduction model to be ready in September will accommodate Corning's six-fiber Corguide cable [*Electronics,* May 15, p. 121].

The new connector requires neither grinding, polishing or gluing of the fibers nor costly precision operations. Although the ends of the optical fibers are aligned precisely, precise optical tolerances for mechanical parts are unnecessary. The fibers, held in place by a matrix of plastic cylinders, are butted up firmly against their mates so that light passes directly from one fiber to the next.

Experimental results. Typically, the loss through a joint of the prototype connector is a relatively low 0.3 decibel, mainly because of offsets in the angular or lateral positioning of the mated fibers and a slight separation between the mated pairs. "Reconnectability seems excellent," says Frank L. Thiel, manager of applied electrophysics at Corning. "We haven't done a complete analysis yet, but variations in measured loss with repeated mating cycles hasn't exceeded 0.1 dB."

In the connector, the wall of each glass fiber is held firmly in an opening formed by the sides of three compressible plastic cylindrical alignment structures (shown at the top of page 30). Each set of three alignment rods exerts pressure toward the center, much as a three-jaw chuck holds a drill bit.

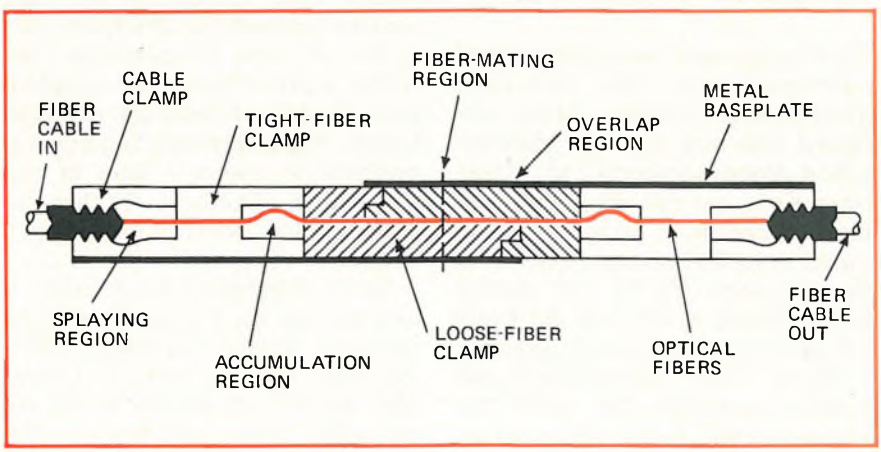
The opening between the alignment cylinders can be held to within a fraction of a micrometer, even though the diameter of the cylinders varies by 1 millimeter or so—a tolerance that can be expected in inexpensive molding materials, Thiel says.

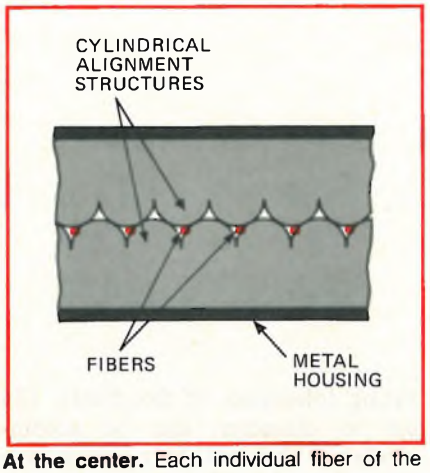
In addition, since the alignment material is compressible, manufacturing tolerances of the fibers, 125 μm in diameter, can be accommodated, and still their centers line up within a small fraction of a micrometer. The diameter of the alignment rods lets smaller fibers merely contact them, whereas large fibers slightly deform them. Forces on the fibers are symmetrical so that the fiber centers don't move.

Getting it together. The optical fibers are prepared in the same way as individual wires of a conventional electrical cable. The ends of the two cables to be joined are cut by a standard tool. They are then pushed into the connector from opposite directions, splayed out, and led, fiber by fiber, into the grooves formed by the contiguous cylindrical surfaces of the alignment structure. Once set in place, the connector halves are clamped together and each fiber is positioned by the three cylindrical surfaces.

The fibers are slightly too long,

Good fit. Entering from opposite ends of the connector, individual fibers of fiber-optic cables are splayed out, then butted up against each other. Metal housing secures the fibers, which are held in place by compressible plastic rods, as shown on the top of page 30.





At the center. Each individual fiber of the fiber-optic cable is held in place by cylindrical rods built into the connector housing.

the excess length feeding back past the clamped region to where the fibers are allowed to bend. The slight bending exerts enough pressure to keep the fibers forced against each other.

Crosstalk isolation is better than 70 dB because the alignment structures are opaque and prevent light from coupling between fibers. "This is extremely important when using each of the fibers as a separate information channel," says Thiel, who adds, "Actually, we had to stop at 70 dB because that was the limit of the measuring system's dynamic range." □

Fiber optics

Glass interconnects fly-by-wire control

Fiber optics may be chasing digital techniques into the fly-by-wire flight-control systems being designed into new aircraft. Marconi-Elliott Avionic Systems Ltd., Rochester, Kent, has run fiber-optic links between the three fly-by-wire computers in its flight control system for the prototype YC-14, the Boeing Co. candidate in the U.S. Air Force advanced medium STOL program.

When this short-takeoff-and-landing prototype flies next year, M-E says it will be the first practical demonstration of fiber optics in avionics. The Boeing plane will compete in a flyoff against a candidate from McDonnell-Douglas Corp., which will have a more conventional flight-control system. In the M-E fly-by-wire system, three parallel-acting digital computers, instead of the conventional mechanical linkages between the stick and rudder, translate the pilot's commands into signals to be sent via electrical wires to the aircraft's control surfaces.

Immunity. Besides weighing less than electrical cables, fiber optics are immune to electrical interference or transients. "A blowup of one computer can't electrically affect the other computers," explains project leader Howard Pearce. This is important because the computers, which process at a 250-kilobaud serial data rate and share the flight-control load, must precisely monitor each other's performance in the fast-acting system.

To ensure reliability, the system is arranged so that each computer has its serial electrical impulses converted to optical information and vice versa within its own junction box. Within that junction box is an optical splitter connected to splitters in the other two junction boxes by optical cable. The cables contain four bundles of 100 fibers each, providing one transmit and one receive channel to each of the other two computers. The fibers are low-loss multimode glass, each 50 micrometers in diameter.

Gallium-arsenide light-emitting diodes were chosen as the light sources because the absorption loss is low at their 930-nanometer infrared wave length, and standard p-i-n diodes are used for photodetectors. The connecting housings are designed to ensure a tight fit and good fiber alignment for low attenuation loss, which is about 3 to 4 decibels.

Each three-meter-long cable is housed in a polyvinyl-chloride sleeve to provide a strong but flexible tube, Overall, since the optical fiber has an attenuation of 0.1–0.4 dB/meter, the system has an adequate performance margin, the company says, adding that the design conquers such bugbears as fiber breaking and attenuation from heat loss.

More to come. Perhaps equally important is that the fiber-optic unit will pave the way for more fiber-optic avionics systems. Use in digital engine control systems is one possibility. M-E also envisions that the large bandwidth capabilities of fiber optics will lead to its use in large transports in such gear as integrated flight, navigation and multiple display systems.

Components of the fiber-optic system are available off the shelf, including the fibers from Schott and Gen's Jena Glasswerke, Mainz, West Germany, and the connectors and splitters made by Bowthorpe-Hellermann Ltd., East Grinstead, Sussex. □

Military

Air Force plans radar balloons

Seeking to extend its over-the-horizon capabilities while holding down system costs, the Air Force is stepping up its development of balloon-borne radars by creating a new program office at the Electronic Systems division, Hanscom AFB, Mass. Deadline for establishment of the office, an outgrowth of the Seek Skyhook project, is year's end, according to a program management document now being circulated at the Pentagon.

Seek Skyhook is currently funded at about $500,000 which covers tests of a Westinghouse Electric Corp. balloon-borne radar tethered at about 10,000 feet over the Florida Keys. The system is operated by the Aerospace Defense Command and Range Measurement Laboratory at Patrick AFB, Fla.

Competition. Officials at the Command and Control division of Westinghouse, Baltimore, estimate they have received approximately $3 mil-

lion in DOD funds since military interest began about five years ago. But if the Air Force's plans to acquire new systems over the next two years produce procurement of blimps and their radar packages, competition is expected to increase, bringing in such radar makers as General Electric, Raytheon, and perhaps Hughes Aircraft, as well as blimp builders like Goodyear Aerospace.

The essentially stationary nature of a balloon eliminates much of the ground clutter that afflicts down-looking radars in moving aircraft like the E-2C Hawkeye and the Airborne Warning and Control System, USAF advocates point out. They add that balloon costs, too, are no more than 10% of those of an aircraft. Also, Seek Skyhook extends the capability to detect attack aircraft flying at 50 to 500 feet to 125 nautical miles, beyond the range of ground-based systems.

The present 17-by-4-foot Seek Skyhook antenna is capable of 360° scan, while the larger antennas of Hawkeye (22 by 2 ft) and Awacs (24 by 5 ft) require complex and costly mechanical rotodomes to achieve the same capability. Onboard power supplies are presently a limitation of Seek Skyhook, says Westinghouse project engineer James F. Patton. Compared to the 120 kilovolt-amperes available to a radar in a Boeing 707, the Seek Skyhook is limited to about 15 kilowatts. A tether cable now in development will be able to conduct more power to the balloon from a generating source on the ground.

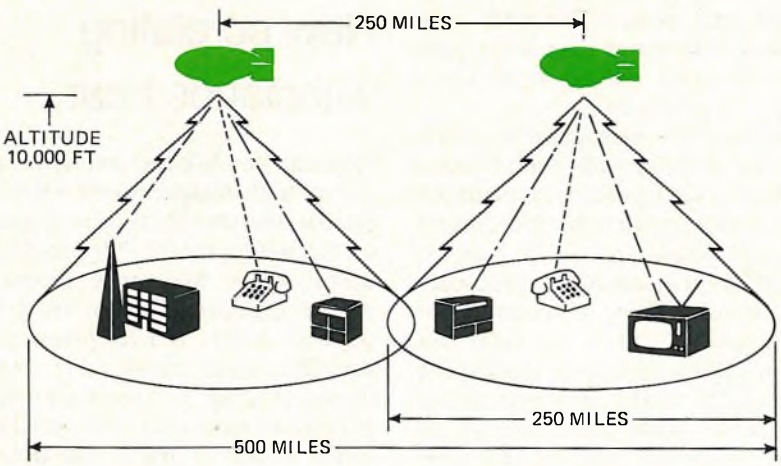
Past imperfect. Prejudice is the principal enemy of blimp buffs anxious to sell their tethered radars to the military, according to Patton at Westinghouse. Pentagon reactions "range from incredulity to hilarity," he says. If this kind of resistance can be overcome, Westinghouse officials see a large potential market in the long term.

The Naval Air Systems Command and Coast Guard are both researching antisubmarine warfare and reconnaissance applications [*Electronics*, Aug. 7, p. 63]. So is the Army, which sees a potential for small tethered blimps as "mini-satellites" for tactical communications platforms. □

Blimps for broadcasting

The overseas commercial market for tethered Aerostats as TV and radio broadcast platforms is currently developing faster than military radar usage, particularly in developing third-world nations. TCOM Corp., Columbia, Md., a subsidiary of Westinghouse Electric Corp., which has been pushing tethered-balloon technology since the late 1960s, says it expects to have its first three broadcast blimps operational in countries overseas before the end of the year.

The first, already in flight test in South Korea, costs about $7 million and will serve the northern sector of that country. The other two, ordered by National Iranian Radio and Television for $10 million, will serve the southern and southwestern portions of that country. The 175-foot long, non-rigid Aerostats are built by Sheldahl Inc., Northfield, Minn. Each has a 250,000-cubic-foot volume capable of supporting 3,500 pounds of transceiving and power-generation equipment in hurricane-force winds when tethered at 10,000–15,000 feet.



Photovoltaics

Solar cell plan goes to Congress

The Ford Administration's 10-year plan for solar-energy research and development, including photovoltaics, was sent this month to a Congress anxious to accelerate solar energy use in the United States. The report adds some detail to the objectives for development of solar cells that had been partly disclosed by the Energy Research and Development Administration in June [*Electronics*, June 12, p. 75]. However, the report still seems to lack a few details and specific schedules.

The Federal Government's long-range solar-energy plan is to develop solar-electric concepts, such as wind power and solar cells, as primary sources of energy in the next century, when fossil-fuel resources will be depleted. ERDA predicts that total industry production would reach 500 to 1,000 megawatts by 1985, largely by applying silicon solar-cell technology, at a price of 50 cents per watt. The plan includes:

- A series of Federally sponsored tests and demonstrations of a wide variety of applications of solar photovoltaic-conversion systems, including tests of applications developed for the Defense Department.
- Initial demonstration of multi-

100-kilowatt systems by the late 1970s and demonstration systems producing as much as 10 megawatts by the early 1980s. Preliminary study contracts for these systems have been awarded in July to Westinghouse Electric Co., General Electric Co.'s Valley Force Space Center, and Spectrolab Inc. [*Electronics*, July 24, p. 36].

Developing standards. While the demonstration projects are under way, ERDA officials hope to develop performance standards and data to decide whether solar-cell-powered central power stations can be built. Key decision points are:

- During this fiscal year, to specify interim measurement techniques for tests and standards and have photovoltaic-test facilities operational.
- During the late 1970s, complete system-design specifications for large-scale systems. Also in the 1970s, ERDA will initiate demonstrations of residential systems costing $5 per watt and using optical lenses to increase the concentration of radiation on the solar cells. (Present photovoltaic-cell arrays cost nearly $20 per watt.) ERDA also wants to demonstrate the feasibility of manufacturing solar arrays for 50 cents per watt.

The energy administration recently informed Congressional committees (but did not include in the report) that its solar-energy plan would cost at least $1.4 billion from fiscal year 1976 to 1981. A "quickie" study by Mitre Corp.'s Washington office produced the cost estimate, an ERDA budget official says. Mitre also "guesstimated" that $350 million would be needed for the photovoltaic development planned. □

Microprocessors

Distributor offers processor kits

A microprocessor needs many other components to turn it into a functioning microcomputer. And potential users have had little alternative but to invest thousands of dollars and months of engineering time in prototype designs.

But now Cramer Electronics, a nationwide electronic parts distributor in Newton, Mass., is trying to cut that cost below $500 and the time to less than a week with kits that contain everything needed to build a microcomputer. Each kit contains about 150 components and comes with wiring diagrams for a computer that has been optimized around the particular microprocessor chip selected.

The microcomputer kits, designed for Cramer by Microcomputer Technique Inc., a microprocessor consulting firm in Reston, Va., are now available for the Intel 8080A, Motorola M6800, and Texas Instruments TMS8080 chip. Also included with the kits are a user's manual and a magnetic-tape cassette with a prerecorded test program. Later in the fall, another kit built around Advanced Memory Devices' 9080 chip will be introduced.

Cutting costs. "The idea behind the kits is to make microcomputers low enough in cost so that everyone who could conceivably use one can have one," says Micromputer Technique's founder Jerry Odgin. "We asked ourselves what would the designer want if he spent six weeks of his own time, and that's what we ended up with."

Delivery of the kits is slated to begin in September. Cramer's executive vice president A.J. DiNicola predicts that 15,000 kits will be sold in the next year. "The price is as much as 50% lower than if the parts were bought on an individual basis," he points out.

Besides the microprocessor chip, each kit includes 1,024 8-bit bytes of random-access memory, expandable to 64 kilobytes with the first 16 kilobytes decoded, and 1,024 bytes of erasable programable read-only memory containing a system monitor. Each kit also contains four input/output ports each 8 bits wide, expandable to 512 ports with decoding for 16 ports, plus support circuitry, controls, displays, and interfaces. As options, Cramer will supply boards and power supplies.

Expansion. By mid-January, Cramer expects to add kits for Mostek's F8 three-chip set and RCA's Cosmac TA6889 two-chip set and is also looking at the possibility of offering a bipolar microcomputer kit early next year. In addition, Cramer will offer kits for related equipment such as a switch-programable ROM programer.

The reason for Cramer's interest in the kits is simple—as a distributor, it stands to profit on the sale of microprocessor chips. With the design kits, it hopes to make things easier for the potential customer. Other distributors have also been getting involved with microprocessors. Some have offered themselves as consultants for engineering and programing, opened centers to demonstrate hardware, and provided cross-assemblers and simulators [*Electronics*, June 26, p. 78].

In 12 locations around the country, Cramer is also opening design centers with programing and test equipment that can be used by customers to conduct engineering final tests and to program and debug their microcomputer systems. Each center will be manned by consultants from Microcomputer Technique. DiNicola notes, "we will be careful to leave selection of the micro to the customer, whether we have it in stock or not." □

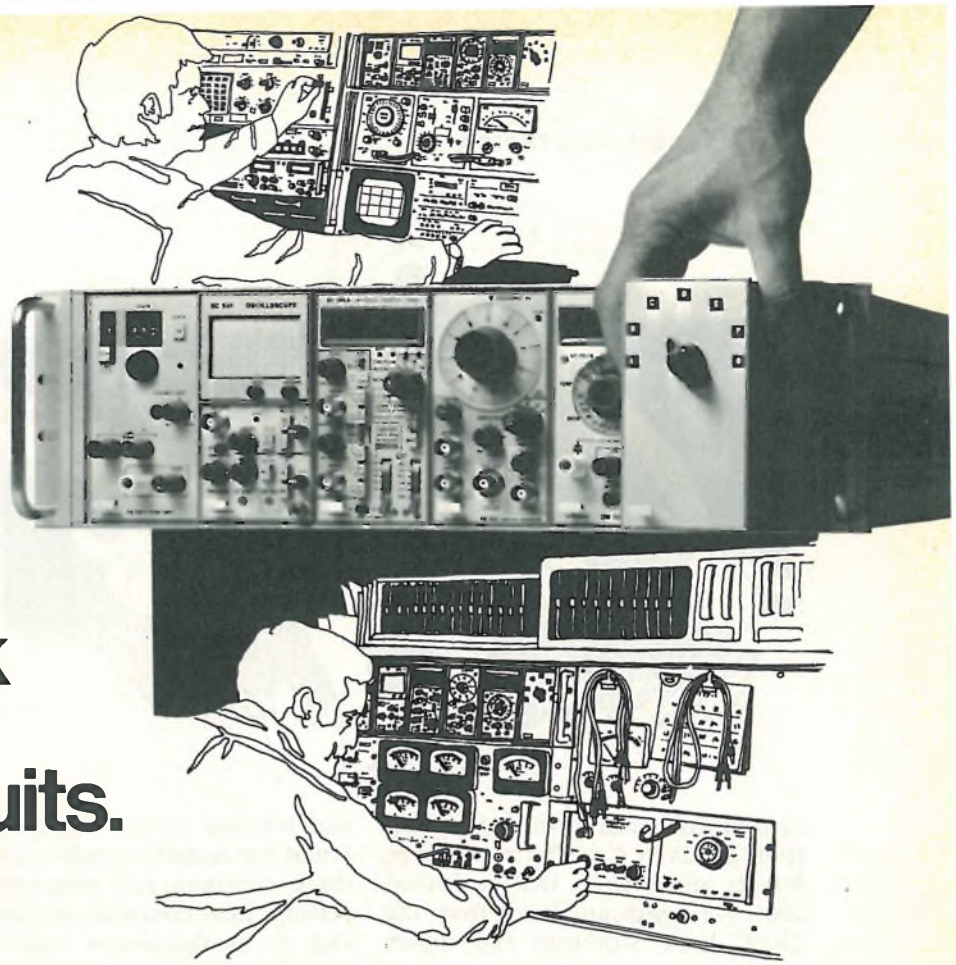
Packaging & production

New pc plating withstands heat

How can you life-test transistors and ICs at high temperatures when the boards and sockets they're mounted on fail before they do? It couldn't be done when Motorola Semiconductor Products division tried life-tests at 200°C a half-dozen years ago. But, after painstaking experiments leading to the adoption of polyimide laminates and beryllium-nickel socket contacts, the division has cleared the final hurdle with a

Tektronix TM 500

a line of 29 test instruments that go six-in-a-rack including custom circuits.



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A common interface circuit board within the mainframe permits the intercommunication of inputs, output, and various parameters among the plug-ins. Tektronix will supply you with data on voltages, currents, and pin connection diagrams, so you can determine the feasibility of assembling your special circuits in blank TM 500 plug-in kits.

The TM 500 family of instruments is designed to fulfill your test and system needs in such widely divergent areas as high-speed logic; dc, power line frequency, audio, and rf to 550 MHz; oscilloscope and other instrumentation calibration; and even medical instrumentation calibration. They represent Tektronix standards of quality in design, performance, and ease of operation. Included are pulse generators with features such as independent pulse top and bottom controls and repetition rate to 250 MHz. And the DC 505A Universal Counter/Timer features direct counting to 225 MHz and time interval averaging with resolution to 100 ps.

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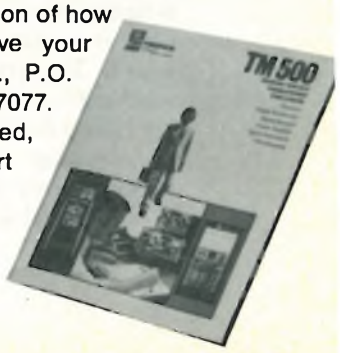

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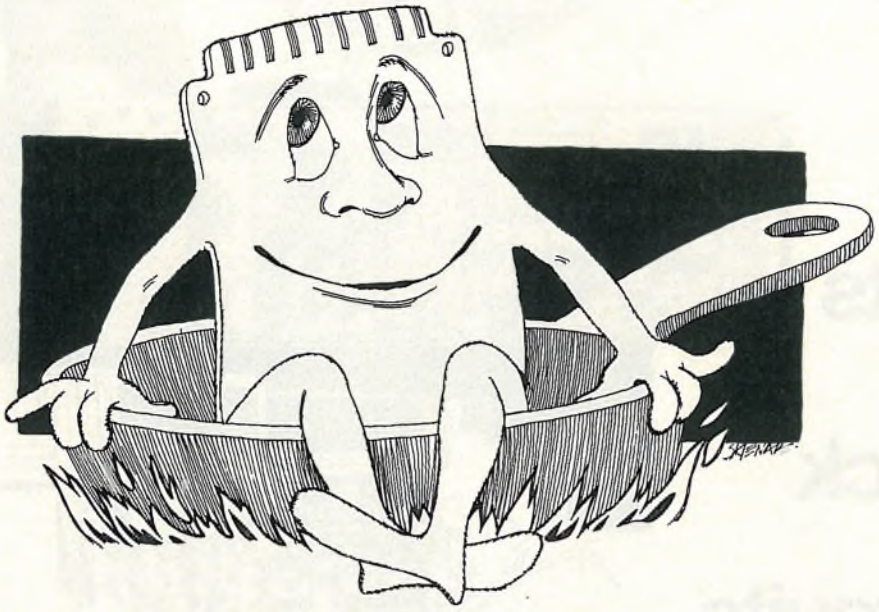


new nickel-boron pc-board plating from Du Pont Co. The result is pc boards and sockets that withstand 200°C—a significant boost from the 150°C limit Motorola and others had been forced to accept.

"Originally, the basic [copper] stripes on the boards were plated with nickel-gold" to improve the copper's conductivity at high temperatures, says Robert Bauer, an equipment engineer in Motorola's life-testing group in Tempe, Ariz. After a short time at 200°C, however, gold migrates through the nickel to the copper, causing the contacts to fail.

Electroless coating. The improved plating alloy is Sylek 202, introduced earlier this year by Du Pont's Industrial Chemicals department, Wilmington, Del. A phosphorous-free, low-boron, electroless nickel coating, it does away with the gold migration problem and cuts material costs.

The coating is also being used by Motorola to plate the beryllium-nickel contacts on the semiconductor sockets that plug into the pc boards. This makes it easier to solder the sockets to the Sylek-coated board. The resulting board/socket combinations are expected to run for 10,000 hours at 200°C.

According to Bauer, "The new plating resists wear. Solderability is excellent and it allows us to rework and resolder parts." Motorola also found the material yields uniformly thick coatings and through-hole plating. Low electrical conductance and no amalgamation with solder are other advantages. □

Industrial

Fault detectors getting mine test

The push to boost U.S. coal production as an alternate to petroleum has triggered an effort to make mines safer—particularly to prevent fires caused by low-current electrical shorts across power lines. Arthur D. Little Inc. of Cambridge, Mass., has just completed a prototype to detect such shorts, and a system developed by Westinghouse Electric Corp. is already being tested in a Pennsylvania mine.

Both systems were developed under grants totalling $400,000 from the Bureau of Mines Research Center, Pittsburgh. Officials point out that circuit breakers already protect the high-current trolley lines that supply up to 3,500 amperes dc to coal-carrying locomotives in the mines. But the Westinghouse and Arthur D. Little systems are designed to detect the low-current, 15–30-A faults that occur when equipment or coal accidentally makes paths between the overhead trolley lines and ground.

Monitor. The Arthur D. Little system monitors the direct current being put out on the line. It compares this level with the amount of power that encoding transmitters say each piece of equipment is using. If too much dc is going out, there's likely to be a fault on the line, and the circuit breakers can be automatically tripped.

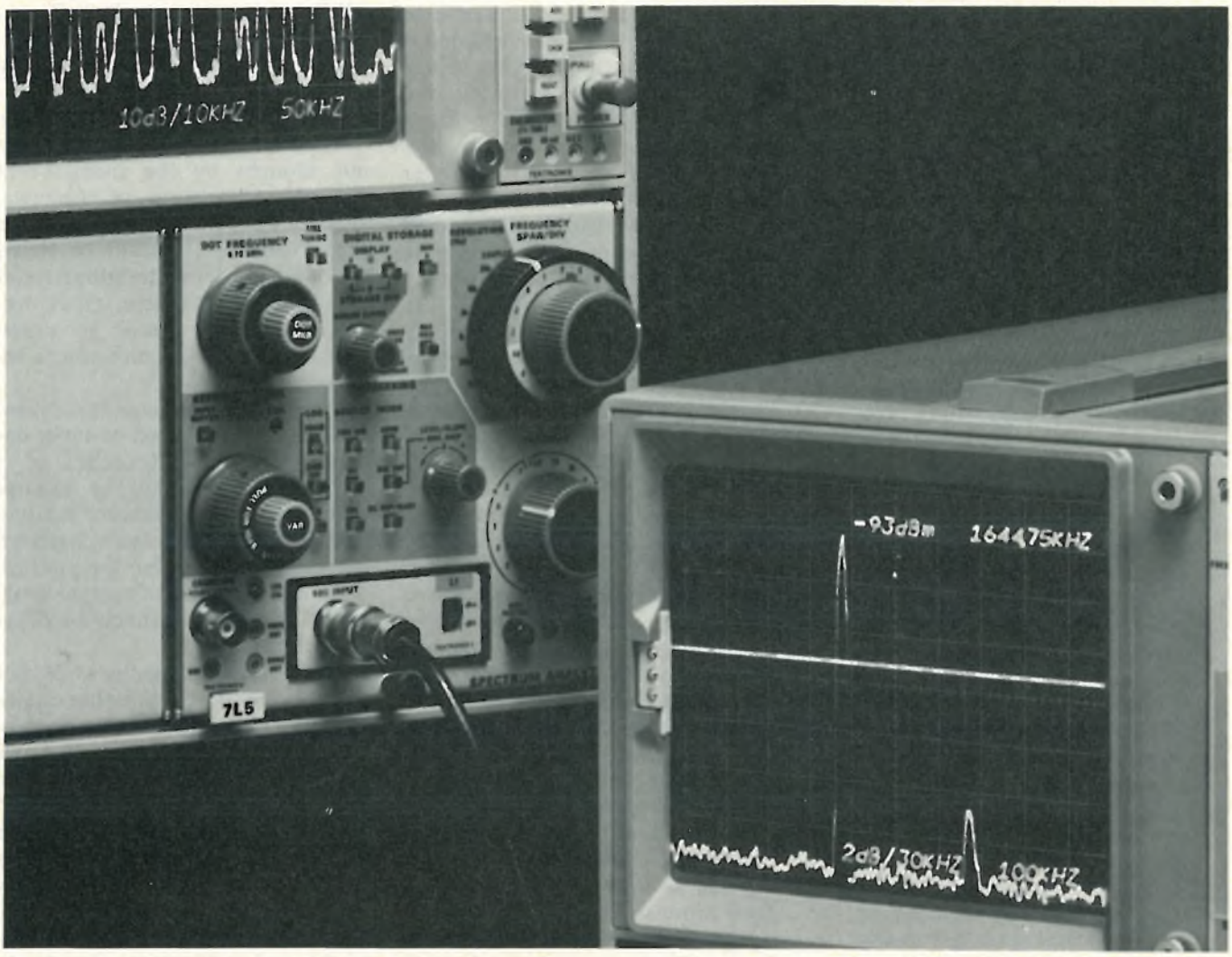
The Westinghouse system, built by the company's Research and Development Center in Pittsburgh, resembles one developed in France—it monitors the level of an ac signal which it superimposes on the trolley lines. It adds a 10-volt, 3-kilohertz voltage to each of the dc power distribution segments—feeder and trolley lines with a grounded rail return—into which the 300-V trolley lines in a mine are divided. To prevent the legitimate loads from drawing on the ac power, each is equipped with a filter, either a series inductor for relatively small loads like fans or pumps or an active filter, developed by Westinghouse, for the large 3,500-A automotive loads.

Tuned transformers located at the power substation encircle the dc feeder wires to detect the presence of a 3-kHz current. If the current reaches 15 A and lasts more than a half second, the breaker trips.

Digital code. In ADL's "differential current fault detection" system, the dc level being drawn by each load is translated into digital form and transmitted via a loop antenna strung through the mine to a summing point circuit. There the individual currents are added and compared with the dc being supplied by the power substation. A logic digital processor determines whether the power-station current is too high. If it is, the system sends out a warning signal or trips a circuit breaker.

Each segment of the system can handle up to five loads, each transmitting at a different carrier frequency. To minimize interference in adjacent trolley-line sections, one of

A new spectrum analyzer– you set center frequency with 6-digit resolution–and it stays there.



The new 7L5 5-MHz spectrum analyzer has exceptional frequency accuracy, stability, and 6-digit resolution thanks to a combination of synthesizer and digital technology.

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7L5 Spectrum Analyzer (requires plug-in module)	$4,500
L1 Plug-in Module (50Ω)	300
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10 frequencies can be selected.

The transmitted signal also contains an identifying prefix code. Thus, when a load crosses from one section to another, it acquires a new prefix and frequency from a communications link controlled by the processor at the summing point. The system could, in the future, also be used to transmit an identifying number so that all loads in the system could be identified.

Tests with the Westinghouse system are continuing. There are no firm plans yet for testing the Arthur D. Little system. A Bureau of Mines official estimates an operational system won't be ready before 1980. □

Lasers

Helium-neon laser gets second source

Students of technology often point to the parallels between the development of lasers and of semiconductors. Although the phenomenon of transistor action was discovered by using germanium, ruby material was used to develop lasers. And as germanium was quickly replaced by silicon for most commercial applications, ruby was replaced by the more efficient and less costly helium-neon laser technology.

But there the parallels end. Even though the semiconductor industry has learned the value of, among other things, second-sourcing as a way to lower costs and expand the market, this lesson, until recently, has been overlooked by the laser industry.

Now, however, Coherent Radiation Inc., of Palo Alto, Calif., reflecting the experience of its president, Pierre Lamond, former manufacturing vice president at National Semiconductor Corp., is planning to be the first to second-source a laser—the Spectra Physics Corp. model 136 helium-neon laser, priced for mass markets [*Electronics*, June 13, 1974].

Mass-produced. The 136 was the first low-power—1 to 2 milliwatts—helium-neon laser to be mass-produced as a component for use in high-volume original-equipment applications such as point-of-sale systems, video disk scanners, and facsimile applications. When introduced, it had 33% fewer parts, 50% lower materials costs, and 40% fewer manufacturing steps than other standard lasers. And the 136 pushed laser prices below the magic figure of $100 each in quantity.

Coherent Radiation's CR 136 Eyelite, says Lamond, is a true second source in that it offers plug-in interchangeability with Spectra Physics' helium-neon tube. Alignment of the optics is not needed. Priced at about $126 in single quantities, the CR 136 will sell for about $50 each in large 2,000- to 5,000-unit orders, Lamond says.

"To date there are only three or four viable large-volume suppliers of helium-neon tubes to serve what is now a $10 million OEM market," he says. "It could be 10 to 100 times larger if it were not for the limits placed on it by the lack of standardization. Helium-neon—indeed almost every type of laser developed—is of unique design."

But one major need of OEM users is multiple sources for the same products—plug-compatibility—a need more often met by non-laser equipment, Lamond points out. "If the laser industry is to continue to grow, it must tap these large-volume markets," he says. "If it is to do this, it must learn the value of second-sourcing, and our plans don't stop with the 136." □

Commercial

Banks get "no" on remote terminals

Electronic funds-transfer systems got a confusing jolt this month when a judge of the Federal District Court in Washington ruled that national banks may not set up computerized teller terminals away from bank premises.

"Frankly, the ruling is so broad it's difficult to interpret," says Russell Brown, assistant to U.S. Comptroller of the Currency James E. Smith. But other Federal banking officials expressed "shock and disappointment" at the decision of Judge Aubrey Robinson Jr. supporting a suit brought by the Independent Bankers Association of America. Pending the outcome of appeals, the ruling prevents Federally chartered national banks from installing credit authorization and debit/credit terminals in such places as supermarkets and other point-of-sale locations.

Judge Robinson ruled that terminals, either automated or teller-operated, constitute branches of a bank and would not be exempt from Federal regulations limiting their number. The state-chartered independent banks fear the proliferation of such terminals might overwhelm their comparatively small organizations.

The ruling runs counter to the position taken by Comptroller Smith last December when he said automated terminals were not bank branches and were, therefore, exempt from the regulations [*Electronics*, January 9, p. 50]. The Comptroller's office has requested a stay in the decision and plans to appeal. Until appeals are decided, however, it won't order the disconnection of equipment already in place or the halting of current projects.

"Most banks are ignoring the decision and continuing with their plans to install systems [off premises]," notes an official of the American Bankers Association. "There is so much confusion, this just appears as another anomaly." National bank officials are concerned, however, that savings and loan associations, unaffected by the ruling, may try to expand their off-premises terminal systems to fill what could become a gap in financial services.

Like the banks, hardware manufacturers aren't worrying yet about the possibility of off-premises banking being made illegal. "Orders are still coming in at an undiminished

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speed," says Oliver Woodburn, marketing manager of Honeywell Information Systems Inc., Waltham, Mass.

Asserts another manufacturer, Homer Kirby, "I am confident the decision will be reversed on appeal." Kirby is senior vice president and general counsel for Docutel Inc., Dallas, the premier maker of automated tellers with an estimated 80% share of the 3,000 tellers installed (mostly inside banks) to date. Kirby and others agree that the off-bank-premises issue will wind up in the Supreme Court. □

Hearing up in air on hiring case

There are likely to be months of legal haggling and corporate one-upmanship between National Semiconductor Corp., Santa Clara, Calif., and Fairchild Camera & Instrument Corp. of nearby Mountain View before the question of "Who can employ Martin J. Alter?" is answered.

Fairchild, for whom Alter had worked on high-density bipolar memories in the company's Isoplanar group, plans to do "extensive" discovery research, according to a spokesman, before a hearing is held on an injunction barring Alter from working for National, his new employer. The Fairchild spokesman can't estimate when the actual hearing should begin to determine whether Alter may work at National in a similar high-density bipolar-memory effort.

The legal battle began June 26 when a temporary restraining order was issued, at Fairchild's request, to prevent Alter from imparting proprietary information on its Isoplanar technology to National. It was issued by a superior court judge in San Jose, Calif., following an action in which Fairchild alleged National intended to "appropriate" Isoplanar technology by persuading employees familiar with it to take up jobs with National Semiconductor.

A preliminary, or "show cause" injunction hearing on July 22 before Superior Court Judge John Brenner has served only to further cloud the issues, since both sides claim the decision represents at least a temporary victory for each. Brenner's decision vacated the earlier temporary order restraining Alter from working at National. At the same time, however, Brenner enjoined

News briefs

MESFETs operate at high efficiencies
Schottky-barrier field-effect transistors, called MESFETs, have been developed at RCA Princeton Laboratories, Princeton, N.J., with the highest reported efficiencies of any solid-state devices operating at 4 and 8 gigahertz. Class-B amplifiers operated with power-added efficiencies of 68% at 4 GHz and 41% at 8 GHz. At the lower frequency, power output was 260 milliwatts and gain was 11 decibels; at the higher frequency, the figures were 280 mW and 8 dB.

Gillette embarks on watch development
Integrated Display Systems Inc., Montgomeryville, Pa., a joint venture of General Electric Co. and Solid State Scientific Inc., has signed a research and development agreement with the Gillette Co., the safety-razor maker. The agreement calls for IDSI to undertake R&D work on quartz modules for digital watches. Solid State Scientific will supply integrated-circuit chips to Integrated Display Systems. However, no marketing of a quartz digital watch is proposed by Gillette at this time.

Monolithic Memories to introduce microcomputers
Monolithic Memories Inc., a Sunnyvale, Calif., memory-components manufacturer, will offer a family of three microcomputers in its first venture outside the components business. The company has set up a new division, MMI/Systems, to handle the business and sell to OEMs. The first device, now being delivered, is the System 300, which is software compatible with Data General Corp.'s Nova minicomputers. The second, System 600, is scheduled for delivery in volume in the fall. The third, System 100, is scheduled for delivery next March.

Bendix underbids competitors by 50% for Omega flyoff
Bendix Corp.'s winning $382,000 bid in an Air Force three-way competitive flyoff for Omega airborne navigation systems is regarded by industry and military sources as reflecting the company's need to pick up new Government communications business. The Bendix price is slightly more than half the other winning bids of $729,000 by Dynell Electronics Corp. and the $659,000 of Tracor Corp. The very-low-frequency Omega system is designed to provide an interim solution to worldwide military air transport navigation in the decade between the phase-out of Loran A and operation of the Navstar satellite global position system in about 1987 [*Electronics*, Feb. 6, p. 69]. Up to 1,000 on-board Omega systems could be procured in July, 1976 for as much as $22 million, say Air Force officials.

New UMTA chief shy of electronics R&D
The new head of the Urban Mass Transportation Administration, Robert E. Patricelli, says that the agency will steer away from advanced electronics research and development in the future. "We shouldn't be into high technology. We have to concentrate on systems with near-term benefits," he explains. He wants the transportation agency to concentrate on improving transit systems already in existence and to discontinue its efforts on such projects as the Advanced Personal Rapid Transit System. [*Electronics*, Feb.20,p.68].

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National and Alter from using any unpublished Fairchild Isoplanar secrets in the development and manufacture of high-density bipolar memory devices.

Charles Sporck, president at National, says he is in complete agreement with the decision. "We feel it justifies our original position that Alter should be allowed to work in any product area he wishes," he says. "It's a matter of principle. We simply do not feel that any one can be forced to work in one area and not another. It's a form of slavery."

Defending his employment of Alter, Sporck says, "We look for competent people rather than people with specific proprietary information."

On the Fairchild side, company patent attorney Alan MacPherson says the issues involved in the case include "unfair competition, breach of confidential relationships, wrongfully attempting to appropriate trade secrets and confidential information, breach of contract, and inducing breach of contract." □

Add-on makers gain for the present

Unnoticed amid the news of the Xerox closing, the subsequent jockeying of rival mainframe and mini makers, and the anguished cries of Xerox users is the situation of the makers of add-on equipment for Xerox mainframes. At first glance, they might seem to be in for some rough sailing now that there are no longer any new mainframes to add on to. But there is a positive side after all, at least for the next few years, say the add-on makers.

Datum Inc., Anaheim, Calif., for example, recently developed a computer that emulates the Sigma 5 and 7 computers and can be sold as a second processor to give a system dual-processor capability. "The demise of Xerox has changed our thinking quite a bit," says Allan Devault, director of marketing for Datum's Computer Products division. "A number of problems that we would have faced in trying to add to Xerox systems just go away—such as would Xerox be in there with an add-on second processor of its own? And also the problem of service—if our equipment were added to an installed system, would the Xerox service organization pick it up?" Devault admits that this is a one-time business opportunity and is not "something I would bet a business on," but even if it's a mixed blessing, "it's more on the positive side."

Another add-on maker feels the same way. "In the short term, we feel that there will be significant new business for us," says Sam Edens, president of Telefile Computer Products Inc., Irvine, Calif. Telefile makes many types of Xerox add-on equipment, including magnetic-disk drives, printers, core memories, and data communications equipment. Although some Xerox customers will use the occasion to drop the Xerox line with little justification necessary to their own managements, some will keep the equipment. He says, one of the reasons being the Xerox CP-5 operating system, which Edens says is "one of the most fantastic software packages ever developed."

Xerox users wait for word

If Xerox Corp.'s sudden July 21 announcement about dropping out of the mainframe business sent its computer personnel into shock, the news jolted its customers into action. Organized for years as a user group called "Exchange," these Xerox customers know they have big trouble. "We don't have another vendor to go to," moans J.B. McAlpin, chairman of Exchange and chief of information systems at Western Electric. Because much of the XDS equipment was designed with input from the group, and developed for specific customer applications, it cannot be easily replaced. "Other suppliers can't even come close to the price," confirms another user.

The users wasted little time in trying to clarify where they stand in relation to the "legal and moral commitment" that Xerox acknowledges it owes to computer customers. Out of face-to-face meetings lasting several days between Xerox management and the Exchange executive board, a list of more than 100 "questions" was agreed upon and given to the company for a written response. Some users say these questions are really "demands" that must be met.

Critical areas. The most vital ones deal with what the users feel are the critical areas: quality of maintenance support for equipment, service, and spare parts. "The fact that Xerox has said it will honor existing agreements for seven years doesn't really have any meaning," McAlpin says. "What if their top service people leave, for example, or spare parts run out?" Although users expected the written answers as soon as last weekend, McAlpin says they will be only a beginning for negotiations lasting for months, or perhaps years.

"There's a big difference between a legal and a moral commitment," he says. "How does it apply to new products which Xerox has promised to develop for several of us, which we are planning on, when the promise is not in writing?"

What the users would most like, they agree, is for a stable company to acquire XDS intact and carry on all obligations. "We'll talk to any prospective buyer anywhere," McAlpin says. "I'd say about 90% of their products are excellent and could be profitable," another user commented.

A Xerox spokesman confirms that no layoffs have occurred at the computer operation and no top personnel have been lost but is tight-lipped about any other developments. It is known that Xerox is making a maximum effort to sell the entire subsidiary, and speculation has touched on many buyers, including mid-East interests and several firms outside the electronics industries. Xerox won't comment, except to note that the company soon hopes to have progress to report. □

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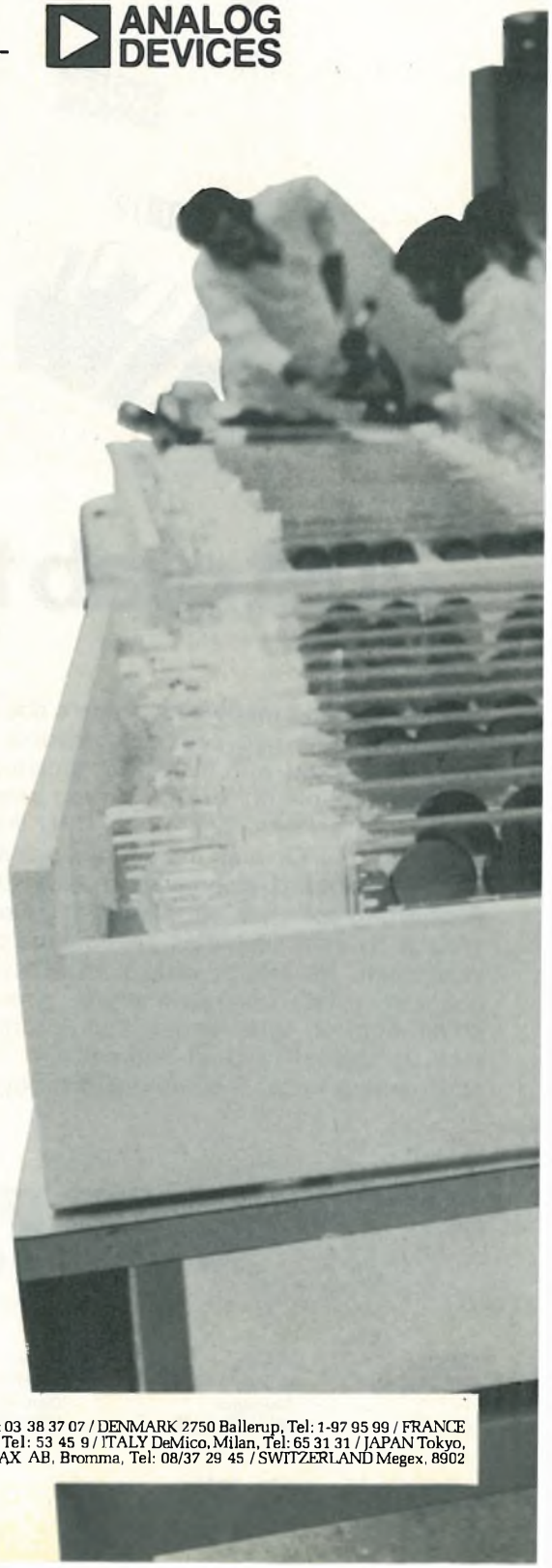

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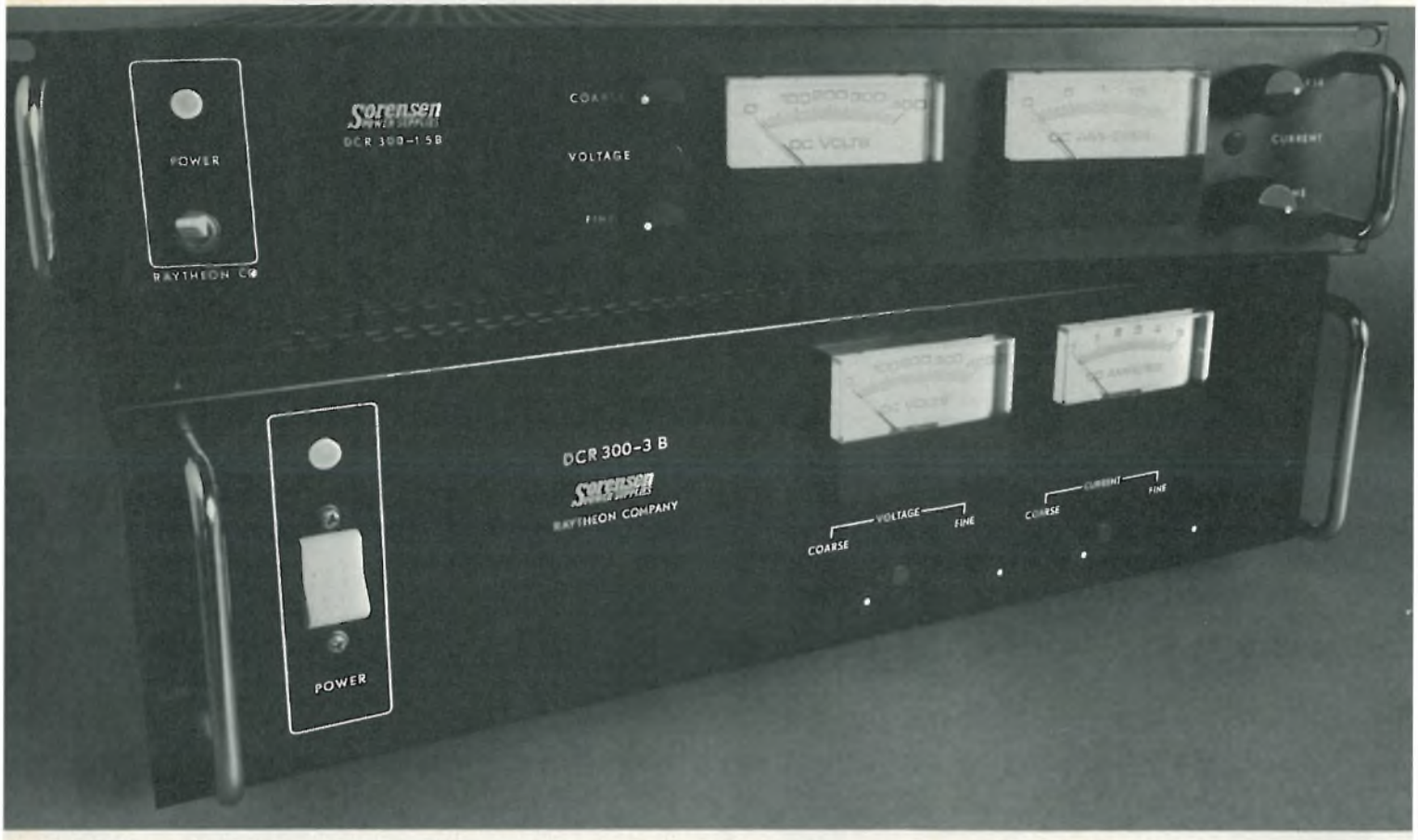

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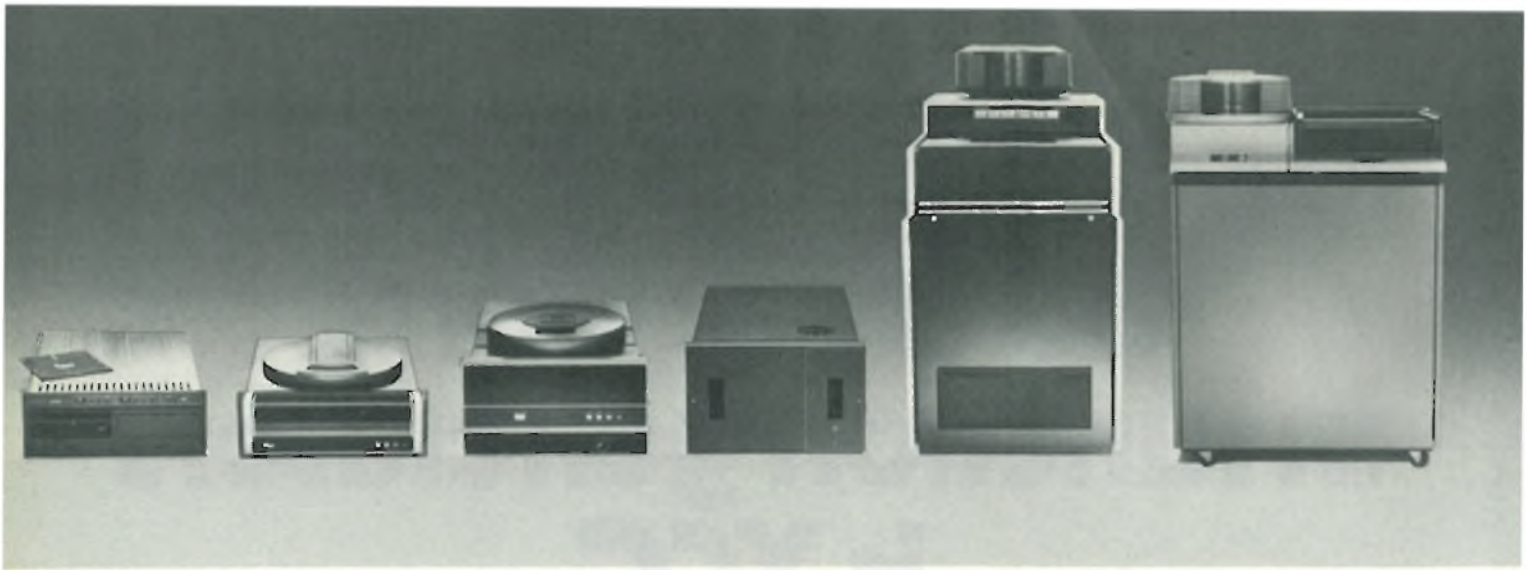

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AT&T-Iran pact portends further trade boosts

American Telephone & Telegraph Co. has entered the world communications market with its agreement with Iran to plan and engineer "an integrated national telecommunications system" for that country's needs over "the next 10 to 20 years." **"We may be able to bid on some equipment when it gets to the hardware stage in several years," admitted an AT&T spokesman.** Dollar value of the service contract is still being negotiated between Iran and AT&T and the USAF Electronic Systems division, Hanscom AFB, Mass., the official U.S. contracting agency under the Foreign Military Sales Agreement.

"AT&T most likely will use its own technical standards," said one industry official of the Iranian program, "and that should certainly provide export opportunities for the U.S. More so, certainly, than if Siemens designed it." Goal of the planning is development of a fully integrated system to be implemented by 1983. That Iran expects foreign producers to establish telecommunications manufacturing facilities there is expressed in the nation's policy to develop "modern technological capability and increased manufacture of communications equipment in Iran under the direction of the Iran Electronics Industries."

Contest narrows for Postal Service prototype award

The companies involved aren't talking, but industry sources say **three firms remain in serious contention for a U.S. Postal Service contract—to be awarded at the end of this month—for a prototype "small parcels and rolls sorter."** They are the Garland division of E-Systems Inc., of Dallas, Fairchild Space and Electronics Co., of Germantown, Md., and Rohr Plessey Inc., of Rockville, Md. Earlier this year, Emerson Electric, Boeing Computer Systems, and FMC Corp. were said to be out of the running, but the Post Office says all six are technically qualified.

At stake is a potential $200 million production order for a minicomputer-controlled, fully-automatic sorter for major post offices. The winner of the prototype award will operate the prototype for 30 months before the Postal Service makes a production decision.

Contracts for UMTA vehicle-ID system expected next year

Possibly three prototype contracts for an off-the-shelf automatic vehicle identification and location system for big-city transit systems will be signed early next year, says an official of the Urban Mass Transportation Administration. At least seven companies are expected to submit bids by Oct. 14, the deadline for proposals. **Winners of the prototype awards, to be let through the Department of Transportation, will install their systems, including general-purpose computers and CRT displays, on part of a bus system in Philadelphia for a 90-day competitive shakedown test.** The winner of that contest, says the UMTA official, will get a contract worth about $3 million to equip 200 buses and 25-bus-related service vehicles for a one-year test in the Los Angeles area. Industry sources expect that a successful prototype trial will result in follow-on orders from urban mass transit and police departments.

Bidders for the initial prototype contracts will include Fairchild Space and Electronics Co., RCA Corp., Westinghouse Electric, Hoffman Electronics, Boeing Computer Systems, Teledyne, and Cubic-Western Data Corp.

Washington commentary

Making cable TV pay

In the long dispute between television broadcasters and cable TV interests, some of the realities and the means to resolve them—and thereby open a long promising entertainment market—were detailed recently by Donald I. Baker just before he left the Justice Department, where he was deputy assistant attorney general for antitrust, to teach law. Baker's observations were made before the Senate judiciary subcommittee on antitrust and monopoly, which is considering updating the Communications Act of 1934, and are summarized below. **—Ray Connolly**

To the broadcast industry, or at least some of it, cable television, generally, and pay cable programing in particular, represent two of the major competitive issues with which the Federal Communications Commission has been grappling for the past decade or more. The question of how best to integrate a new technological development into a market environment dominated by established regulated firms has generated a great deal of emotion. . . .

Industry images

To the broadcast industry . . . CATV represents what has been alternatively described as "the devil incarnate" or, even more flamboyantly, "a piranha tearing at the flesh of broadcasting." And the cable industry's countercharges are no less imaginative. Cable industry advocates portray the TV broadcast industry as immensely rich, profiting from public franchises assured them by a "captured" FCC. . . . Cable, on the other hand, is portrayed as a medium of abundance which will provide a wide variety of new and innovative program choices. Objective realities, of course, differ quite a bit from [this] rhetoric . . .

While the Justice Department is often seen as "pro-cable" by both the cable industry and the broadcast industry, it would be more accurate to view our position as being in favor of affording CATV the opportunity to develop, and not that the Government should necessarily make any commitment to guaranteeing cable a certain future.

The FCC has proceeded more or less on an *ad hoc* basis to erect barriers to cable services, largely on the basis of the speculative fears of the broadcast TV industry. Rules were adopted, for example, that essentially said that the only way a cable system could import distant signals was to prove that no one would watch them. The stated purpose of this regulation was to protect the audience available to local stations which, of course, earn the bulk of their revenues by importing distant signals from network switching centers in New York.

In view of the breadth of the FCC's cable regulations, and their competitive and social implications, a number of people have called for a congressional solution to the matter and, indeed, a number of alternative courses of action are available to Congress.

Congressional options

One alternative, of course, is to do nothing. A similar result could be obtained by ratifying the *status quo* through legislation. The FCC staff, I understand, is drafting legislation which, if enacted, seems likely to do just that.

Another alternative would be simply to deregulate CATV altogether. Such an alternative is not quite so radical a concept as it might seem at first. The case for detailed CATV regulation . . . is presently not that compelling. The oft-repeated concern that cable growth could imperil the continued viability of broadcasters serving sparsely populated rural areas seems on closer examination to be less than convincing.

Assuming, however, that complete deregulation is not [practical], then the question arises: what kind of legislation would be desirable?

A first requirement of such legislation would be that it reflect a policy of providing competitive opportunity along the lines I discussed. . . . A second major consideration is . . . the plain fact that CATV as presently provided is a capital-intensive industry. Common sense dictates that capital-intensive industries require a certain degree of stability and profit incentives in order to develop. Delegations of broadly worded power to the FCC or the imposition by Congress of extraordinary capacity and extra service demands far in advance of conceivable marketplace demands would serve as deterrents to investment. . . .

A third and related major consideration is that any legislation proposed should be a whole unto itself and specify clearly who is to do what as well as who can do what. A fourth major consideration which the department believes is essential is that any legislation endeavor to deal with existing as well as future competitive and regulatory difficulties. Should cable eventually develop into the dominant media, the FCC could be given adequate regulatory powers limited to the public interest problems actually experienced. However, an infant industry should not be fettered with chains designed to handle a giant.

The Harris Report.

New series of generic PROMs—a family affair.

Stand alone PROM designs are now a thing of the past. Now the diverse requirements for density, modularity and performance within a system can be satisfied with Harris' new family of PROMs featuring generic characteristics.

This generic concept of PROMs offers many unique advantages. For instance, each device within the series will feature identical DC electrical specifications plus common programming requirements, permitting easy use of other family elements. So learning is just once per family.

In addition, these PROMs have fast programming speeds. Equivalent I/O characteristics for easy upgrading. Faster access time, guaranteed over temperature and voltage. Improved testability.

Right now, the first two PROM devices are in volume production. The 256 x 4 organization (1K) and the 512 x 4 (2K). Other PROM devices will be available in the months ahead (see table).

So instead of settling for PROMs with unique performance capability and diverse programming requirements, get the new Harris generic family of PROMs. Lower your system costs and make your life easier.

For details see your Harris distributor or representative.

Device #	No. of Bits	Organi-zation	No. of Pins	Max. Access Time* comm./mil.	Availability
HM-7602 (open coll.) HM-7603 (three-state)	256	32 x 8	16	40/50ns	August
HM-7610 (open coll.) HM-7611 (three-state)	1024	256 x 4	16	60/75ns	in stock
HM-7620 (open coll.) HM-7621 (three-state)	2048	512 x 4	16	70/85ns	in stock
HM-7640 (open coll.) HM-7641 (three-state)	4096	512 x 8	24	70/85ns	August
HM-7642 (open coll.) HM-7643 (three-state)	4096	1024 x 4	18	70/85ns	January '76
HM-7644 (active pullup)	4096	1024 x 4	16	70/85ns	January '76

*Access time guaranteed over full temperature and voltage range.
Industrial (T_A = 0° C to 70° C, V_{CC} ± 5%)
Military (T_A = -55° C to 125° C, V_{CC} ± 10%)

Important features of Harris' new generic family of PROMs.

- Simple, high speed programming procedure (Typically less than 1 second per thousand bits).
- Inputs and outputs TTL compatible; Low input current: 400 μA logic "0," 40μA logic "1." Full output drive: 15 mA sink, 2 mA source.
- Fast access time—guaranteed over voltage and temperature (see table).
- Expandable—three-state or open collector—"wired-or" outputs with chip select.
- Industry standard pin-out.

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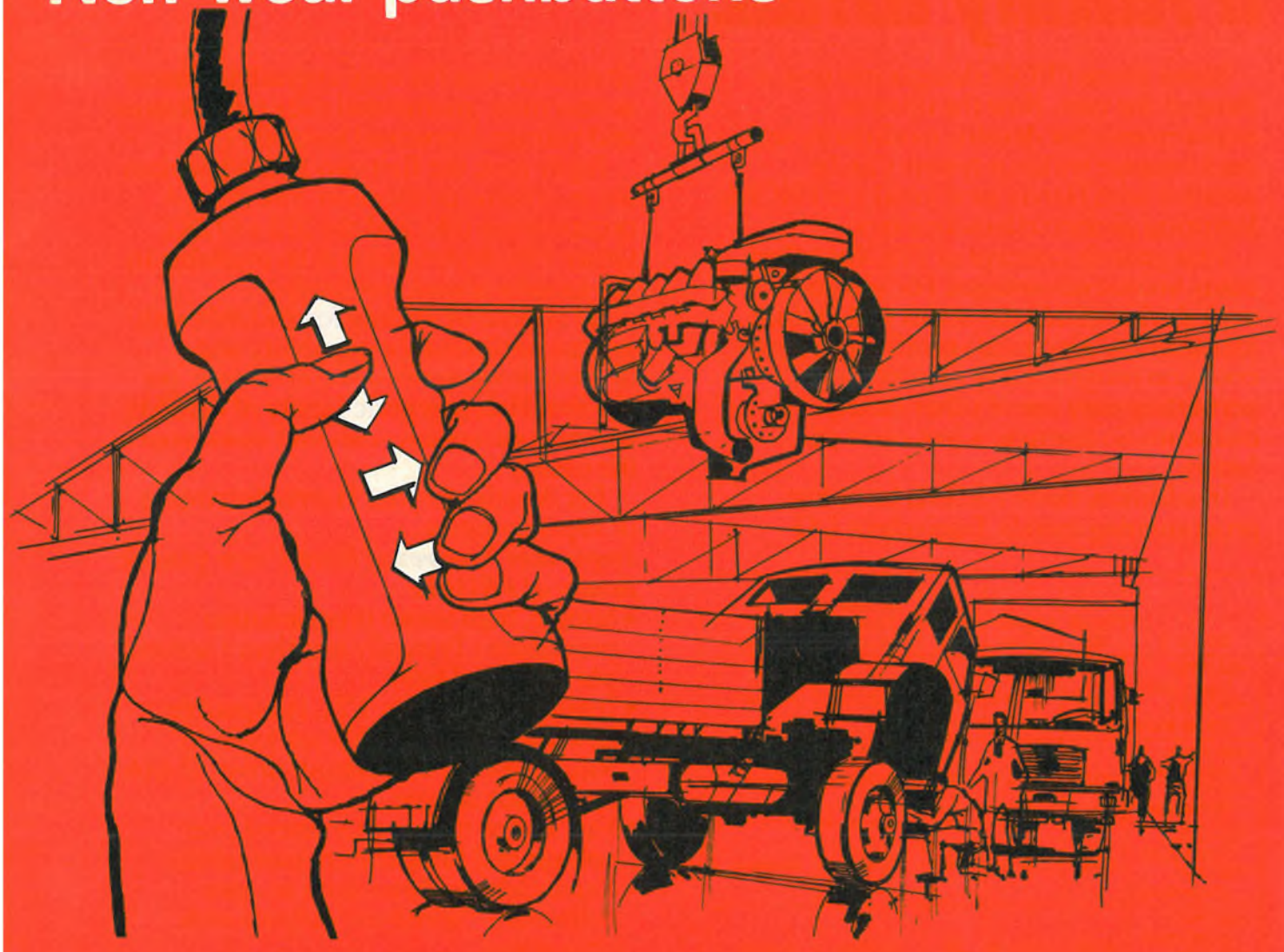
SIEMENS

Electronic sensors at work
Non-wear pushbuttons



Repair shops and construction sites, chemical plants and cement mills, electroplating shops, abattoirs, canteens and laundries – they all have one thing in common: switches and buttons for operating electronic controls are constantly exposed to moisture, dirt, dust and chemically aggressive atmospheres which make heavy demands on service life and reliability.

Piezoelectric devices have helped to provide a simple, safe and rational solution to this problem, in the form of non-wear pushbuttons which are insensitive to moisture, have no moving parts or mechanical contacts, and hence eliminate explosion hazards. Undesired operation due to inadvertent brushing with the fingers is ruled out.

Piezoelectric devices convert pressure pulses directly into voltage pulses for control electronics. In this way, integrated circuits can be driven directly or via simple matching transistor circuits.

Thus, with the aid of newly developed piezoceramic materials, the long-known phenomenon of piezoelectricity has been turned to good account for industrial electronics.

Piezoelectric devices for pushbuttons from Siemens

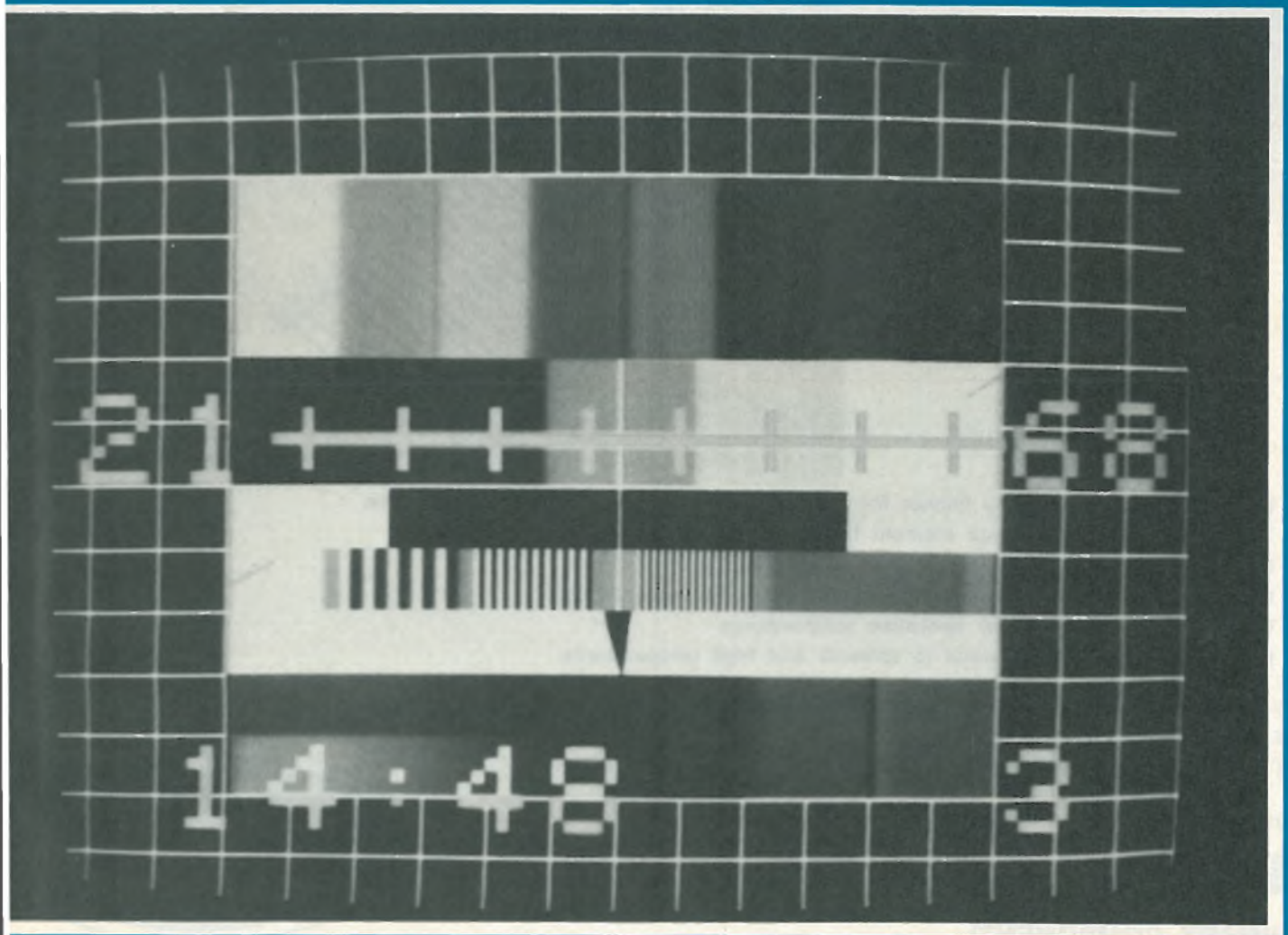
Circle 165 on reader service card

August 21, 1975

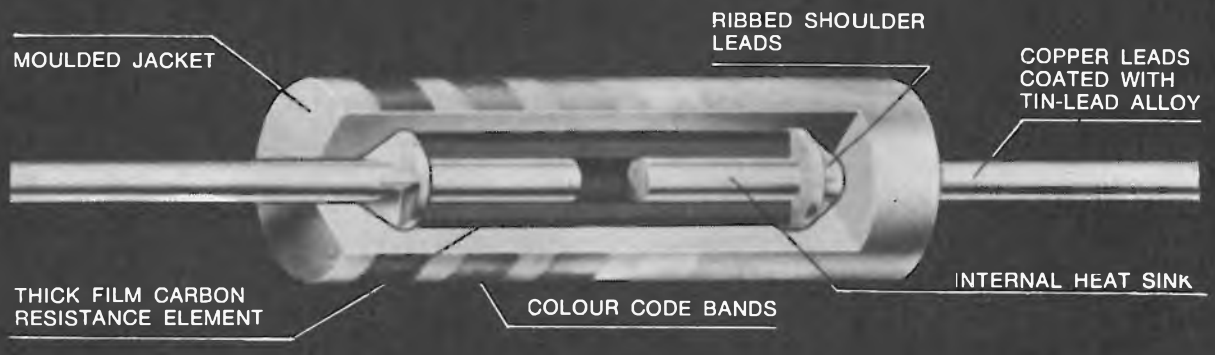
Electronics International

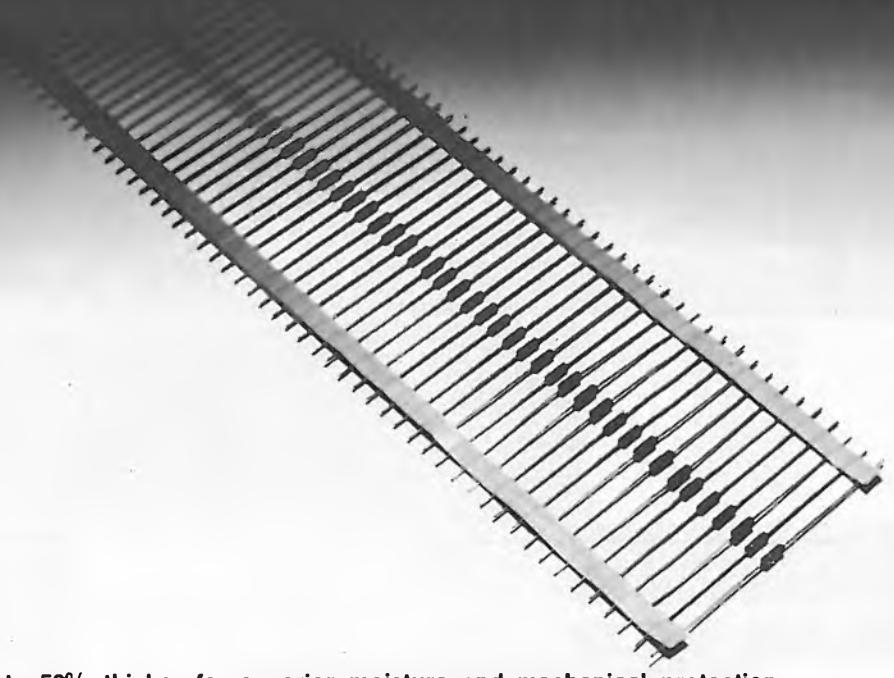
Power MESFETs aimed at TWTs in S and X bands: page 4E

TV screen shows pattern and scale for automatic tuner, plus time and channel number: page 59



THICK FILM CARBON moulded resistors IBT





- **Moulded jacket up to 50% thicker for superior moisture and mechanical protection**
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- **Ribbed shoulder leads for security in jacket**
- **Copper leads coated with tin-lead alloy for excellent solderability**
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IBT 1/4 - 1/4 W, **MIL-R-11 Approved RC07,** TC = 250 ppm/°C
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IBT 1 - 1 W, MIL-R-11 Style RC30

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International newsletter

Philips hopes new BBD will recapture its market lead

The inventor of the bucket-brigade device is about ready to introduce a BBD it is relying on to regain its superiority in the market. **The Philips Elcoma division in the Netherlands says its new device, the TDA 1022 has a longer delay range, longer dynamic range, and less than half the attenuation of other available BBDs.** The high performance is achieved by combining a refined complementary-MOS technology with a controlled local-oxidation process, says G.J. Koopmans, product manager. The device will sell in volume for about $4.

Elcoma claims the TDA 1022, which contains 512 stages, can delay signals from 51.2 milliseconds to 0.512 ms—a delay time not yet achieved by other BBDs; the dynamic range is typically 2.5 volts rms for the input voltage, in contrast to a maximum 2 V for the best competitors, and typical attenuation is 3.5 decibels, compared with 8.5 dB for the best competitive devices. This low attenuation is handy when cascading BBDs to obtain long delay times. **The TDA 1022 can be used with clock frequencies from 5 to 500 kilohertz over an ambient temperature range of -20°C to +55°C.**

Future looks grim for IC makers in United Kingdom

Uncertainty grips integrated-circuit manufacturers in the United Kingdom these days as they try to chart their marketing courses. **The grim prospects result from a lag in the economy in Britain behind the rest of the world, says one marketing executive,** who is "beginning to see the signs of a pickup in Europe," but "I don't see a recovery in the UK for another 12 months." Another executive says that even the "second half of '75 is difficult to forecast," although, overall, the "tough market" probably won't be as bad as the 1971 dip.

Worries are fueled, for one thing, by a fall-off in telephone usage and new-equipment installations caused by price increases. And the British Post Office which has announced a whopping $42 million telecommunications deficit, is understood to be talking with equipment suppliers about stretching out delivery programs for new exchange equipment. **In addition, manufacturers' deliveries of color-television sets, another economic barometer, have plummeted since the government slapped a 25% value-added tax on luxury goods in April.**

NEC's GaAsP light meter surpasses silicon performance

A gallium-arsenide-phosphide light meter that Nippon Electric Co. has developed for cameras is highly sensitive and has a linear response over an illumination change of six orders of magnitude. **The large band gap of GaAsP eliminates all responses to infrared radiation, to which competitive silicon devices have maximum intrinsic sensitivity.** Most silicon cells have blue filters to eliminate this response, but spurious responses can make for large errors. The price of new device is set in negotiations with camera manufacturers, but NEC says it will be lower than for a silicon device with an infrared-elimination filter. The company hopes to sell 500,000 units by March 30, 1976, and 215 million units during its next fiscal year. The reason for both high sensitivity and for large dynamic range of the new device is low dark current, typically several tenths of a picoampere, which is one to two orders of magnitude lower than it is for silicon devices.

International newsletter

Spain expected to adopt PAL TV norm in Italy's wake

Now that Italy has officially decided to use the PAL color-television-transmission norm—after years of political debate in that country—West Germany's AEG-Telefunken, developer of the system, says prospects are good for Spain also to come into the PAL fold. Spain is one of Europe's last holdouts in choosing between the French-developed Secam and the PAL systems. "Italy's decision for PAL is certain to influence that choice," says a Telefunken spokesman at company headquarters in Frankfurt. Large-scale PAL test tramissions have been conducted in Spain for some time. **In Italy, the 30th country to adopt the PAL norm, the German firm predicts the Rome government's commitment to PAL will help that country's television industry, long stymied by the debate.**

Hall effect used in ITT's automatic UK phone exchanges

ITT's Standard Telecommunication Laboratories apparently has turned to the Hall effect in the design of new electronic relays for the low-cost version of the TXE-4 automatic telephone exchanges it is developing for the British Post Office. Largely because they have no moving parts, the new relays should be cheaper, lighter, and smaller than the BPO's venerable 3000-series electromechanical relays they're to replace. STL is guarding details but it is understood that ITT is planning to apply the design principles in other markets and applications. The Hall effect makes a semiconducting material act as an electronic switch when it is perpendicularly biased by current and a magnetic field. STL is believed to be using germanium coupled with a small coil for its devices, which act as detectors in the relay. Also in the relay are reeds and a 1-bit Boolean processor.

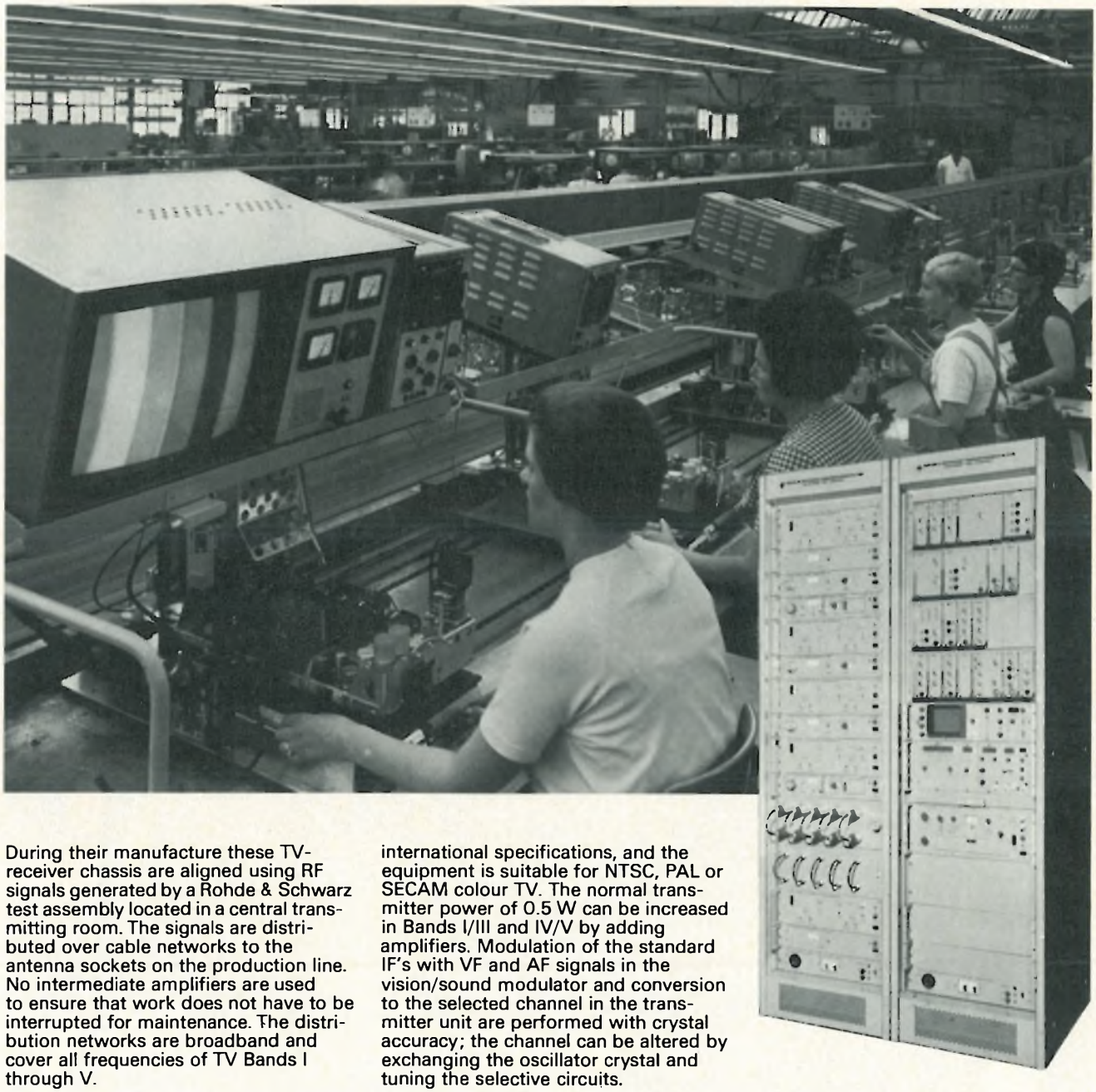
Argentine threats cause Siemens to withdraw Germans

Concerned over the continuing harassment of its employees in politically restive Argentina, Siemens AG has decided to withdraw all its German personnel from plants it operates in that South American republic. Involved in the action are about 25 technicians, engineers, and managers with their family members for a total of about 50 people. A Siemens spokesman at the headquarters in Munich says the reason for the withdrawal is "the threats to which we have long been exposed in that country." Only last month a top Siemens director was kidnapped by a leftist underground organization in Argentina, but was released again after the company paid a reported $2 million ransom. **Siemens, which maintains plants for communications systems and other electrical/electronics equipment in Argentina, is determined, however, to continue manufacturing operations in that country with native managers.**

Lloyds bank to add two IBM 370-168s to central system

While some banks are networking their data-processing functions into regional centers, Lloyds Bank in England is consolidating its two centers into one London site with $26 million worth of additional IBM computer equipment. The new order includes two System/370-168s for branch-accounting operations and seven 3890 document processors to process some 300 million checks a year. **When the physically secure center opens in about two year, it will include a total of four 370-168s and two 370-158s, to be configured into two parallel processing systems.**

Centralized Television Measurements



During their manufacture these TV-receiver chassis are aligned using RF signals generated by a Rohde & Schwarz test assembly located in a central transmitting room. The signals are distributed over cable networks to the antenna sockets on the production line. No intermediate amplifiers are used to ensure that work does not have to be interrupted for maintenance. The distribution networks are broadband and cover all frequencies of TV Bands I through V.

For each channel that is used, the test system has a **TV Channel Signal Generator SBTF** made up of a vision/sound modulator and a transmitter unit. The set can handle Standards B, G, D, I, K, K1, L or M, all transmission parameters come up to national and international specifications, and the equipment is suitable for NTSC, PAL or SECAM colour TV. The normal transmitter power of 0.5 W can be increased in Bands I/III and IV/V by adding amplifiers. Modulation of the standard IF's with VF and AF signals in the vision/sound modulator and conversion to the selected channel in the transmitter unit are performed with crystal accuracy; the channel can be altered by exchanging the oscillator crystal and tuning the selective circuits.

Besides laboratory and production applications, the SBTF can be used for the actual **transmission of TV programs** in mobile stations (outside broadcasting, traffic monitoring).

Rohde & Schwarz has on hand a complete line of equipment for VIT techniques and TV broadcasting in accordance with ITU, EBU, CCIR, OIRT, ARD and FTZ specifications.

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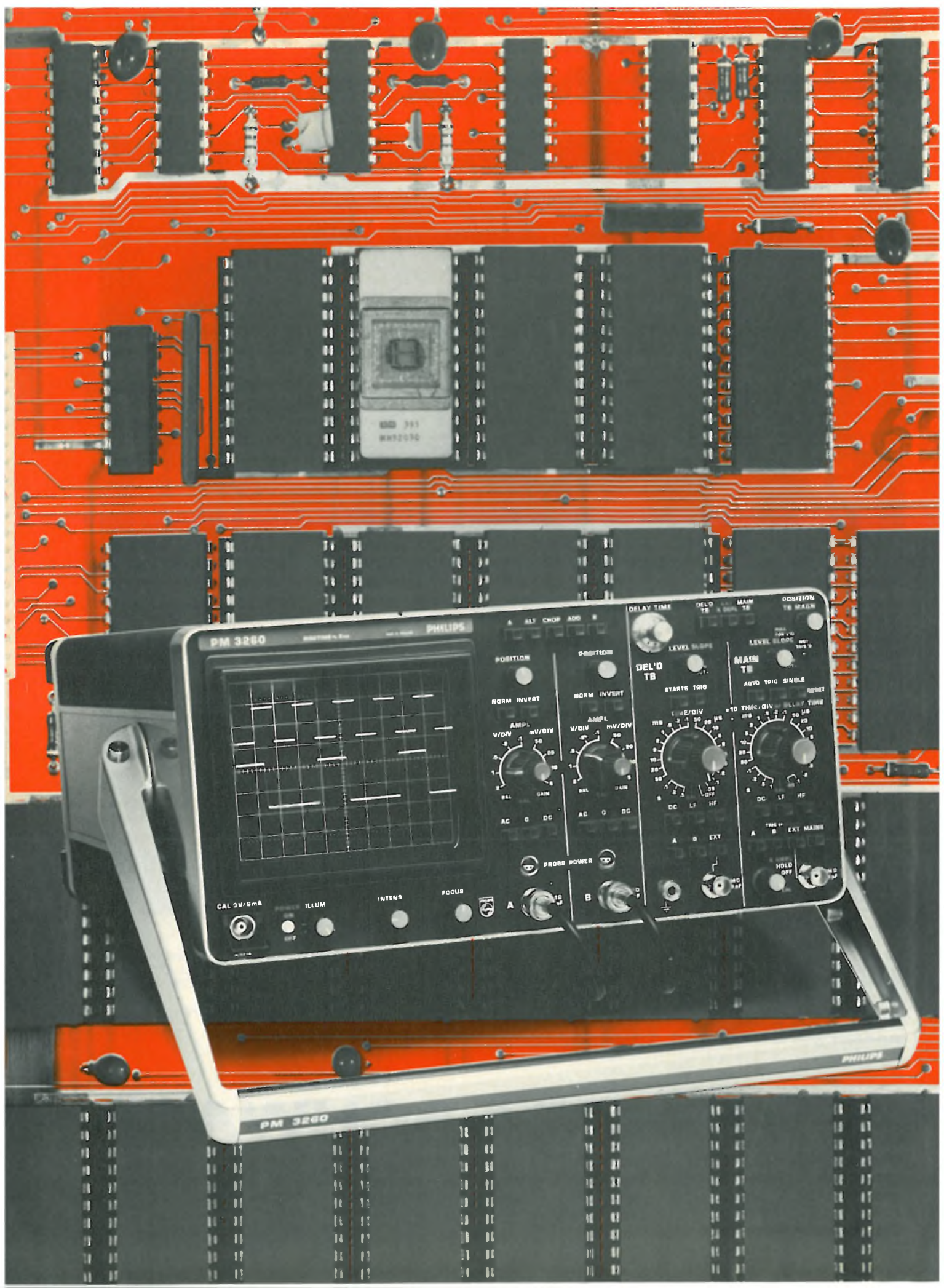
PM 3260
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DELAY TIME
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MAIN TB
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LEVEL SLOPE
STARTS TRIG
AUTO TRIG SINGLE
RESET
TIME/DIV
DELAY TIME
POSITION
NORM INVERT
AMPL
V/DIV
mV/DIV
BAL
GAIN
AC
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DC
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The logical choice for logic circuitry

Compact performance at 50, 120 and 150 MHz

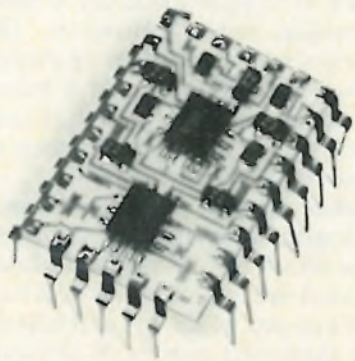
Just as circuits and systems get smaller and faster, so too do our oscilloscopes.

The 50 MHz model PM 3240, for example, weighs in at a mere 8.4 kg. And because it's used as much outside the laboratory as in, we've given it a logical front panel layout where every control falls naturally to hand. The PM 3240 has also been designed to operate from almost any supply, including DC, to have a bright 8 x 10 cm display and good circuit access for short service down-times on the oscilloscope itself.

Moving up to 120 MHz

For higher bandwidth applications the 120 MHz model PM 3260 is available. This 9 kg light instrument therefore keeps you well ahead of Schottky TTL speeds and at the same time goes on triggering to over 200 MHz to meet the great majority of ECL applications.

Like the 50 MHz model, the PM 3260 includes layout features



All three oscilloscopes make wide use of monolithic IC's in order to reduce weight and the number of adjustment points.

such as clear separation of the main and delayed time bases as well as operation from DC plus 100 to 240 V supplies having frequencies from 46 to 440 Hz.

Multiplying at 100 MHz

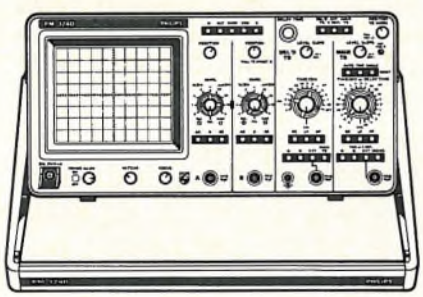
The PM 3265 extends all the previous benefits to a bandwidth of 150 MHz and also adds the unique, built-in 100 MHz analog multiplying facility. Only with this instrument can you therefore make transient power and dynamic phase measurements on high-speed components and circuitry. Moreover this facility, like the rest of the instrument, is extremely easy to use. You simply push the 'A x B' button to obtain the product which can also be displayed together with the B input signal.

A family of compacts

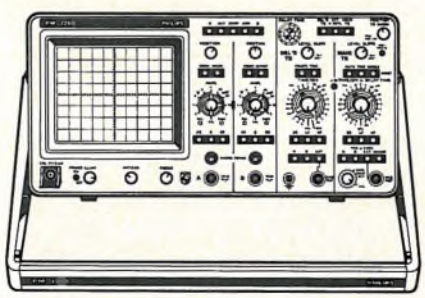
These three compact instruments thus meet the needs of designers and users - at 50, 120 and 150 MHz - and meet them with a number of significant and unique benefits.

Find out more by writing to :

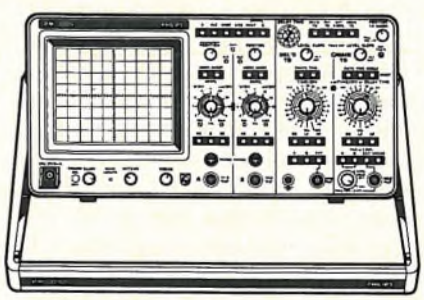
Philips Industries, Test and Measuring Instruments Department, Eindhoven, The Netherlands.



PM 3240 : 50 MHz/5 mV; 8.4 kg; bright 8 x 10 cm display.



PM 3260 : 120 MHz/5 mV; 9.0 kg; ergonomic layout; wide choice of line supplies*.*



PM 3265 : 150 MHz/5 mV; unique 100 MHz analog multiplier; 9.5 kg.

(features common to all models)*

PHILIPS

PHILIPS

Plessey aims power MESFETs at S and X bands

Production nears for devices as replacements for TWTs in phased-array radar and satellite communications

Gallium-arsenide power metal-on-silicon field-effect transistors are about ready to challenge traveling-wave tubes at frequencies in S through X bands. Their developers at Plessey's Allen Clark Research Centre claim that the device will be more compact, provide more efficiency, and use simpler power supplies than TWTs. These characteristics of the transistors, which are called MESFETs and are easy to make, will be particularly attractive in such applications as satellite communications and phased-array radar. The typical 1-watt power requirement appears to be about right for satellite systems, which need efficient transmitters.

Experimental MESFETs, essentially FETs with reversed-bias Schottky barriers on the metalized gates, have already switched 0.5-W lasers for fiber-optic communications. Plessey has fabricated two designs that put out more than 1 W of power at 3 gigahertz in the S band with gain greater than 8 decibels. Power-added efficiency, which is a measure of the device's capability to convert dc power into rf-power output, is 30%.

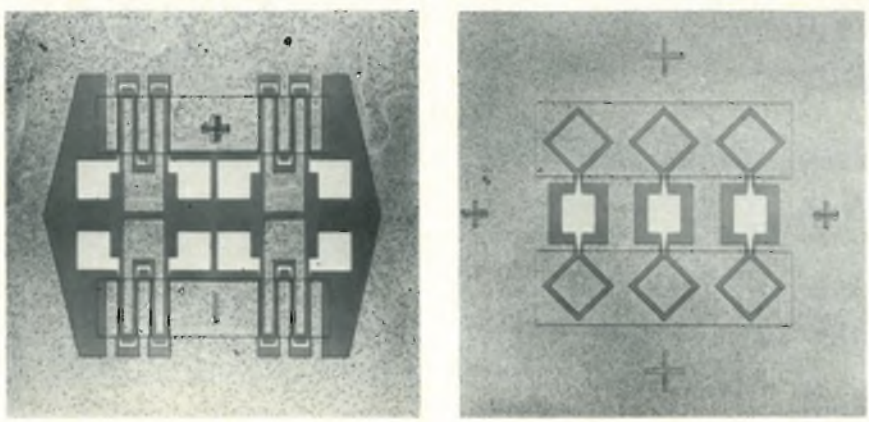
Plessey plans to begin commercially producing the devices soon. James A. Turner, the research-group leader, says that devices are soon expected to reach 5 gigahertz, but that comparable performance from 8 to 12 gigahertz in the X band is "within reach." However, the MESFETs are unlikely to challenge TWTs in the region beyond X band. The designs are to be described next month at the Microwave '75 show in Hamburg, West Germany.

Fabrication. Conventional photolithographic processes are used to make MESFETs. Unlike the multiple diffusion needed for bipolar devices, MESFETs are made by a relatively easy three-step process of photoresist and etching. Turner explains that these steps come after the GaAs epitaxial layer is grown to make ohmic source and drain contacts, to make the mesa pattern and get rid of unwanted GaAs, and to metalize the gates.

The biggest barrier to commercial production may be to choose the better of the two designs. One has interdigitated source and drain fingers separated by a meander gate, and the other is a closed-cell structure with diamond-shape drain areas. Although the diamond design is performing slightly better, both designs enable shrinking the geometries to get the higher frequencies, retaining the gate length needed, and resolving the heat-sinking problem, Turner says.

Meandering. The meander-gate FET gets its name from the metalized gate of fingers that "meanders" across the gallium arsenide several times to create a four-stripe gate over each of the four cells. Turner explains that a power FET needs a long gate to compensate for the mere 1-micrometer width of the gate and to provide for heat dissipation. The source fingers form part of a completely surrounding source metalization on the chip to provide a common low-impedance connection. Turner says, "the higher the dc power that goes into the device, the more rf power comes out."

To make the meander-gate FET, four identical cells, interconnected by bonding, are made in a thin sulphur-doped n-type epitaxial GaAs layer grown on a buffer layer of high-resistivity material on a semi-insulating substrate. The source and



Making MESFETs. Conventional photolithographic techniques are used to make the meander-gate FET (left) and diamond-gate FET (right).

drain contacts are of indium, germanium, and gold, while aluminum is used for the Schottky-barrier gate.

The diamond-gate FET is made much the same way, except that its six cells with diamond-shaped gate-channel walls are produced after the etching process. The devices will need special packages, however, because conventional bipolar power packages don't provide enough heat-sinking. □

Great Britain

SAW technology boosts oscillators above 1 GHz and yields fm signals

The fundamental frequencies put out by conventional bulk-crystal oscillators depend on crystal bulk. However, they are normally limited to fundamental frequencies of about 25 megahertz because bulk crystal is too difficult to process to generate higher frequencies. Now, though, Marconi Research Laboratories is using only the surface of the bulk crystal by applying surface-acoustic-wave (SAW) delay lines on quartz-crystal substrates. The resulting compact, rugged oscillator has a 1-gigahertz fundamental frequency, and frequencies of 1.2 GHz and even higher seem only slightly beyond the horizon.

Achieving the new maximum frequencies enables Marconi to offer SAW-based oscillators to military and civilian customers for a variety of communications and transmission applications from 20 megahertz into microwave frequencies. And, by applying modulating voltages, "you can get fm signals out of it. This opens up a big field in mobile-type communications," points out Dennis W.G. Byatt, head of the materials-applications group.

Rugged. Because of their ruggedness and high spectral purity at the high fundamental frequencies, the devices, Marconi expects, will be used in applications normally denied bulk-crystal units. Although production can be tricky, the devices should be cheaper and smaller because of fewer active multiplying and phase-lock-loop circuits. For example, the company says they can be used as low-noise, phase-locked oscillators. And a unit designed for a wide tuning range has achieved noise levels of only -150 decibels at 25 kilohertz from a 20-megahertz carrier.

The concept has several advantages, Steven C. Gratze, head of the lab's microwave and acoustics section, points out. Because acoustic waves travel slower, "you can get a lot of delay in a small space, compared with an electromagnetic delay line," he says. The delays themselves are defined by the photoetch pattern of the interdigitated fingers, which makes the oscillators amenable to batch processing by means of well-known semiconductor technology, he continues.

In the oscillators, a SAW delay line containing thin-film interdigitated-finger transducers generates the oscillations on the crystal substrate, which are then amplified. The SAW delay line forms a selective feedback loop for the amplifiers. With greater than unity gain around the loop, it oscillates when the phase transfer around the loop is a multiple of 2 Π. Typically, the SAW crystals fit into either a TO-5 or TO-8 package, which with associated amplifier and buffering circuitry, is mounted on a small printed-circuit board of about 10 square centimeters.

The structure is inherently frequency-selective. "The bandwidth approximately equals the number of finger pairs," Gratze notes. And, it fixes itself on the correct frequency because of the many finger pairs in the transducers.

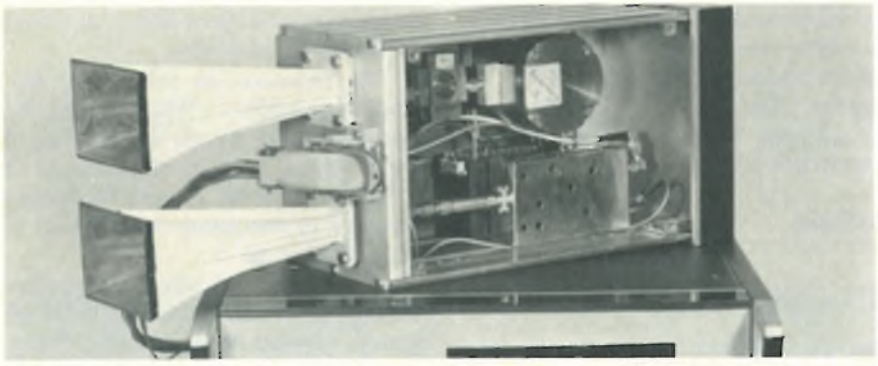
Drawbacks. However, manufacturing the oscillators won't be all gravy. Gratze says, for one thing, the tight tolerances can stretch photoetch techniques. Whereas bulk quartz crystals get thinner as frequencies are increased, the interdigitated SAW pattern diminishes. Thus, the finger width of 2.5 micrometers in a 300-MHz oscillator shrink to 0.8 μm in a 1-GHz device, he says. There would be "fundamental problems" in going up to 2- to 3-GHz devices, but a 1-GHz oscillator could be "trebled up" by conventional multiplication circuitry to make a 3-GHz unit, Gratze notes.

Another problem to be worked on is aging, or deterioration of stability. Standard high-frequency-overtone bulk-crystal oscillators normally lose about six parts per million annually in stability. The SAW oscillators, however, lose about 20 ppm, a reasonable figure, but one Marconi believes can be improved. After all, only a few months ago, its SAW oscillator was peaking at only 720 MHz. The third prime factor in oscillators, temperature stability, seems to be in hand. The devices exhibit parabolic frequency-temperature characteristics similar to those of standard BT-cut bulk-crystal oscillators. □

West Germany

Microwave radar measures precisely

Aimed at uses as diverse as remote measurements of liquid levels and helicopter landing aids, a new prototype microwave radar system can pinpoint distances of several hundred meters with a resolution as high as ±2.5 millimeters. The system, which is built around a frequency-modulated continuous-wave X-band radar with a 1.5-gigahertz sweep width, measures the total phase length of the intermediate-



Accurate. Prototype microwave radar system shifts phase of successive i-f pulses 200 times and counts zero crossings to get 2.5-mm resolution.

frequency waveform, which exactly represents the distance to the target.

Developed at the Philips Research Laboratories in Hamburg, West Germany, the system uses a new phase-sampling technique to measure total i-f phase length. The result is processed by a combination of a single-sideband receiver and a low-frequency modulator, followed by digital circuitry. The measurement to millimeters is indicated on a light-emitting-diode display.

Rolf Jacobson, who developed the hardware, says one of the most promising applications is in process control to measure the level of substances in containers, ovens, and other vessels. The system, to be described next month at the Fifth European Microwave Conference and Exhibition in Hamburg, could remotely measure the level of, say acidic liquids, which are difficult to measure by conventional mechanical techniques. Another likely use for the system, Jacobson says, is the precise determination of altitude for helicopters when landing.

Resolution. Generally, the resolution of a distance-measuring fm-cw radar is directly proportional to the accuracy with which the intermediate frequency can be determined, but this accuracy is limited by the finite length of the i-f waveform. When an X-band radar is swept at, for example, 1.5 GHz, the maximum theoretical distance resolution would be about ±10 centimeters, Jacobson says.

It is the significant improvement in this resolution that sets the Philips system apart. As a prerequisite for higher resolution, the energy reflected from the target must considerably exceed unwanted reflections. But this condition, Jacobson says, can be guaranteed by simply using a suitable antenna design. An analysis of the i-f waveform from this setup then shows that the total phase length of an i-f pulse is proportional to the distance to the target.

Because, for a constant distance, successive i-f pulses have the same start phase, the number of times that these pulses cross the zero, or X, axis is also the same; therefore, by counting the number of zero crossings, the phase length can be measured. That is where the new phase-sampling technique comes in. To increase the accuracy of the measurement, the starting phase is shifted through 360° by a certain number of steps—typically 200. Then the number of zero crossings changes according to the total phase length of the i-f waveform.

Analysis. If this procedure is mathematically analyzed, the resolution of the distance measurement works out to ±2.5 mm. This resolution, Jacobson says, was obtained in anechoic chamber with target distances from 0.5 to 8 meters. The Philips man says the new technique should also make possible 2.5-mm resolution for targets several hundred meters away.

In the system, the radar frequency is swept from 9.0 to 10.5 GHz. The i-f waveform is generated by simply mixing the transmitted fm-cw signal with the received one. To produce the X-band frequency, the output of an yttrium-iron-garnet oscillator is modulated by a free-running oscillator that produces a 400-hertz triangular wave. The YIG oscillator output is fed to the transmitting antenna, to the local-oscillator input of a marker/mixer, and to a single-sideband receiver.

This receiver generates two i-f signals that are 90° out of phase. These two signals are individually modulated by two 2-Hz sine waves that are also 90° out of phase. The summation of the two modulated signals causes a continuous shift in the starting phase of the i-f waveforms.

The phase-modulated i-f signal which is filtered and clipped, is passed to a counter, and the counter's output is displayed on the LED indicator. The marker/mixer compares the harmonics of an rf signal derived from a quartz oscillator and generates a sequence of pulses from which a control unit produces the start and stop pulses driving the counter-input gate. The marker/mixer gives the system calibration capabilities and a long-term operating stability. □

Great Britain

ITT modem speeds data on phone net

Computer data transmitted over European telephone lines can't always get through properly because of distortion and other interference that are characteristic of analog switched networks. However, turning to MOS LSI technology, ITT's Standard Telecommunications Laboratories Ltd. has designed a modem that operates at 4.8 kilobits per second in an effort to push messages over the lines against most such obstacles.

Not only does the modem automatically handle interference and distortion for clearer transmission, but it also can drop its data rate to 2.4 kb/s if the 4.8 kb/s rate jams the analog lines, explains Roy Privett, transmission division manager. The modem, now in preproduction engineering at Standard Radio and

Telephone, an ITT affiliate in Sweden, conforms to European standards set by the International Consultative Committee for Telephone and Telegraph. These standards call for eight-phase modulation for 4.8-kb/s transmission over leased circuits. ITT has added the switched-network capability for the modems. The price has not yet been revealed.

Scheduled to go into production in 1976, the modem may be the most advanced of its type "especially designed and developed in Europe for the vagaries of the European network," states John T. L. Sharpe, principal research engineer.

Considering competition. ITT admits that, although it might be first out, its European competitors could have similar units in development. Among the eager competitors for data modems in the European market are L M Ericsson in Sweden, Siemens AG and Telefunken in Germany, and TRT in France. Potential customers include government agencies and private corporations for various kinds of data-processing units, data exchanges, and multiplexed low-speed data channels.

LSI keeps the modem small—only 5 by 10 by 18 inches. Direct electrical coupling is used for point-to-point connection over the switched network. The eight-phase system transmits the data by phase changes of the carrier frequency. The modem consists of 10 highly interconnected subunits for transmission, receiving, automatic equalization, and control. Switching of data rates is manual.

A key to the success of the modem is the digital-filtering technique, which uses shift registers and operates like an analog tap-delay line. The different filtering shapes are obtained by changing the coefficients as the modulation speed changes. Allied is "the incorporation of the automatic equalizer into a phase-modulated modem," Sharpe says. The equalizer was developed for amplitude-modulated units.

Converting the equalizer to digital techniques "entails some bits of hardware trickery," with a nonrecursive digital filter. The phase-modulated transmission is shaped according to standard line characteristics and stored in a read-only-memory.

Ingenuity. Applying digital techniques to perform normally analog functions required an intricate design for high-speed processing and pushed LSI technology to its limits, researchers say. The design engineer and the LSI-production technician were on the same floor for close and meticulous collaboration. Basis for the modem are four custom designed p-channel MOS chips, which ITT says are unusually complex.

"With LSI-type technology, it pays you to cram as much on a chip as possible," Sharpe observes. Two

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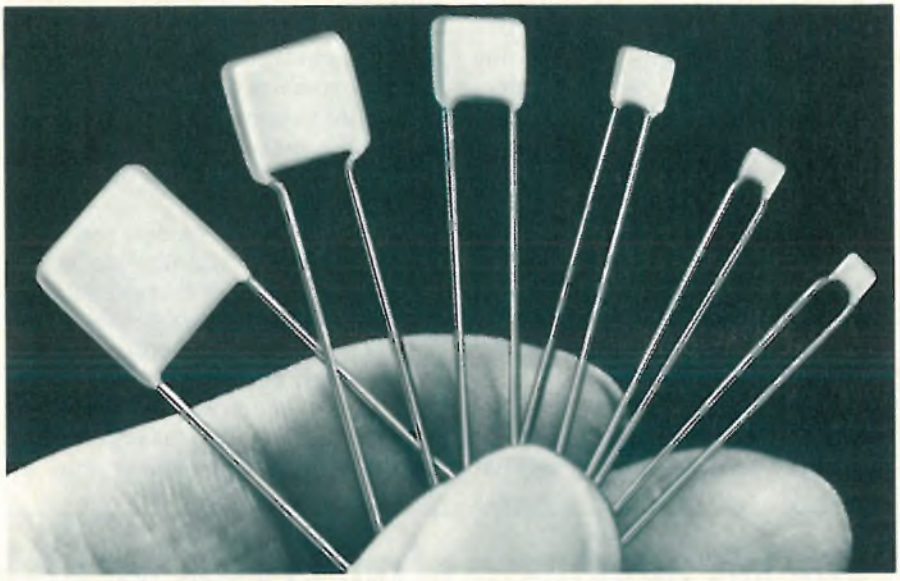

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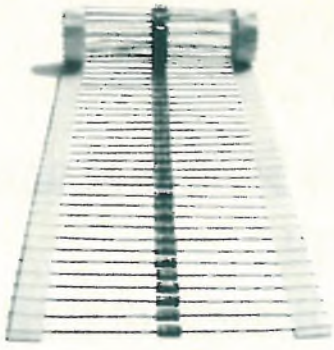

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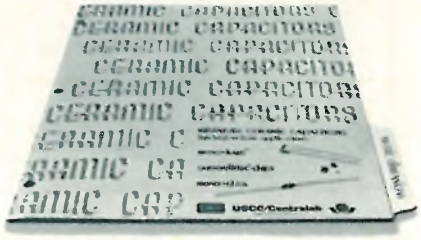

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Electronics international

410-gate timing chips—one each for transmitting and receiving—establish the equalization and synchronization. The 716-gate transmitter circuit provides functions for scrambling and encoding, baseband-filter modulation, and digital-to-analog conversion.

A receiver chip of 730 gates handles some of the carrier-receiver logic, including decoding, demodulation, and linear-phase detection. The equalizer is a 602-gate chip, while a 2,048-bit ROM stores the premultiplied filter coefficients. □

Japan

Image sensor has high contrast range

Spike noise, the curse of solid-state image sensors, usually limits dynamic range to about 40 decibels. However, the addition of a novel noise-canceling circuit on a new 64-bit device developed by Matsushita Electronics Corp. reduces noise by an additional 20 dB. The result is a sensor that can reproduce images with a higher contrast range than previous devices could handle.

However, the developers encountered an unexpected obstacle that had to be overcome before their simple noise-cancelation idea would work. At high brightness levels, noise sets the minimum output. Lowering the noise, therefore, results in a widening of the dynamic range. So far, so good. But, instead of saturating when the output of the sensors reached a certain point, the cancelation circuitry caused the maximum output to fall.

Basics. The sensor, made by silicon-gate technology and a single layer of aluminum-metalized interconnect wiring, operates at frequencies between 100 hertz and 2 megahertz. Sensitivity is 120 picoamperes per foot candle with a saturation charge of 12 picocoulombs. Sold in a 16-pin dual in-line package, the device can be used in pattern-recognition sensing in computer-terminal applications, precision industrial measurements, and positive and deviation measurements in process control.

The sensing device is similar to many others, with 64 photodiodes spaced 50 micrometers center to center. These diodes also serve as sources in the p-channel silicon-gate MOS transistors used as switches for scanning the output. The output line is connected to the drains of these transistors, and the sequential scanning is provided by an MOS shift register on the chip.

Unfortunately, scanning pulses, capacitively coupled to the output line through MOS-transistor gate-to-drain capacitance, are superimposed on the output signal. To cancel these noise signals, the developers put another row of MOS devices on the same chip. They produce pulses of equal amplitude but of opposite phase to the noise pulses from the sensor-switching devices. Noise-cancelation elements, which also have an output line connected to all drains, receive sequential scanning signals from the shift register. These transistors are shielded from incident light by a layer of aluminum.

An external operational amplifier boosts the video signal. The sensor's output line goes to the noninverting-signal input, and the noise-output line from the noise-cancelation elements is connected to the inverting input. Feedthrough spike noise on the two output lines cancels well enough to increase signal-to-noise ratio to about 60 dB.

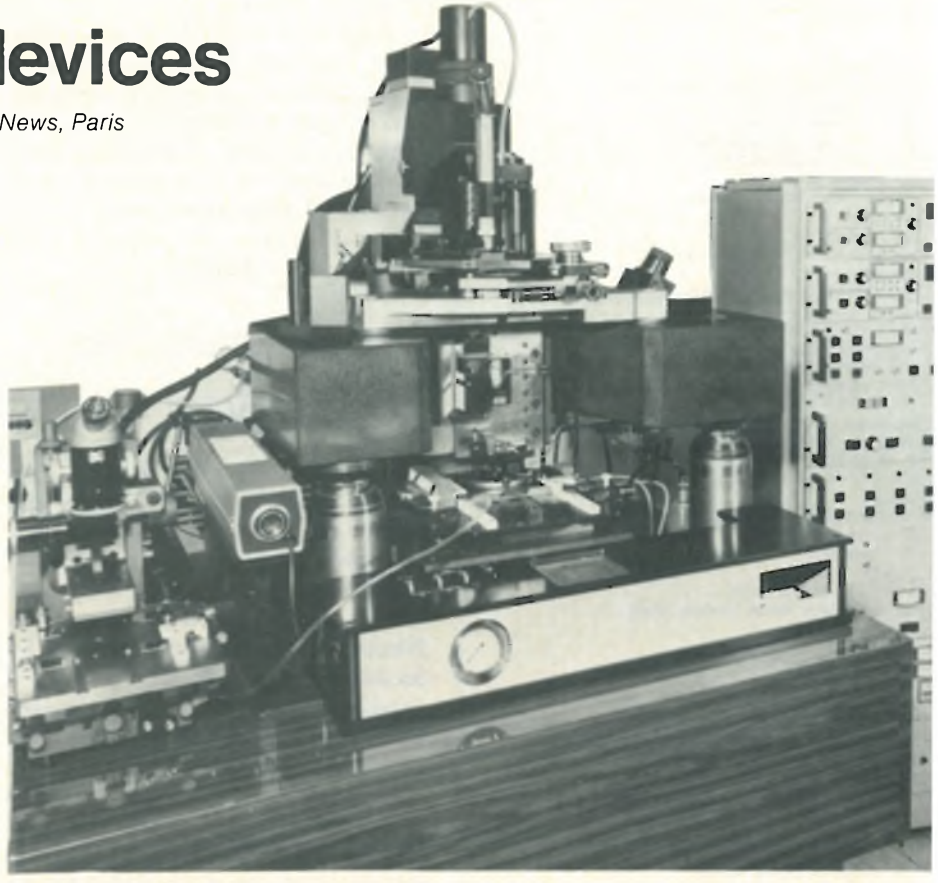
Glitch. However, the noise-cancelation elements caused the sensor output to fall off instead of saturating as these devices should do when light intensity increases beyond a certain point. Although the cancelation elements were shielded from incident light, charges flowed through the substrate to their sources at higher light intensities.

To eliminate that difficulty, the engineers removed the sources of the elements on the noise-cancelation line, leaving only gates and drains. The capacitive feedthrough from gate to drain remains unchanged, but the source-to-drain parasitic current is eliminated. □

Mask-generating camera built for microwave devices

by Richard Shepherd, McGraw-Hill World News, Paris

Computer-controlled system from Thomson-CSF division also has the precision for large microprocessor chips



Masks for the new, higher-frequency semiconductor components need correspondingly higher resolutions, while masks for the latest—and largest—LSI chips need their repeating patterns of circuit elements perfectly aligned. Thomson-CSF's Masktechnique division which has been supplying turnkey, mask-generating systems for more than a year now [*Electronics International*, May 30, 1974, p. 11E] provides both features in a computer-controlled step-and-repeat camera. Designed especially for microwave-device applications, the new system can also align a succession of images with enough precision to generate large microprocessor chips.

Visitors to the fifth European Microwave Conference and Exhibition in Hamburg, Sept. 1–4, will be able to learn about the new machine, the LCP-201, in detail. Its basic feature is a high-resolution lens that produces 0.5-micrometer-wide lines over an image field measuring 2.4 millimeters in diameter—a combination that best suits the requirements of manufacturers of high-frequency devices. In fact, image field took second place in the design to resolution, since for LSI purposes, this image field is rather small (the earlier LCP-101 has an 8-mm image, but with only 1-μm resolution). Clearly, the larger the image projected by the lens, the fewer pictures are needed to build each chip mosaic and the smaller the risk of error in lining them up to create the chip mask.

Nevertheless, the 20-mm-diameter field capable of handling a chip at a time remains a distant goal, and meanwhile the LCP 201 is equipped to tackle big-chip masks, opening the door to very-high-resolution super-LSI circuits.

Higher resolution. In the LCP-101, Masktechnique had used laser interferometry in conjunction with piezoelectric transducers to position the table bearing the mask or substrate as precisely as possible under the lens. In the LCP-201, an automatic focusing servo system is added, which maintains the lens at a fixed distance from the mask or substrate. The problem is that the resists normally used on a mask surface demand an exposure time of almost 1 second. To keep the lens in position that long, Masktechnique's support laboratory built a gas-filled sensor within the lens housing and linked it to a stack of piezoelectric disks.

The smallest movement of the lens will change the gas pressure, which in turn varies the current applied to the disks, so that they expand or contract and correct the lens position. In order to obtain the accuracy necessary for the focusing system, the pressure of the gas is kept low and acts on an area that's smaller than is usually found in such sensors.

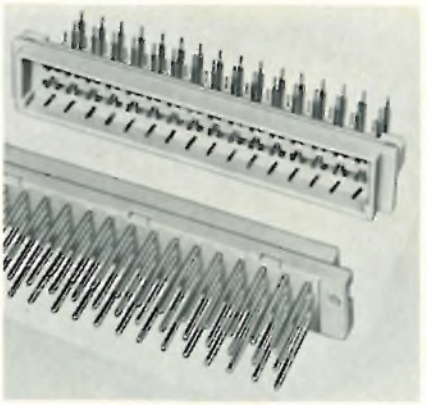
Other complications arise when it

comes to direct masking of a design, chip by chip, straight onto a wafer or substrate, since the substrate, unlike a mask, may already have some functions on it. This means that the lens must be aligned with both the reticle and the substrate, and Masktechnique resorts to a split-field microscope to obtain the fraction-of-a-micrometer tolerances.

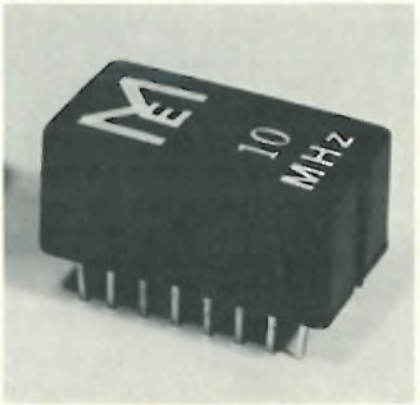
But the improvement in precision requires other changes. In this case, sources with two different wavelengths are used for the alignment and for the projection—if they were the same, the resist would be exposed even before the alignment had been completed.

Thomson-CSF, Masktechnique, Domaine de Corbeville, BP 10, 91401, Orsay, France [441]

Silicon fast-recovery avalanche rectifiers are built for special applications such as high-frequency rectification, inverters, and free-wheeling diodes. Of 17 types available, four also provide transistor protection by avalanche characteristics. Semitron Ltd., Cricklade, Wiltshire, England [461]



The series Gds A-E connector comes with 48 poles and is designed to handle 6 amperes at 125 volts ac. Contact resistance of the connectors is less than 15 milliohms, and contact spacing is 0.1 inch. Harting, 4992 Espelkamp, P.O. Box 104, West Germany [464]



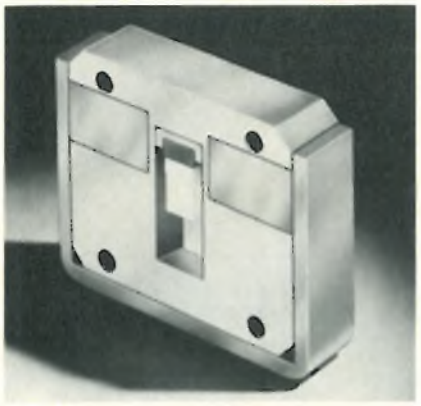
Crystal oscillators in 16-pin dual in-line packages are compatible with TTL and C-MOS. Series covers from 5 to 25 MHz. and stability exceeds 50 ppm over the range from 0°C to 70°C. Meon Electronics Ltd., Savoy Works, Petersfield, Hampshire, England [462]

A lightmeter called Mavolux has 16 measuring ranges, the lowest from 0 to 1 lux and the highest from 0 to 60,000 lux. The unit has an output for recorders and operates off four 1.35-volt batteries. Gossen GmbH, 8520 Erlangen, P.O. Box 1780, West Germany [465]

Two scanners in a new series enable a single instrument to read a multitude of low-level signals. The 702/7028 permit picoampere-level currents to be switched and the 7029 does the same for microvolt-level signals. Keithley Instruments, D-8 Munich 70, Heiglhofstr. 5, West Germany [463]

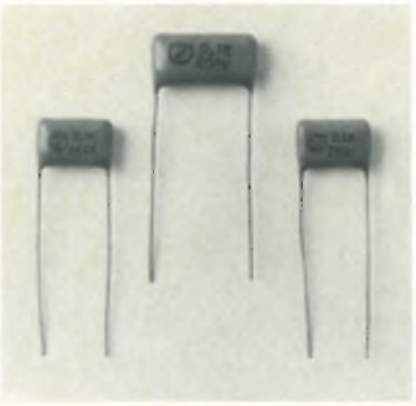
Positioning control CNC 305.1, for numerically controlled machines, uses solid-state displays with 12.7-millimeter-high digits. A data bus allows inputs via tape readers, code switches, keyboards or semiconductor memories. Heidenhain GmbH, 8225 Traunreut, P.O. Box 1260, West Germany [466]

New products international

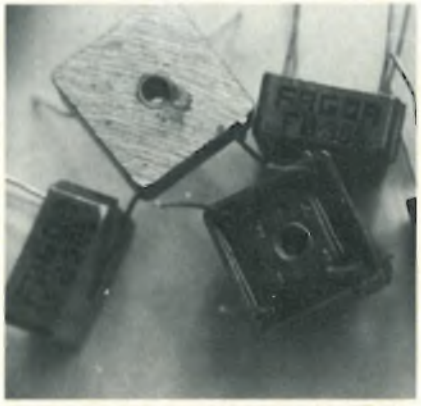


Three miniature field-displacement isolators for X band cover the range from 8.5 to 9.6 GHz among them. They may be used with Gunn oscillators, and the reflection referred to the oscillator is independent of the load. Philips, P.O. Box 523, Eindhoven, The Netherlands [467]

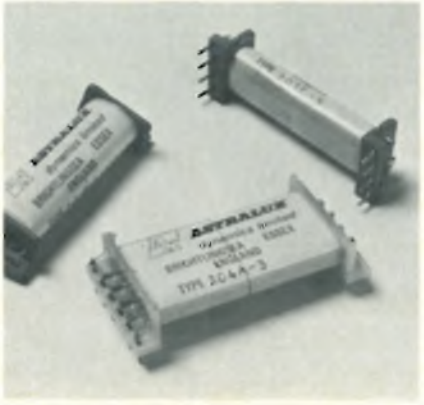
Prime applications for line of brushless resolvers are phase-shifting and conversion of coordinate information in machine-tool control. There are no sliding contacts, and operating frequencies go to 10 kHz. Moore Reed & Co. Ltd., Andover, Hampshire, England [470]



Metalized film capacitors, type W223P, for board-mounting in TV and radio sets, are rated at 250, 400, and 630 V dc. They are wound of polyester film and thin-gauge foil. An epoxy coating protects against moisture. Sprague, 19 chemin F. Lehmann, 1218 Geneva, Switzerland [473]

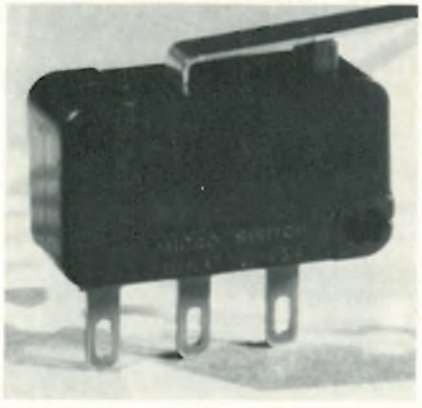


Rectifier bridges in the FB300 series are rated 3.5 A at 200-1,100 V. Units can withstand transients of 50 A for 10 ms; the maximum inverse current is 15 μA. They are packaged in aluminum. Fagor Electrotecnica, Barrio San Andres s/n, Mondragon (Guipuzcoa), Spain [468]



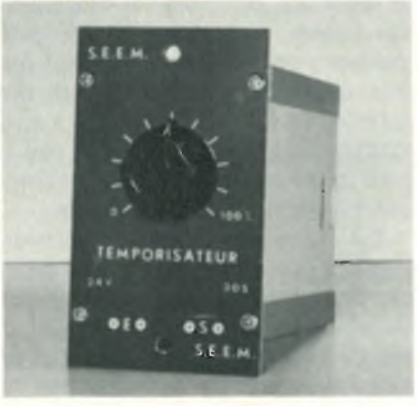
A series of miniature mercury-wetted reed relays is suitable for low-level switching. The units can interface with logic equipment, and relatively high power ratings enable them to switch inductive loads. Astralux Dynamics Ltd., Brightlingsea, Colchester, Essex, England [471]

Photoresist spray developer, model 2303, handles wafers that measure from 24 to 80 mm in diameter. Spray time of the four nozzles is adjustable from 1 to 110 seconds in steps of 1 s. Capacity is 300 wafers per hour. VEB Elektromat, 808 Dresden, East Germany [474]



Because Microswitch XL uses a Hall-effect IC instead of the usual mechanical contacts, there's no contact bounce. The IC has onboard regulation to handle any dc supply between 1 and 16 V. Honeywell Europe, 14 ave. Henri Matisse, B1140 Brussels, Belgium [469]

Model TX910 tester for IC op amps checks supply and input currents, offset voltages, and open-circuit gain. It can also measure common-mode rejection and the output/input transfer curve. Program cards adapt the unit to different op amps. Metrix, BP30, 74010 Annecy, France [472]



Packaged electronic relays come in time-delay, voltage-threshold, and current-threshold versions. Time delays range from 0.25 to 180 s for 12, 24, 36, or 48 V. Voltage thresholds are 9-28 V; current, 0.1 or 1.0 μA. S.E.E.M., 19 rue Jean-Bleuzen, 92170 Vanves, France [475]

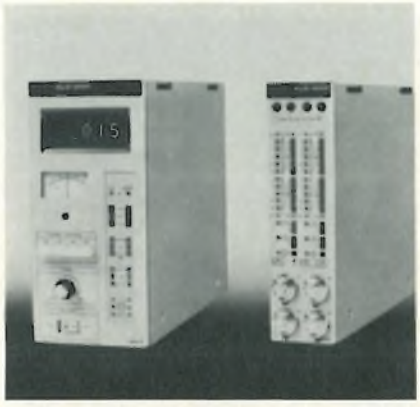
Slide controls that are designed for consumer and semiprofessional applications have slide distances of 48, 65, 80, and 100 millimeters. Nominal linear resistance of the controls ranges from 50 ohms to 16 megohms. Preh Werke, 8750 Bad Neustadt/Saale, West Germany [443]

Reed relays, series 842, are built for 10-watt switching. Coil dissipation at 5 V is only 20 mW, making the relays compatible with TTL. The latching-type units come with one or two rhodium contacts. Elfein GmbH, 6 Frankfurt, Wiener Str. 143, West Germany [444]

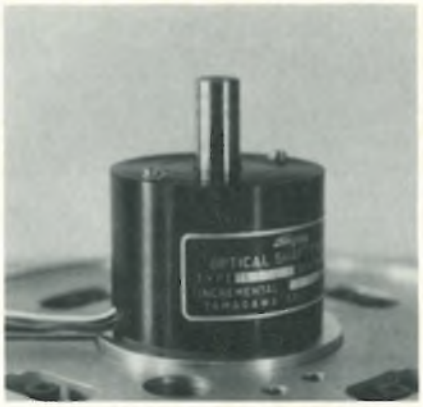
Two-pole relay designated the RHL402 is for circuit-board mounting and is rated for 3 A at 60 V. Base area measures 25 by 35 mm, and height is 10.5 mm. Allowable switch-on current for 25 ms is 20 A. Hartmann & Braun, 6 Frankfurt 90, P.O. Box 900507, West Germany [445]

New products international

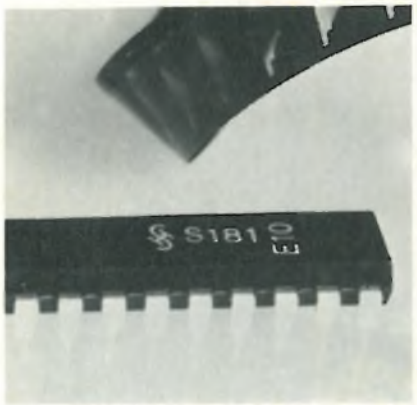
A diagnostic test set, called the model DTM 1000, is designed for use in Burroughs test routines for checking intelligent terminals and other computer peripherals. The portable unit includes a digital multimeter. Weir Instrumentation Ltd., Bognor Regis, Sussex, England [446]



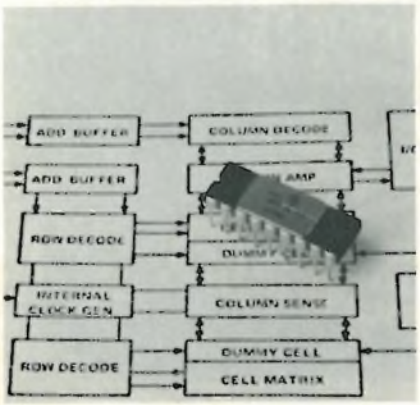
Analog arithmetic units, series ALS-20M, have a built-in programing mechanism. The series of data-processing instruments includes two linear models, two nonlinear types, and one control unit. Hitachi Electronics Ltd., 1-23-2 Sudacho, Chiyoda-ku, Tokyo 101, Japan [447]



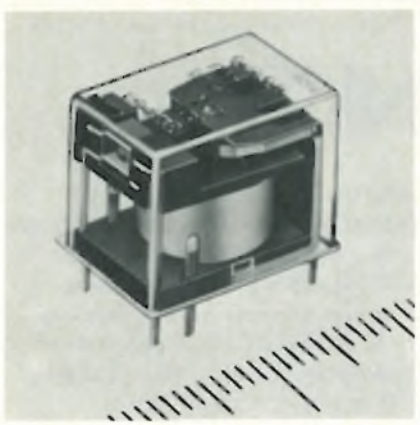
Modular-type optical encoders are suitable as tachometers for the drive systems of tape readers and of other computer peripherals. They have both low inertia and low friction torque. Tamagawa Seiki Co. Ltd., 3-19-9 Shinkamata, Ota-ku, Tokyo 144, Japan [448]



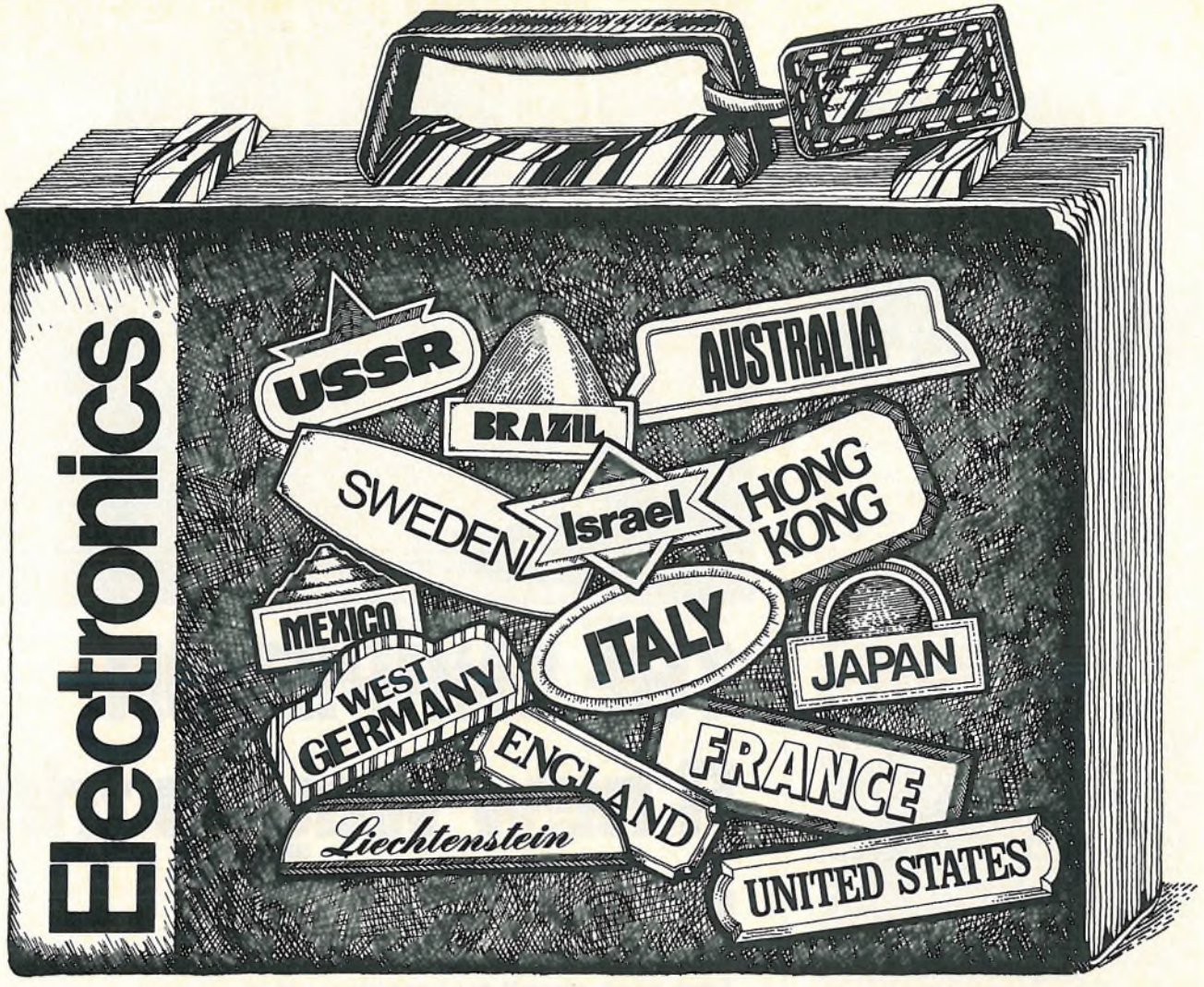
Integrated circuit, type S181, is an MOS type for use in movie cameras for frame and motor control, automatic release, and other functions. The chip, measuring 3 by 3 millimeters, has 1,800 transistors. Siemens AG, 8 Munich 1, P.O. Box 103, West Germany [449]



A 4,096-bit RAM, the TMS4050, offers an access time of 300 nanoseconds. By using a common data input/output line and by not having chip-enable and V_{cc} lines, only 18 pins are required by the unit. Texas Instruments GmbH, 805 Freising, West Germany [450]



Microminiature relay, type G2E, is 10 millimeters wide by 15 mm deep and 10.2 mm high. Suitable for mounting on printed-circuit boards, it can control varied loads with quick response. Omron Tateisi Electronics Co., Heiwajima Ohta-ku, Tokyo 143, Japan [451]



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Electronics IS THE SOURCE.

TV sets take on international look

West Berlin exhibition shows that U.S. and European designers are, for first time, heading in the same direction

by John Gosch, Frankfurt bureau manager

For the first time, television-set designers on both sides of the Atlantic are charting similar courses. The only differences are timing, cost, and ripeness of the markets. For example, after taking the lead in electronic varactor tuning, the Europeans have plunged ahead into development of digital addressing for the tuner. And, one step behind, U.S. designers are working on the same features.

The new digital-tuning equipment on display at Funkausstelung, West Berlin's biennial international radio and television exhibition, Aug. 29 through Sept. 7, also previews what can be expected eventually from U.S. production lines [*Electronics*, June 26, p. 65]. And the 1975 buzzword is digital tuning.

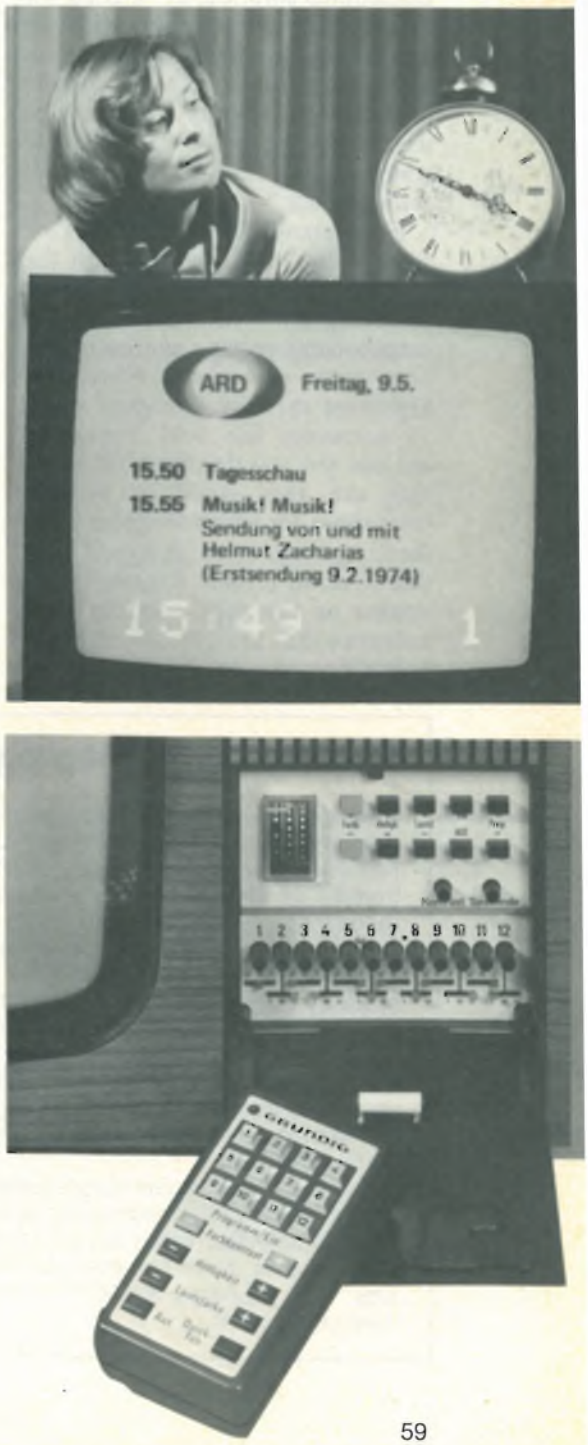
To be sure, receivers with digital tuning haven't made their market debut yet. But within a year, the first sets will be coming off the production lines to predictions of fast acceptance by consumers, notably in West Germany, which usually sets the pace in European buying trends.

Motivations. In contrast to the U.S., where Government regulations are behind the switch to new tuning techniques, in Europe, the impetus is coming from other directions. Important stimuli are speeding and easing programing, increasing operating comfort, and extending flexibility in receiver design. But perhaps uppermost is the industry's desire to benefit from the long-run savings in labor costs that the new tuning technique offers—savings because there is less wiring, and the more reliable electronic circuitry is less expensive. Furthermore, since remote control is going digital, digitized tuning is considered the logical next step.

As in the U.S., two digital-tuning techniques are competing for acceptance in Europe—the closed-loop frequency-synthesis method and the voltage-synthesis approach. The European firms most active are Philips Gloeilampenfabrieken in the Netherlands, the ITT Semiconductor Group's Intermetall GmbH in West Germany, and Plessey Semiconductors in Britain. Philips refers to the frequency method as DICS (for digital channel selection) and to the voltage technique as DIPS (for digital program selection).

Although Plessey seems committed to the frequency method—the British company is also working on it with National Semiconductor Corp. in the U.S.—Philips and Intermetall are pursuing both tuning concepts, but with different degrees of priority. The Dutch company is strongly emphasizing DICS, whereas Intermetall is gravitating, at least for now, toward the voltage approach. "It's less expensive to implement," says Ruediger Karnatski, Intermetall's product manager. "Besides, voltage synthesis does not require modifying the tuner and does not call for a complex high-frequency divider. What's more, no interfacing is needed with remote control and on-screen display circuitry," Karnatski adds.

Intermetall's solution is an MOS-LSI circuit set consisting of two or



Time check. Grundig is showing on-screen display of time and channel (top), and remote control of 12 channels, color contrast, brightness, on-off, and tone.

three chips, depending on whether the system is designed to handle 18 to 16 channels; probably, it will be a 16-channel version, Karnatski says. "It could enter the mass-fabrication stage during the first half of next year," the Intermetall man notes, "and a price between $10 and $12 seems attainable for quantity-produced systems."

At Philips, however, the voltage approach is considered merely a transitional solution, as "a good way of acquainting set makers with digital tuning," as Rob Ockeloen puts it. He, the product manager for professional ICs at Philips' Elcoma division in Eindhoven, adds, "so we are concentrating our development efforts on DICS."

Understandably, Intermetall designers don't quite agree with that assessment. As Karnatski points out, his company is not the only firm emphasizing voltage synthesis. Perhaps more powerful is Karnatski's argument that for European cable-TV networks, the field frequencies are not yet standardized, and once they are, they could be different from those for which frequency-synthesis systems were designed. Furthermore, in private frequency converters of the type used in cable networks that are not owned by the post office, the uhf band is usually converted into vhf to reduce dissipation. Even these networks may have problems with frequency-synthesis methods—problems that don't exist with voltage-synthesis techniques, which have open-loop/closed-loop design options.

Tradeoffs. Elcoma's Ockeloen agrees that frequency synthesis is more expensive, but the extra costs, he says, "are justifiable, in view of the added features that DICS provides." DICS has the edge over DIPS because the TV set can be tuned without actually receiving any station signal, says Nico Nissen, an engineer at Philips' Hamburg-based Valvo GmbH, where the DICS development is concentrated.

Furthermore, the DICS system allows for easier search tuning—DICS takes less than 12 seconds to tune through both the uhf and vhf ranges. Another advantage is that the tuner itself need not be very stable, Nissen adds, because DICS is based on less critical closed-loop principles.

DICS is part of a modular concept that provides circuits for remote control, local control on the set itself, and for on-screen character displays. The modular system, which is also based on MOS-LSI circuits, will be available in sample quantities toward the end of this year. And, like Intermetall's system, DICS could go into production during the first half of next year. After production is under way the system price could be $20 to $25, Ockeloen hints.

While semiconductor producers are gearing up for digital-tuning circuitry, set makers are in full swing toward on-screen character displays, which are replacing on-chassis indicators using cold-cathode tubes and light-emitting diodes. Blaupunkt GmbH, a member of the Robert Bosch group of companies, late last year introduced sets with the channel numbers on the screen, implemented by Intermetall MOS circuitry. Now, other companies are following suit, but adding the correct time to the display.

Pace-setter. Going a step further is Grundig AG, the German leader in color-set sales. The Nuremberg company is going to market with six color-TV models with an on-screen display, not only of time and channel, but also of the channel-tuning scale. Displayed across the entire width of the screen, the test pattern makes service easier for technicians searching for a station when setting the receiver's automatic-program-selection circuitry.

The quartz-controlled time indicator on the six Grundig models is displayed on the lower portion of the screen by touching a sensor plate on the set or a button on the remote-control keyboard. Time is displayed in hours and minutes by 4-centimeter-high green digits, and seconds are shown by flashing dots between the hours and minutes.

The channel number of the selected program is automatically displayed for 10 seconds when the set is turned on and after each station change. However, the number, along with the time, can be displayed at any time by touching the sensor plate or by ultrasound remote control.

All three indications—time, channel, and tuning scale—are implemented by five ICs from Texas Instruments—three of them MOS. The base for the timing circuitry is a 2.097-megahertz quartz oscillator. Its frequency is reduced by divider stages, and their output drives the character generators. The three on-screen indications add only about 2% to the price of Grundig's standard color models that have ultrasound remote control. □

Finding sounds of progress

Although new TV features will star at the Berlin show, there will be much to draw the attention of audiophiles. For example, West Germany's BASF, a heavyweight in magnetic tapes for commercial and consumer uses, will introduce its Ferrochrom two-layer tape, which provides a wide dynamic range for compact cassettes.

Conventional single-layer tapes require a compromise in the choice of the tape's dynamic range. However, BASF says its tape avoids all compromises by using a ferrooxide layer on the bottom for the low frequencies and a chromium-dioxide layer on top for high frequencies.

Another audio innovation comes from the German headset manufacturer, Sennheiser electronic, which will introduce a cordless headset that picks up sound transmitted on infrared-light beams. Photodiodes pick up the sound-modulated infrared beams sent out by light-emitting diodes on the audio equipment.

Grundig AG, West Germany's leader in entertainment equipment, will unveil its Studio 2240 quadriphonic system. It consists of a hi-fi radio, a four-channel amplifier, and a record player. The basic equipment operates by SQ principles, but it can easily be modified for CD-4 by plugging in modules. And Grundig's S9000 TV console boasts sound reproduction that meets hi-fi norms.

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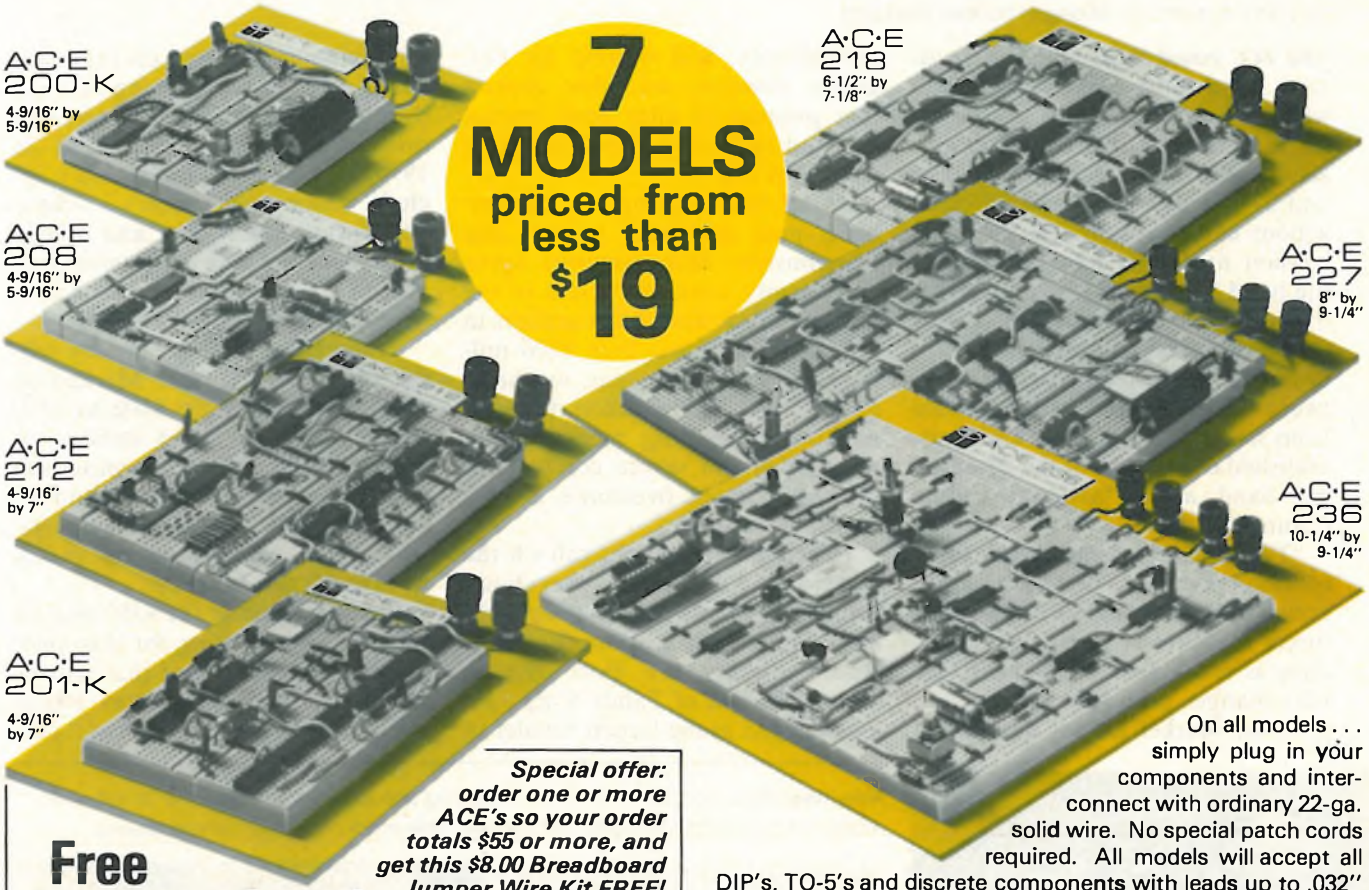

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Communications

CB makers sweat out rulings

Boom in equipment sales goes on, but FCC decisions awaited on channel numbers and allocation could affect designs and profits

By Larry Armstrong, Midwest bureau manager

The FCC tuned in to reality on citizens' band radio earlier this month when it relaxed some of its restrictions on the use of the class D citizens' radio service between 26.96 and 27.23 megahertz. Among other actions effective Sept. 15, the commission no longer bans the use of the band "as a hobby or diversion," it eliminates the restriction against interstation communications, it abbreviates the "silent period" between five-minute conversations from five minutes to one, and it established channel 11 of the 23-channel band as a "national calling channel."

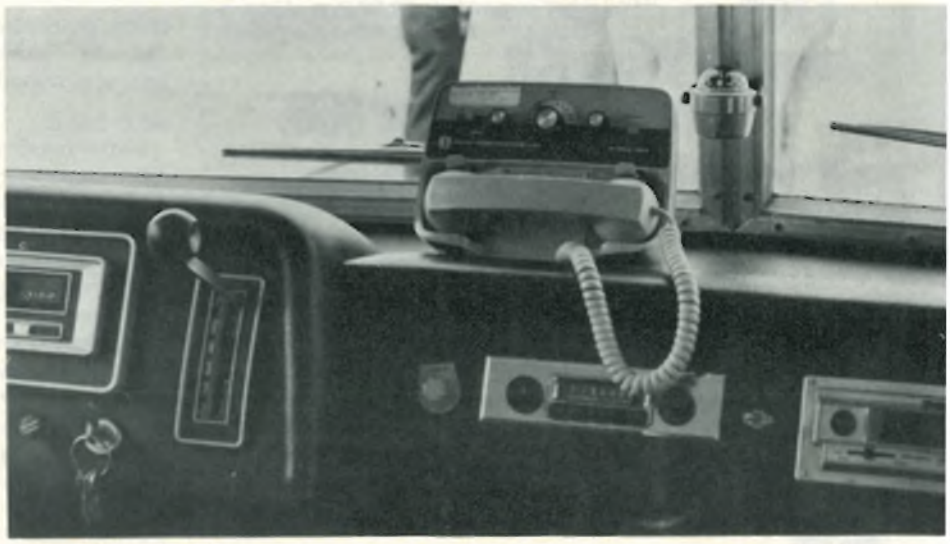
"They merely legitimized some common practices," one CB operator points out. And since CB manufacturers are already straining to produce as much gear as they can, the FCC changes probably will not impact the market for CB equipment immediately. Still waiting for FCC action, however, are other dockets that promise to alter both market size and technology (see "Awaiting action," p. 63).

As all this is going on, citizens' band gear continues to sell like Gangbusters. Manufacturers agree that factory sales of CB sets in the U.S. doubled from $100 million in 1973 to slightly less than $200 million last year. This year, estimates range from $350 million to $400 million—depending primarily on whether or not severe components shortages can be overcome, as well as on FCC action.

Demand. "You might call CB the electronic hula hoop—everybody wants it right now," comments Robert Katz, communications buyer for Radio Shack, the Fort Worth, Texas, division of Tandy Corp., acknowledged as the largest retailer of CB equipment. "Based on the number of licenses now coming through the FCC, there could be as many as 4 million transceiver sets sold in 1976," he says. "That doesn't include walkie-talkies; that's 23-channel, 4-watt-output base and mobile units. And the industry guesses that growth will continue at current rates for the next two or three years."

Transceivers' average factory selling price is $100 each. Marked-up retail prices run from $100 to $200 for mobile units; base stations go from $160 and up. In comparison with this year's 4 million estimate, EIA's Citizens Radio section estimates that 6.3 million CB radios were in use this January.

Imports. "Out of the $350 million sales we're projecting for this year, maybe $250 million of that will be done by import distributors selling equipment built in the Orient," says



Now hear this. Citizens' band radio is gaining popularity as a hobby, but is still used mostly by truck and taxi fleets and the like. Here are a pair of typical installations.

David Bradley, CB marketing manager for E. F. Johnson Co., Waseca, Minn., one of the few survivors of the Japanese CB onslaught of 1970 and by far the largest domestic manufacturer of CB gear.

The U. S. industry lines up behind Bradley's 70% import figure. So does the Japanese Ministry of Finance, which says that in 1974, that country exported 1.435 million CB transceivers with a value of $68 million to the U. S.

Many of the industry's market figures are derived from the number of CB applications filed with the FCC. Observers estimate that 90% of the transceivers are purchased before the applications are filed; a license application is packed in every crate. And the FCC's own rules of thumb are that, for every licensed operator, there's an unlicensed one, and every operator owns 2.5 radios.

In the first six months of this year, the FCC received about 786,000 applications, a figure that's 259% ahead of the first six months of 1974. License applications also show that the year got off to a slow start; the last four months' applications have been averaging 331% ahead of the same month a year earlier.

Awaiting action

Two FCC dockets that have manufacturers on edge would expand the badly overcrowded citizen's band service, but both would require changes in the design of CB transceivers. They are:

- Docket 20120. The FCC has postponed action on this proposal to reallocate the band between 27.23 and 27.54 MHz, and to limit certain channels to single-sideband communications. A proposal to phase out all communications in the band over five years, permitting only single-sideband on the air, will almost certainly be stricken.
- Docket 1975. This proposal would create a new class E CB service at around 220 MHz. Proposed almost five years ago, class E service would open 40 to 80 new channels. The FCC has indicated that it will act on this proposal by the end of the year.

Typical of most sudden and spectacular markets, CB makers were caught short of people, bricks, mortar, and components. E. F. Johnson's Bradley comments, "we've been sold out of equipment for more than a year, and we're on an allocation basis with our existing distributors." John Passini, marketing manager for the Cobra Communications group of Dynascan Corp., Chicago, adds, "the major shortages are switches, which are still labor-intensive, and quartz crystals. And it looks like it's going to continue. Someone's got to grow the quartz blanks—that's where the problem is." Although many manufacturers, particularly the Japanese, are trying to design around the crystal problem by using digital and phase-lock-loop synthesizer designs that require one to three crystals, most sets still need 12 to 14 per 23-channel set. □

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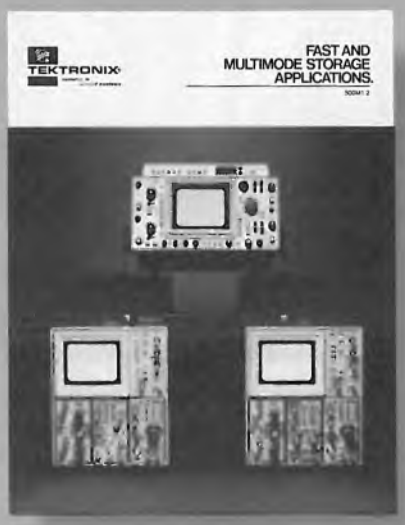

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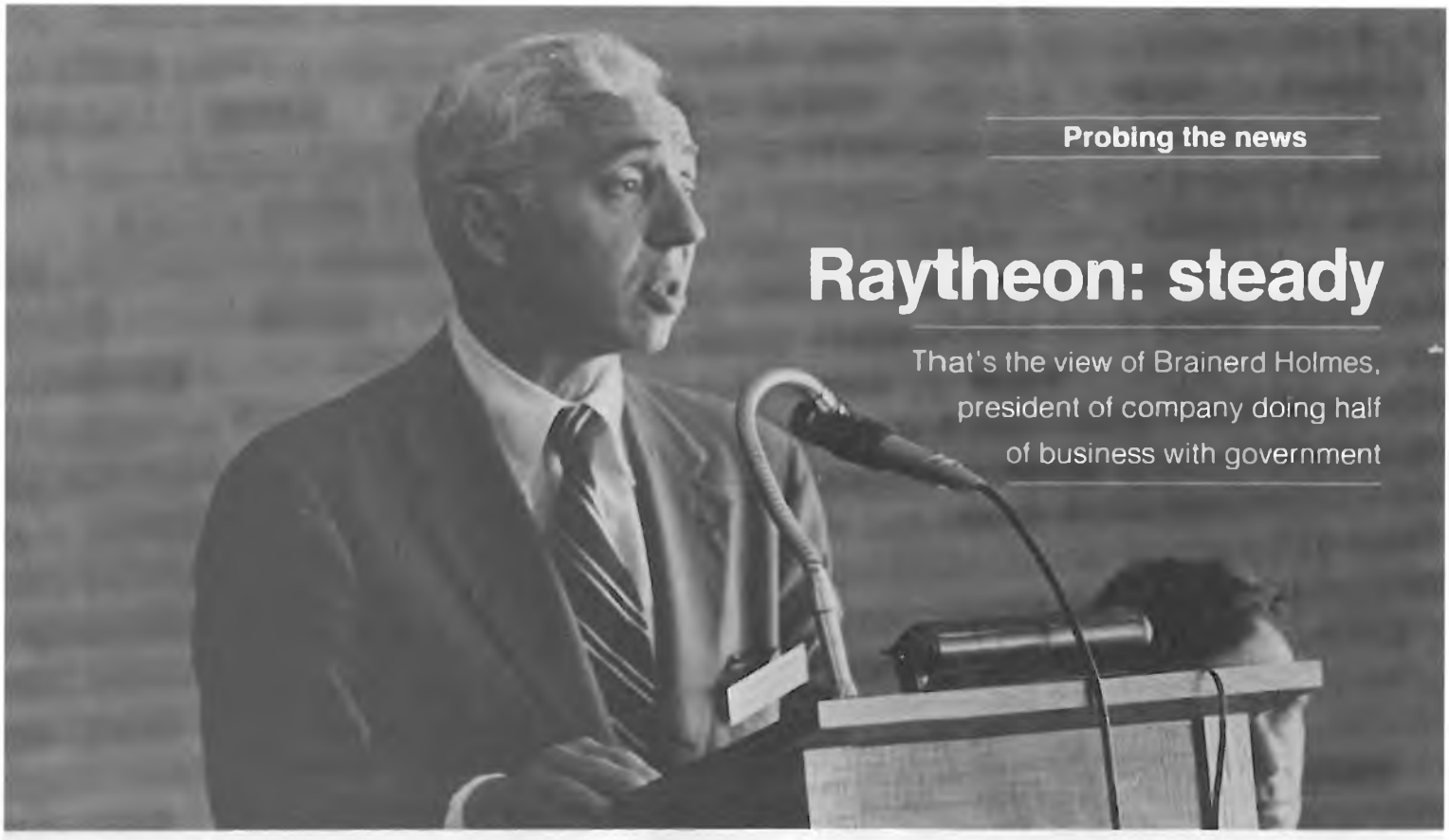


Raytheon: steady

That's the view of Brainerd Holmes, president of company doing half of business with government

Raytheon Co. is one corporation that has been prospering from Government business. Those sales have climbed from $300 million in 1964 to more than $900 million today. This growth has been fueled by a number of high-priority defense programs that include the Army's Improved Hawk air-defense system, the Sparrow air-to-air missile, and SAM-D, a surface-to-air missile system now in development.

Architect of this performance is D. Brainerd Holmes, Raytheon's new president, who joined the firm in 1963 after heading NASA's manned spaceflight program. While Raytheon has much more going for it—in 1974, total sales were $1,928,855,000—Government business still accounts for 41% of sales. And electronics, which includes the Government business, figures prominently with more than $1 billion.

To get Holmes's views of trends in Raytheon's Government and electronics business, the editors of *Electronics* recently interviewed him. Here are the major points:

Q. Why has Raytheon's Government business done so well?

A. Some of the growth is good fortune. A lot of it is due to larger investments in independent development. We've gone from around $9 million in company-funded R&D for Government products in 1964 to $41.6 million for 1974.

Q. How has your military business changed?

A. Our business complexion is entirely different. A very large part of those sales I mentioned in 1964 were two systems—Hawk and Sparrow. We're now pretty diversified in many programs that are in tens of millions. That, I think, has given us a certain stability. This includes programs such as the Improved Hawk, Sparrow, the TPN-19 Air Force landing system, and the Seasparrow.

Q. Do you expect additional growth in your Government business?

A. It gets harder at this level. I don't see it growing at any great rate, other than perhaps through inflation. I see the next five years as roughly flat with sales from $900 million to $950 million.

Q. What are some of the new areas you are working in? For instance, what's the status of SAM-D?

A. SAM-D is one of our most important programs. We hope that it might go into production in 1979. That would probably be the earliest. Proof-of-principle tests to evaluate the missile-guidance program are going well. The program over the next few years is primarily engineering. I think we will have several billion dollars of business out of SAM-D, including foreign sales.

Q. What are some of your other new programs that look good to you?

A. Well, we have several different sonar programs. In the past, we have supplied virtually all of the sonar in the attack-submarine fleet. Now that's being updated, and we're putting it in a lot of locations now. We lost some years ago to IBM for the follow-on fleet—the new ships. But we still built half of it instead of all of it. We have a sonar that we developed with our own funds for patrol frigates. The Navy has bought it, and we're selling that abroad—we have orders from Italy and Spain. In electronic countermeasures, we have jamming equipment on the EA6B aircraft. We are competing with Hughes Aircraft on countermeasures for the surface fleet, with a potential of 250 ships or more. We're going to build jamming equipment for the F-111.

Q. Is there any area that looks better because of overseas business?

A. Well, Hawk is very big overseas. We have this NATO Hawk job, which is just in its early stages, and we're selling Hawk to many other countries, both NATO and Mideast—

we sell it to Japan. But we also are selling Seasparrow, and will be selling Sparrow internationally.

Q. How healthy is Raytheon Semiconductor?

A. It's sort of hanging in there. We have cut back overhead, got a lot leaner and more efficient. We've been running some loss, but we're close to break-even. We haven't seen the turnaround. Optimistically, we expect it at year-end.

Q. Do you plan to put more effort into semiconductors?

A. One of the reasons we've kept the semiconductor business, despite the fact that it hasn't been a big one over the years, is that it gives us a basic technology. We do a lot of advanced development in medium-scale integration, large-scale integration, linear devices, and other devices. So we think it's important to the reliability of our over-all business. We also want to make money, and we think we will in good time.

Q. What's in Raytheon's future?

A. I see a continuing significant effort, particularly in technical contributions to the Government area. But I also see, barring some general change in policy, flat sales. One goal I would like to see us achieve—it's difficult—is to increase to a significant extent the highly technical commercial business. The reason is that, while the diversification program we've had in recent years is fine as far as our total financial position is concerned, it has done very little to diversify the employment of technical people. The only way I see to do that would be to have such people contributing to an end product not for a military use.

Q. What are your goals there?

A. All I can say is that we're not going to do it so fast we would lose a lot of money. But we are looking at areas such as public transportation, environmental work, and a way to process wastes.

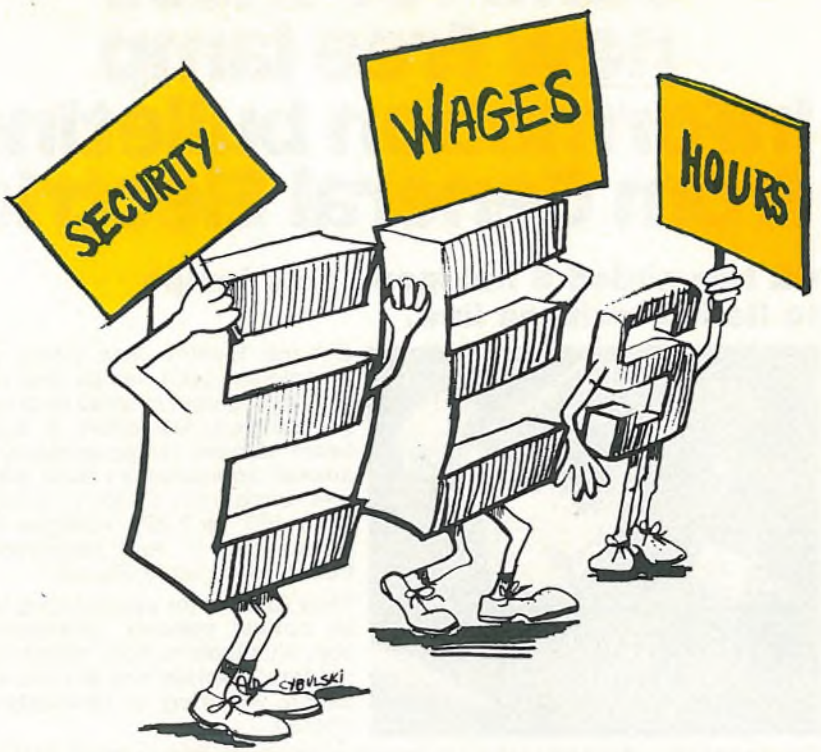
Q. How do you see next year?

A. I think we'll have a good year. With the backlog of business that we have in the energy business and the Government business, even if conditions don't get a lot better, we would still have a very good year. □

You and your career

Wema keeps wary eye on unions

by Bernard Cole,
San Francisco bureau manager



Unionization does not now rank as a pressing issue to most IEEE members, but that attitude could change rapidly if management doesn't act on "major concerns that are troubling the members." That's the view of IEEE president Arthur P. Stern, who is also a Magnavox Corp. vice president, after talking with members across the country. His warning dovetails with a new attitude of vigilance on the part of Wema, the Palo Alto, Calif.-based professional organization representing the electronics industries.

Ever since several of its meetings were subjected to a series of demonstrations six to eight months ago by production workers fearing layoffs, Wema has been keeping a nervous eye on what it considers "relevant" union activity. Wema's concern is focused on a new threat—unionization activity among electrical engineers. Several efforts are accelerating to organize the aerospace industry by the United Auto Workers, the International Association of Machinists, the National Engineers and Professionals Association, the Engineers and Scientists of California, and the nationwide Council of Engineers and Scientific Organizations.

The fear is, says Jerome H. Quigley, of Four Phase Systems Inc., Cupertino, Calif., that if these groups are successful with the aerospace industry, which employs large numbers of electrical and electronic engineers, they may turn their efforts to the semiconductor and instrument companies. Quigley is also a member of Wema's industrial relations unit.

Poll. This concern has been reinforced by an ambiguous, but still statistically significant, 49-question survey taken of its 1,750 members in January by the San Fernando Valley Chapter of the IEEE. Not all the questions were about unionization. But in those that were, of the 503 persons who responded, 166 were in favor of the IEEE's acting as their bargaining agent in negotiations with employers—which its charter currently forbids—41 were willing to pay extra dues to support IEEE collective bargaining activity, and 75 were in favor of an IEEE affiliation with an organization that would do such bargaining.

But if the survey was ambiguous, the unionization of professional engineers within the aerospace industry to date has not been. The focus of organizing efforts has been on six companies in California—General Dynamics/Convair in San Diego, Aerospace Corp. in El Segundo, Kaiser Aerospace and Electronics Corp. in Palo Alto, Rockwell International in Los Angeles, and Lockheed Aerospace Corp.'s Space Technology Center and Missiles and Space Co., both located in Sunnyvale. So far, union organizers have been successful at the first two.

As Four Phase's Quigley puts it, "In terms of significant union activity, the semiconductor and electronics industries, in general, and the San Francisco peninsula, in particular, are untouched territory." But that's not for lack of trying. For example, in Palo Alto, Kaiser on May 4 was able to resist an attempt to organize its professionals.

Worrisome. But to nearby companies in the San Francisco peninsula area, the worrisome thing was the realization that a switch of only five votes would have turned the 30-to-22 company win into a union victory and provided a foothold.

However, an independent engineers' organizing committee, a joint effort by the Engineers and Scientists of California and the International Association of Machinists at Lockheed Missiles and Space Co., has continued to campaign since losing an election in 1972. With the help of NEPA and the UAW, the committee, which is actively pursuing the engineers and professionals, is expected to petition for a new election soon, when it feels it has the strength. Still in the embryonic stage in Los Angeles are unionization efforts among the professional employees at Rockwell International.

How much importance do the big

unions place on organizing engineers? NEPA, with one solid success under its belt, has solidified its relationship with the UAW to the point where the latter has set up a NEPA department under the personal supervision of Leonard Woodcock, UAW president. And while the orientation of NEPA so far is to aerospace, UAW officials point out there is no reason to believe that it will limit itself to that industry. It was simply easier for NEPA to start there because the UAW already has organized some segments of that industry at the nonprofessional factory-worker level, and because "aerospace has less job security."

Don Ephlin, of the United Auto Workers headquarters in Detroit, Mich., says some of the UAW's efforts may involve taking more independent unions like NEPA under its wing. "There are a number of small independent unions that are looking to affiliate with a large national organization," he says. In electronics, there are such organizations as the Association of Scientists and Professional Engineers in Personnel (Aspep) at RCA Corp.'s Camden, N.J., division. Although Ephlin does not claim that the UAW expects to pick up Aspep, he observes that "the desire of professionals to be organized is growing rapidly," a trend he attributes to the recession and to diminishing job security.

CESO resolutions. Other reasons for the increasing unrest among the engineering ranks are apparent from two resolutions passed at the Council of Engineers and Scientific Organizations' recent annual meeting. Both involved legislative efforts to revise patent laws (1) "to ensure the inventor receives economic recognition for his knowledge and efforts," and (2) to eliminate what CESO calls the unfair application of the Fair Labor Standards Act exempt status, which "results in duress placed upon our members to work many, many hours of unpaid overtime, resulting, in effect, in lowering their pay rate, depriving other engineers of employment, and degrading our profession to sweatshop status." □

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Companies

CBS returns to the basics

Renamed Technology Center is concentrating on company's future

by Gerald M. Walker, Associate Editor

The record. Benjamin B. Bauer, head of Tech Center, with four-channel disk.

When CBS Inc. last spring reduced the size and activities of its then CBS Laboratories and changed the name to CBS Technology Center, the move appeared to be a retrenchment, a cut in research and development. However, the intent and result were the opposite—to get back to basic R&D in fields directly related to CBS.

The activities involved in manufacturing and marketing of professional broadcasting equipment were sold to Thomson-CSF of France, and the Government contract R&D operations were spun off to Epsco Inc. of Westwood, Mass. What is left in the CBS Technology Center located in Stamford, Conn., is a greatly reduced staff—about 100 from a high of more than 600—that is concentrating on basic technology involving television and audio research in projects ranging from 10-year horizons to immediate marketability.

Redirection. Heading the reorganized center is Benjamin B. Bauer, vice president and general manager, who has specialized in acoustics and magnetics at CBS Labs for 18 years. He reports to Harry Smith, corporate vice president of technology. "The decision to change directions was simply that we found the lab was spending too much time doing product business and Government R&D and not enough on work for our own future," Bauer explains. "Now it's very unlikely that we will ever manufacture and sell any hardware. Our interest is in technology development and expanding our understanding. That's what a technology center is for; only we had lost sight of that goal."

Still, the former CBS Labs turned out some notable products for commercial and Government use. Perhaps best known is the 33⅓-revolution-per-minute long-playing record, which some experts credit with virtually spawning the modern recording industry. For the Government, CBS developed the field-sequential color-television cameras that went to the moon. Commercially, CBS' automatic color and time-base corrector has made possible the use of portable, lightweight videotape recorders.

Projects. With this background, it's not surprising that despite the emphasis on basic research, practical product development remains an objective of the technical center. That goal is underscored by a rundown of the center's present projects. Now on the drawing boards are:

- Digital television transmission. Perhaps 10 years from practical application, development of techniques for transmitting TV signals digitally is now centered around reduction of bit rate of information without affecting the quality of the picture.
- High-density recording. This is a code word for video-disk recording and playback equipment. CBS has hinted an interest in this potentially big business. As a result, the center has set up a team to keep tabs on other developments in video disks and to explore new recording techniques.
- Audio systems. This group is exploring developments that range from a means of improving the sound of 1⅞-inch cassette tape to the possibilities of transmitting radio signals digitally. Obtaining an acceptable audio bit rate for radio is further along than for picture images, so that practical digital transmission of voice signals is probably five years away.
- Sound reproduction. Bauer's pride and joy, the SQ quadraphonic record is a here-and-now project. Although market acceptance was slow at first, SQ will begin to grow rapidly, now that a single-chip integrated-circuit decoder for the playback equipment has been developed, Bauer believes. Right now, the tech center is concentrating on methods for more efficient manufacture of four-channel matrix records.
- Speakers. The center will continue to refine the Dipole with Variable Axis speaker system developed and marketed a couple of years ago as the Leslie DVX. □

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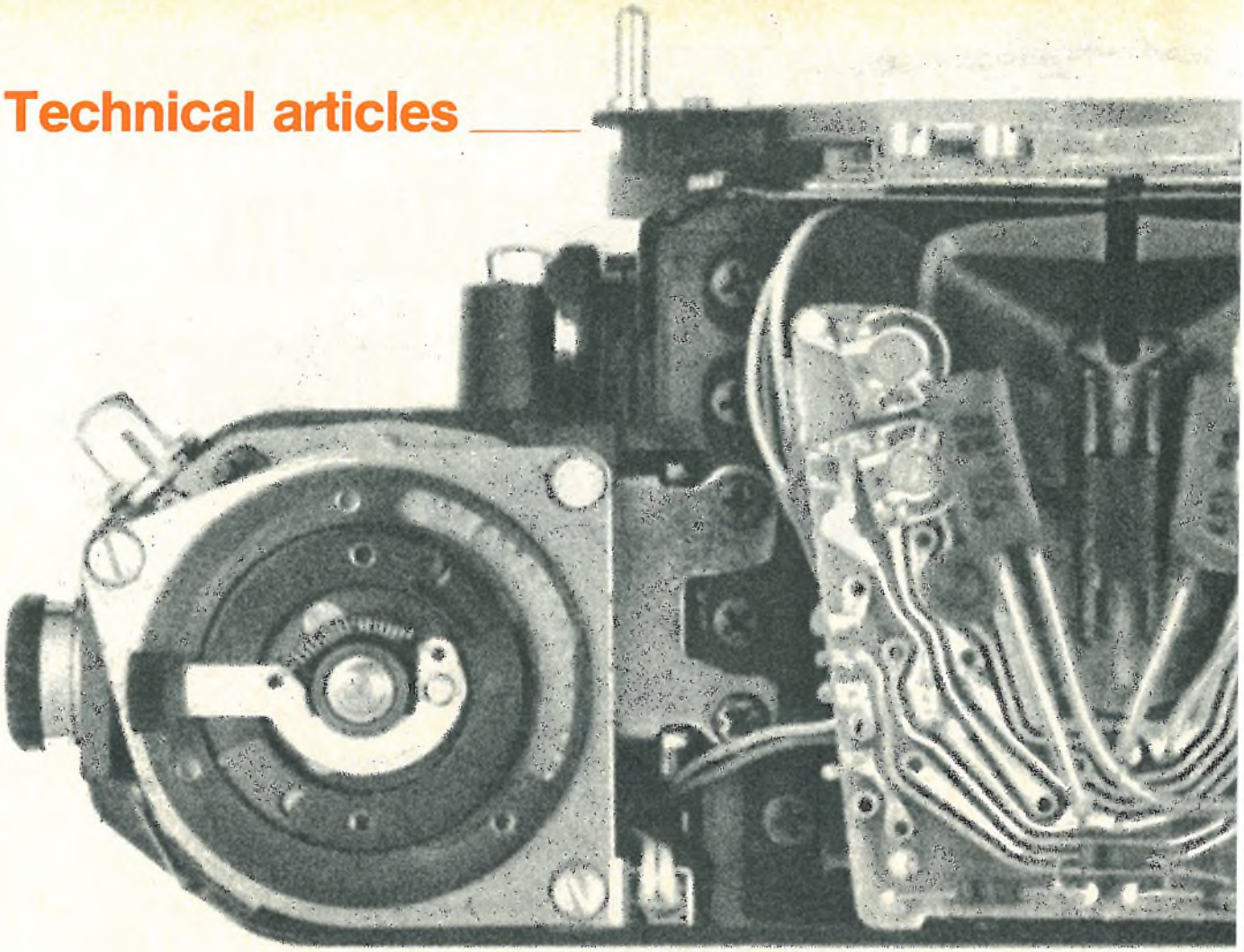


SMART CAMERAS CLICKING

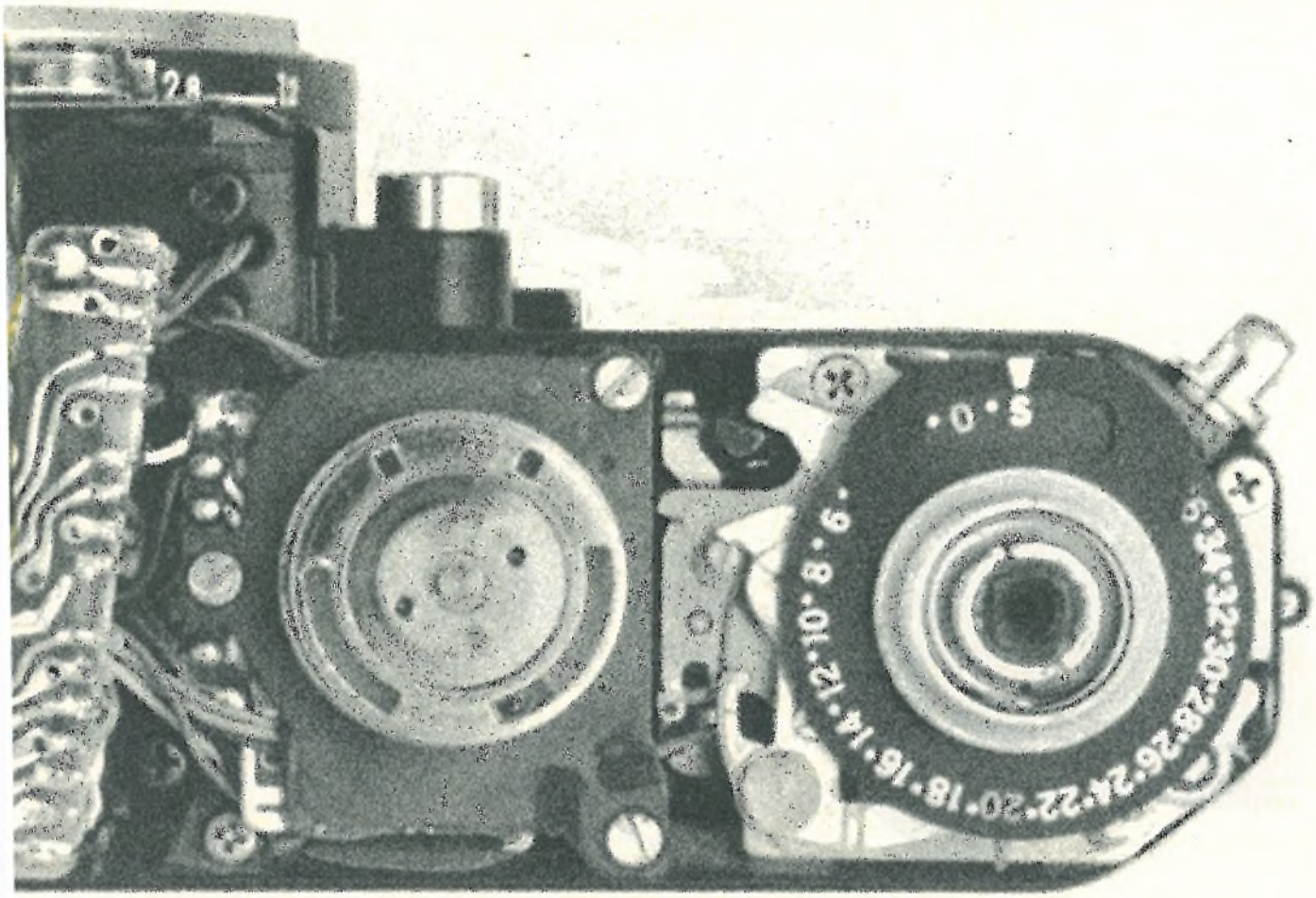
Providing yeast for robust expansion of an already huge photography market, electronic automation shows no signs of slowing down; cheaper, even more reliable ICs, plus new automatic features, are still to come

by Ron Schneiderman,
New York bureau manager

☐ "You press the button," George Eastman said of his Number One Kodak when introducing it in 1888, "and we do the rest." And they did. The exposed film *and* the camera were sent to Eastman Kodak in Rochester, N.Y., where the film was developed, prints made, and the camera reloaded. While some cameras being made today basically are no more sophisticated than Eastman's Kodak Number One, there are other cameras. Indeed, in these cameras, electronics seems almost omnipotent, being largely responsible for one of the fastest and most lucrative growth rates in industry today.

What began simply enough several years ago with the incorporation of photoelectric cells into the body of a camera has come a long way fast. It is now an avalanche of electronics displacing mechanical and electromechanical devices in still- and motion-picture cameras in virtually every price range.

"What all this means," says one camera maker, "is more and more interested people focusing their attention on top-of-the-line cameras, lenses, and specialized accessories." A supplier of electronic components, noting the main business of Kodak, puts it another way: "Kodak sells film. And the best way for it to sell more



WITH ELECTRONIC FUNCTIONS

film is to make it easier to take good pictures."

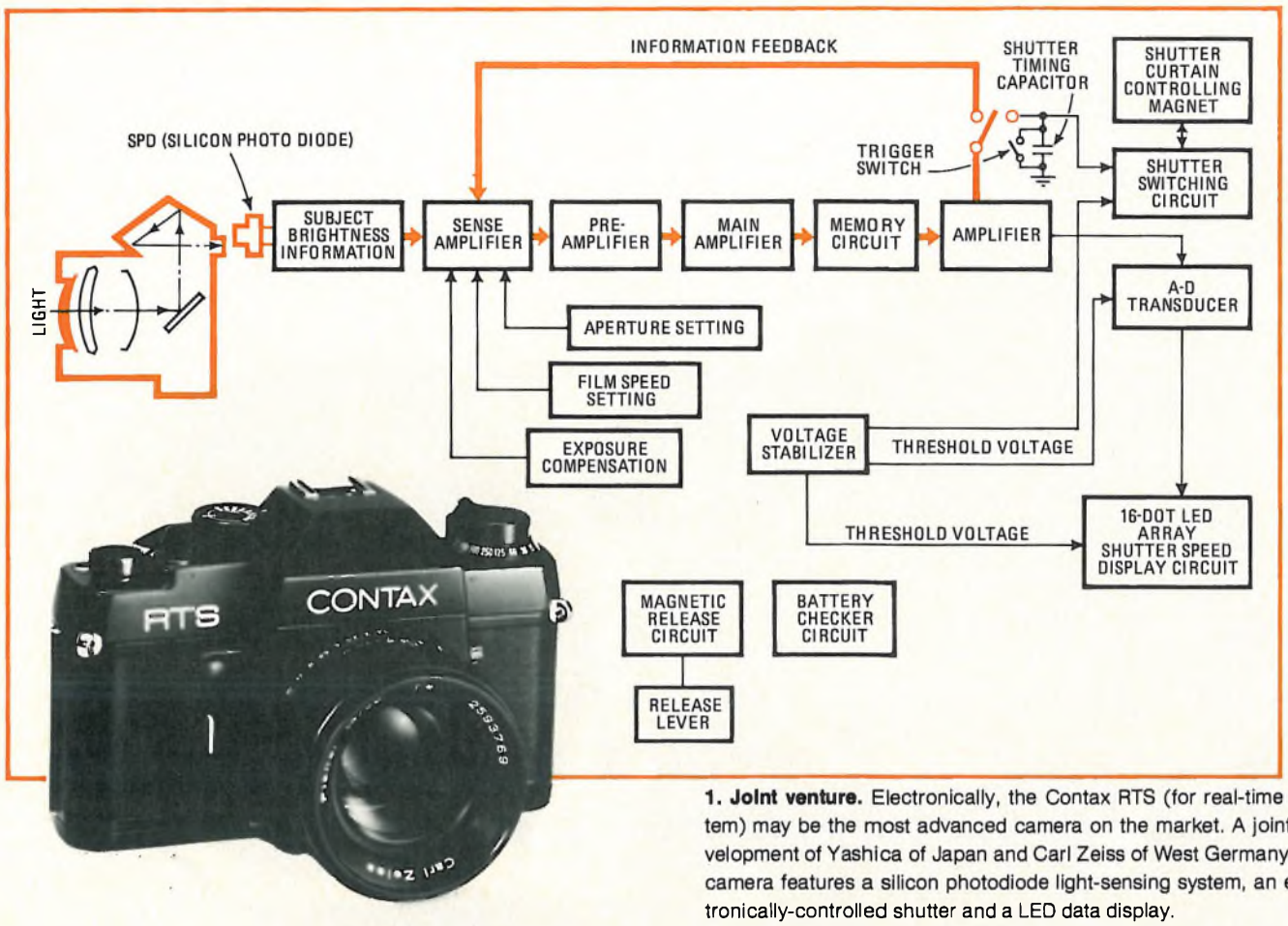
By any measure, photography is a huge market. In the U.S. alone more than 40 million people use cameras. Amateur photographers shoot in excess of 5 billion pictures annually and their yearly expenditures on film, equipment, and photographic services runs to more than $4 billion. In fact the U. S. Department of Labor's Bureau of Labor Statistics has estimated that photography will be the second or third fastest growing industry in the economy during the 1970s, rising an average of 9% a year.

The camera electronics market should grow just as fast. Of the 15 million cameras of all kinds now being sold worldwide each year, barely a third contain any electronic components. That leaves about 10 million cameras that could, but don't, enjoy electronic advantages. Two things must happen to fill the void, according to sources in both the photographic and semiconductor industries: device prices must drop (most camera devices are custom ICs, although both camera and IC makers are anxious to standardize wherever possible), and reliability must be higher. "Reliability has to be fantastic," says one IC supplier. "Everything has to work. Reputations are important in the photographic industry; it's one of the most heavily studied consumer markets there is."

Fairchild Camera & Instrument Corp., which last year dropped out as a supplier of control-circuit modules to Polaroid when the two companies couldn't agree on price (see "A ticklish affair: supplying the biggies," p. 77), has estimated that the market for camera devices will grow to $300 million in 1980. Edward A. Sack, vice president and general manager of General Instrument Corp.'s Microelectronics group in Hicksville, N. Y., sees the market for MOS devices alone as worth $10 million to $15 million. "It's a market we haven't attacked yet," says Sack, "but it's a very exciting area, and we hope to be doing something in photography very soon."

The big picture

Sam Zausner, executive vice-president of Berkey Photo Inc. and former president of the National Association of Photographic Manufacturers, foresees a wide range of developments to keep things interesting. He predicts "mass production of self-focusing lenses, more integrated circuits for shutters and other camera con-



1. Joint venture. Electronically, the Contax RTS (for real-time system) may be the most advanced camera on the market. A joint development of Yashica of Japan and Carl Zeiss of West Germany, the camera features a silicon photodiode light-sensing system, an electronically-controlled shutter and a LED data display.

trols, and a greater combination of photography and other video forms. Photography and electronics are simply becoming more closely allied."

Kodak, which sells literally millions of Instamatics each year, and Polaroid, with its "instant-picture" cameras, naturally generate most of the interest among semiconductor makers. They are, so to speak, "the mass market." The Japanese, however, have been outstanding innovators in electronic camera controls. By 1972 the Japanese-produced Pentax, Canon, Yashica, Minolta, and Fuji were all featuring electronic models with automatic exposure capabilities. Fuji, Nikon, Miranda, and Yashica, in their 35 mm single-lens reflex (SLR) cameras, have since gone so far as to drop the mechanical needle for indicating correct exposure in favor of light-emitting-diode (LED) indicators. A further shift now underway by several Japanese camera makers is from cadmium-sulfide (CdS) light sensors to silicon blue cells, which generate their own current and are more reliable under very bright lighting conditions.

Unlike the U. S., where two companies dominate the camera field (and with each of them having a series of cameras that essentially are only step-up models of one another), in Japan, models of the same general class of camera from the same manufacturer can be based on entirely different philosophies. One example is the Nikon and its brother the Nikkormat EL. The Nikkormat EL uses an "aperture-preferred" exposure system in which the photographer selects the diaphragm opening he wants and the camera automatically adjusts the shutter speed for the correct exposure. In such cameras a "memory" capacitor is charged by the light-sensing photocell, and when the shutter is opened, charging is discontinued. With the voltage on the capacitor as a reference, a timing capacitor begins to charge, and when its voltage equals that of the memory capacitor, the shutter is closed. The Nikon F2, on the other hand, has a "shutter-preferred" system in which the photographer selects a shutter-speed and the camera automatically sets the correct aperture, usually with positioning servos. Most electronically-controlled models are aperture-preferred, presumably because automatic shutter control is a simpler and more mature technology.

Guarding jealously

Kodak likes to be secretive about the innards of its cameras ("Of course," as one spokesman observed, "we can't stop you from buying one and breaking it open"). What *is* known is that Kodak is expanding its IC design group. Initially the group's interests are in bipolar linear ICs but expansion into MOS and integrated-injection logic (I^2L) is planned.

The cameras that Kodak has been selling so far have largely been the simpler ones, those at the low end of the Instamatic line. "A high proportion of their sales," says Susan Black, a photography analyst for the Wall St. brokerage firm of Drexel Burnham Co., "has been in the Model 20, for example, just a simple aim-and-shoot

A ticklish affair: supplying the biggies

With few exceptions, supplying camera circuits to Polaroid and Kodak has been pretty much an on-again off-again affair.

Texas Instruments supplies the motor and shutter-control modules for Polaroid's highly-touted SX-70 instant-picture camera. A third SX-70 module, the flash circuit, was originally built by General Electric. When GE left the IC business, Fairchild Camera & Instrument Corp. and Sprague Electric Co. in North Adams, Mass. became Polaroid's flash-bar-control circuit sources.

Fairchild's contract with Polaroid, signed in late 1972, called for what was then expected to be $19 million in circuitry for the SX-70. Under the contract, Fairchild supplied all three electronic modules for the SX-70, for exposure control, flash-firing, and motor-control functions. But subsequently the two companies failed to agree on price and volume terms in negotiating a renewal of the contract, and Fairchild stopped delivering two of the three modules at the end of March 1974. Some months later Fairchild also stopped delivering Polaroid's flash-control modules.

The SX-70's timing or exposure control and the motor control modules for loading and ejecting film were developed independently by TI and Fairchild, but both to Polaroid's specifications. They differed only slightly in packaging but significantly in the degree of integration. TI made a discrete photocell, whereas Fairchild integrated the light-gathering silicon photocell and bipolar exposure-control circuits on a single chip. In fact, a number of semiconductor industry sources believe the reason Fairchild dropped out of the Polaroid picture was that it could not compete successfully with TI's more competitive discrete prices.

At the moment, Fairchild has no activity in the photographic area. Wilfred Corrigan, FC&I president, in an obvious reference to Polaroid, says that to commit a major production effort to "a demanding customer who participates in an unpredictable market is not too smart. If we ever do it again we want a share of the profits."

Polaroid over the years has gained a big chunk of the total consumer camera market. The Cambridge, Mass.-based company is now selling at the rate of more than 2 million non-SX-70 camera models a year and has just sold its 2 millionth SX-70 after three years on the market.

Sprague, meanwhile, in addition to the flash-bar-control circuit for Polaroid, supplies flash-firing devices to Berkey Photo. Sprague also has made shutter-control ICs for Kodak, but currently has no Kodak business.

G. T. Schjeldahl Co.'s Electrical Products division in Northfield, Minn. makes flexible circuitry for both Polaroid and Kodak, and GE is Kodak's prime source of flash-control pc boards for its top-of-the-line Instamatics. Significantly, GE went so far as to develop a new technique for fabricating pc boards to satisfy Kodak's high production and low-cost requirements for its flashcube control assembly.

This development, says GE, should make it one of the world's largest quantity producers of pc boards within the next 12 months, with production scheduled to reach tens of millions of units annually.

One such circuit board is incorporated in each of the millions of FlipFlash arrays that GE is now marketing. The circuits will feed electricity to the eight flashcubes and—in combination with special switches developed by GE—control the sequence of firing. To meet Kodak's requirements, Arthur M. Bueche, GE vice president for research and development, says GE had to invent an inexpensive, fast-drying conductive ink that could be applied by a screen-printing process and dried in a few minutes. At GE's FlipFlash plant in Matoon, Ill. the conductive ink is automatically screen-printed in circuit patterns on low-cost substrates.

Motorola's Semiconductor Products division in Scottsdale, Ariz. had developed several proprietary devices for Kodak, Polaroid, and a few Japanese camera companies, but the only thing a division spokesman would say about its current photographic activities is, "We no longer supply either U. S. camera maker."

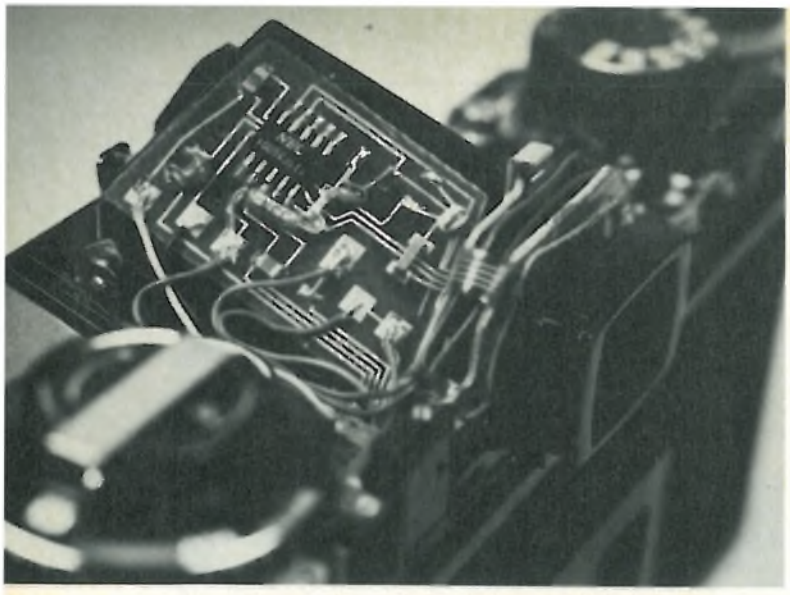
Micro Components Corp., originally the Micro Electronics Manufacturing division of North American Philips Corp.'s Amperex subsidiary in Slatersville, R. I., was formed in May, 1972 when Amperex decided to abandon the IC business. Amperex had been making linear ICs on plastic film in an assembly process similar to the Minimod line developed by GE and was selling them to Kodak for one of that company's cameras. Kodak continues to be Micro Components' biggest customer for custom bipolar linear ICs. Micro Components also supplies Sedic Ltd. in Tokyo, which assembles pocket cameras under contract to Canon, Yashica and Fuji, among others.

"We're shipping more ICs to camera manufacturers than to anyone else," says Micro-Components' marketing vice-president Charles J. Grandmaison. According to Grandmaison, Micro Components was the only IC firm with an exhibition at the last international Photokina equipment expo in Cologne.

camera with a fixed aperture and two speeds, 1/100th and 1/40 second."

Meanwhile Polaroid, which so far has had the instant-picture market all to itself, is taking care to defend the status quo. It has asked a Federal district court in Delaware to enjoin Berkey Photo Inc. from making, using or selling the Berkey XF-1000 instant-picture camera and is seeking triple damages on charges of patent infringement. Berkey officials counter that the XF-1000 is "a product of independent development by Berkey engineers and has many of its own patentable features," although its design will permit it to use the film developed for Polaroid's SX-70 model. Berkey won't say when the camera will be formally introduced.

Polaroid has also gone to court with Bell & Howell Co. of Chicago over its "instant movies" line of photographic products. Polaroid had planned to have an instant motion-picture camera and projector on the market this summer. But Polaroid and Bell & Howell are suing each other for alleged breaches of contract concerning design and development work Bell & Howell did on the camera and projector. According to Polaroid's suit, Bell & Howell informed Polaroid on April 24, 1974 that it had decided to withdraw from the project, which Polaroid insiders referred to as Project Sesame. Bell & Howell is seeking more than $23.7 mil-



2. Timing network. The pentaprism circuit board contains most of the 35 mm SLR's shutter-control system in this Asahi Pentax, an "aperture-preferred" camera in which the photographer selects the diaphragm opening. Shutter speed is then set automatically.

lion from Polaroid in alleged damages, while Polaroid is asking at least $27.1 million against Bell & Howell.

Kodak's long-anticipated instant camera, designed to compete with Polaroid, will necessarily offer more in terms of automated functions. Susan Black, the market analyst, expects Kodak to enter the instant-picture camera market early next year. "But that's a guess," she says. "Kodak new-product introductions are usually well-kept secrets. They don't talk, period. They certainly don't talk about new products, or new product development."

In addition to the instant-picture model Kodak plans to announce sometime next year, a new high-speed color-print film, rated at ASA 400, the same as its popular black-and-white Tri-X film. The move is designed to boost the attractiveness of some of the company's more sophisticated (and higher priced) cameras in the Instamatic line.

Holding back

So pervasive is the Kodak name in pocket cameras and film that Black believes its competitors, particularly the Japanese, have held back on their own new pocket-model introductions—including some with automated features—in anticipation of the higher speed Kodak film. "Kodak's competitors," explain Black, "don't want a new product out on the market that won't accept the new film, and they don't yet know the configuration of the cartridge for the new film."

Contax, the chief German rival against Leica in the days when rangefinder cameras reigned supreme, is introducing its second single-lens reflex camera this month. Electronically, it may be the most advanced 35 mm on the market.

The new Contax RTS (for real-time system) was developed jointly by Yashica in Tokyo and Carl Zeiss of Oberkochen, with Yashica contributing the electronics and camera technology and the West German firm the optics.

The new Contax is jam packed with electronics componentry. On six small circuit boards are grouped almost 100 devices, including hybrid and monolithic ICs, a 16-dot light-emitting-diode display, two electromagnets, and an assortment of resistors and capacitors. The camera uses a voltage stabilizer, an analog-to-digital transducer between the output amplifier and the LED array, and a memory circuit for storing light-gathering data immediately prior to the flip-up action of the deflection mirror.

After the film speed and aperture are set (thus an aperture-preferred system) the light is "read" through the lens by a silicon photodiode, and the current it produces is fed to a sense amplifier. The film speed, aperture setting and light data go to a preamplifier, pass through a main amplifier and then to a computer circuit. Variations of the light intensity are handled by a feedback circuit from the output amplifier back to the sense amplifier. Using this information, the computer calculates the shutter speed and sends this to an output amplifier.

The 16-dot LED array, arranged vertically along the right edge of the viewfinder, coincides with an adjacent column of shutter-speed numbers. If two LEDs light up simultaneously, an intermediate shutter speed is being used. Under manual exposure control, exposure is easily set by matching a LED dot and an indicator needle.

Nothing escapes

Much of the same electronics in the Contax RTS will be found in Yashica's independently designed FX-1, which should be available in the U.S. in late fall. It has not yet been priced.

The sequence of events in both the RTS and FX-1 are basically the same: The ASA film speed is set for the particular film in use, and the aperture setting is deliberately chosen by the photographer. The exposure-reading circuit's main switch is operated when the film is advanced, putting it on stand-by. Partial depression of the shutter release button activates the computer circuit by operating the power switch. With power flowing, the light sensors (the FX-1 uses CdS cells) read the light and send the information to the IC computer which stores it in the memory circuit, after computing the precise exposure in terms of current. At this point, shutter speed readout (a mechanical match needle in the FX-1) displays the shutter speed.

When the shutter release button is fully depressed, input to the memory is switched off and a current activates the electromagnet to hold the rear shutter blind in place. At the same time the mirror flips up and the automatic diaphragm lever operates to close the lens aperture to its preselected position. The front shutter blind then traverses the film plane, exposing the film to the image.

Simultaneously the shutter-timing circuit is activated charging a capacitor to the required level. When this level is reached, discharge takes place, which operates the switching circuit, cutting off power to the magnet that holds the rear shutter blind. With the magnet de-energized, the shutter blind is released and traverses the film plane, closing the shutter. The entire sequence takes place in a fraction of a second. In the manual

ICs play many film roles

Movie cameras usually require only aperture control, as the shutter speed is limited by the frame rate. But engineers at Siemens AG, together with designers at the German-Belgian photographic equipment combine Agfa-Gevaert, have developed an MOS device that performs a variety of camera-control functions previously handled mechanically.

The Siemens device, the S181, is a highly integrated, low-power circuit, designed specifically for a family of 8-millimeter consumer cameras that Agfa-Gevaert plans to introduce in the fall.

They are the Agfa Movexoom 6 MOS Electronic, to sell for about $425, the Movexoom 10 MOS Electronic, to be priced from $638 to $680, and the sound-film Movexoom Sound MOS Electronic, which goes for about $766. All will be built at Agfa's Munich facilities.

Besides the S181 MOS circuit, the Agfa cameras contain two Siemens bipolar ICs, the TCA955, which controls motor speeds, and the TCA965, which operates in conjunction with a light-sensitive photoelement and determines the diaphragm opening. One of the tasks of the S181 is to control a four-phase stepper motor that sets the diaphragm opening.

The S181 also controls the film-feed motor in five different modes. In the single-picture setting, the camera takes only one picture when its release button is pushed. In the so-called single-picture-repeat mode, the camera takes single pictures at a preset rate, which can be varied from one picture each 0.1 second to one a minute.

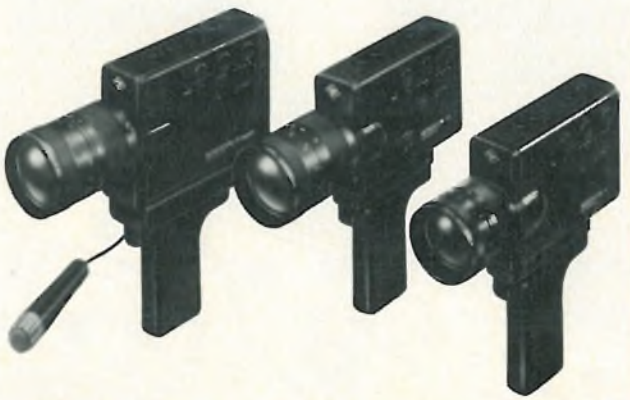
The so-called title-picture function photographs four frames after the release button is pushed, a useful feature for trick photography. In the setting for 5-second operation, the film-feed motor starts to run for 5 seconds 10 seconds after the release is pressed. In the last mode, 10-second operations, the film-feed motor runs for 10 seconds after waiting out a 10-second delay.

The S181, says Gunter Katholing, Siemens MOS-product manager, integrates some 1,800 transistors on a chip measuring 3 by 3 millimeters. This packing density is achieved through the depletion-load process in which the large-scale load transistors common to standard MOS-fabrication techniques can be replaced by much smaller ones exhibiting depletion characteristics.

These small-area transistors, which perform like constant-current sources, consume far less power than the large-area ones made by standard MOS technology, says Katholing. At the same rise-time values, the power consumption of the transistors is smaller by a factor of five. The process also makes possible MOS circuits that need only one supply voltage, another advantage for camera applications. The S181, built by ion-implantation, typically operates on a 7-v power supply and consumes only about 30 milliwatts.

The Agfa cameras also are compact, measuring 15.8 by 9.8 by 4.1 centimeters—a size that may encourage their owners to carry them more often.

For the camera user, the functions the circuit performs spell greater operating ease, allowing greater attention to the more creative possibilities of movie making.



mode, the same sequence occurs but without the memory stage of the computer circuit.

The Contax RTS hit the West German market this month and, according to an official of Yashica Europe GmbH in Hamburg, won't be available in the U. S., or Japan officially until the fall, although promotional work is already warming up. It will be priced at retail between $608 and $650.

Matsushita Electric Industrial Co. has made it possible for many 35 mm SLR makers to install aperture-preferred electronic exposure controls with no major modifications to the present structure of the bodies or lenses of their cameras. Matsushita has developed a kit, available to manufacturers for $20, that contains circuitry for automatically setting the length of exposure, from 0.0005 second to 4 seconds. Since Matsushita's system measures the light at a given aperture in 2 milliseconds, it is not necessary to accomodate special devices to permit the calculation of exposures while the lens is wide open.

Another of the more significant innovations has been the use of fast-turnoff thyristors. It is these device that automatically regulate the duration of an electronic photoflash, and therefore control film exposure.

In early photoflash units, the light source (usually a xenon flash tube) was triggered by short circuiting an electrolytic capacitor through a cold cathode thyratron. In the newer "computerized" photoflash units, a second thyristor turns off the switch thyristor.

In these newer units, a light sensor, normally a silicon photodiode or phototransistor, picks up the light reflected from the subject. Its output, amplified and integrated, actuates a switching circuit when its output reaches a predetermined value. That circuit triggers a so-called quench tube—a small low-impedance gas tube that short circuits the flash tube—thus terminating the flash and discharging the energy still stored in the capacitor. The quench tube is a simple arrestor-type gas-discharge tube with external trigger electrode; capacitive current flowing from the trigger electrode to cathode is sufficient to fire the tube.

More recently, Siemens Corp.'s Components group in Iselin, N. J., which supplies flash tubes and other components to Kodak, Polaroid, Berkey Photo, and Honeywell Inc., developed a triggerable surge-voltage-protector (SVP) tube to replace the commonly used quench-

3. Tens of millions. General Electric Co. has developed a fast, inexpensive technique for fabricating these printed circuit boards for Kodak's "FlipFlash" array of eight flashcubes. GE says it will produce tens of millions of these units annually for the photo market.

type device and thereby increase flash frequency.

According to Donald Epand, Siemens' marketing manager, the triggerable SVP has a two to three times higher holding current than the quench thyristor. "In the actual circuit, that means that the charging resistor of 27 ohms for the 6.8 microfarad quench capacitor can be reduced to 3 ohms. The quench capacitor of 6.8 μF is thereby being charged faster, enabling a flash sequence of, for instance, two to three times per second as compared to once a second."

Epand says the triggerable SVP is completely insensitive to fast rates of current rise, where this parameter has to be considered for the quench thyristor. Furthermore, says Epand, the resistance in the conducting mode for the quench thyristor is higher than for the triggerable SVP. "This makes it possible to generate a current pulse in the triggerable SVP of, for instance, 300 amps, where it is only possible to generate approximately 200 amps with the quench thyristor."

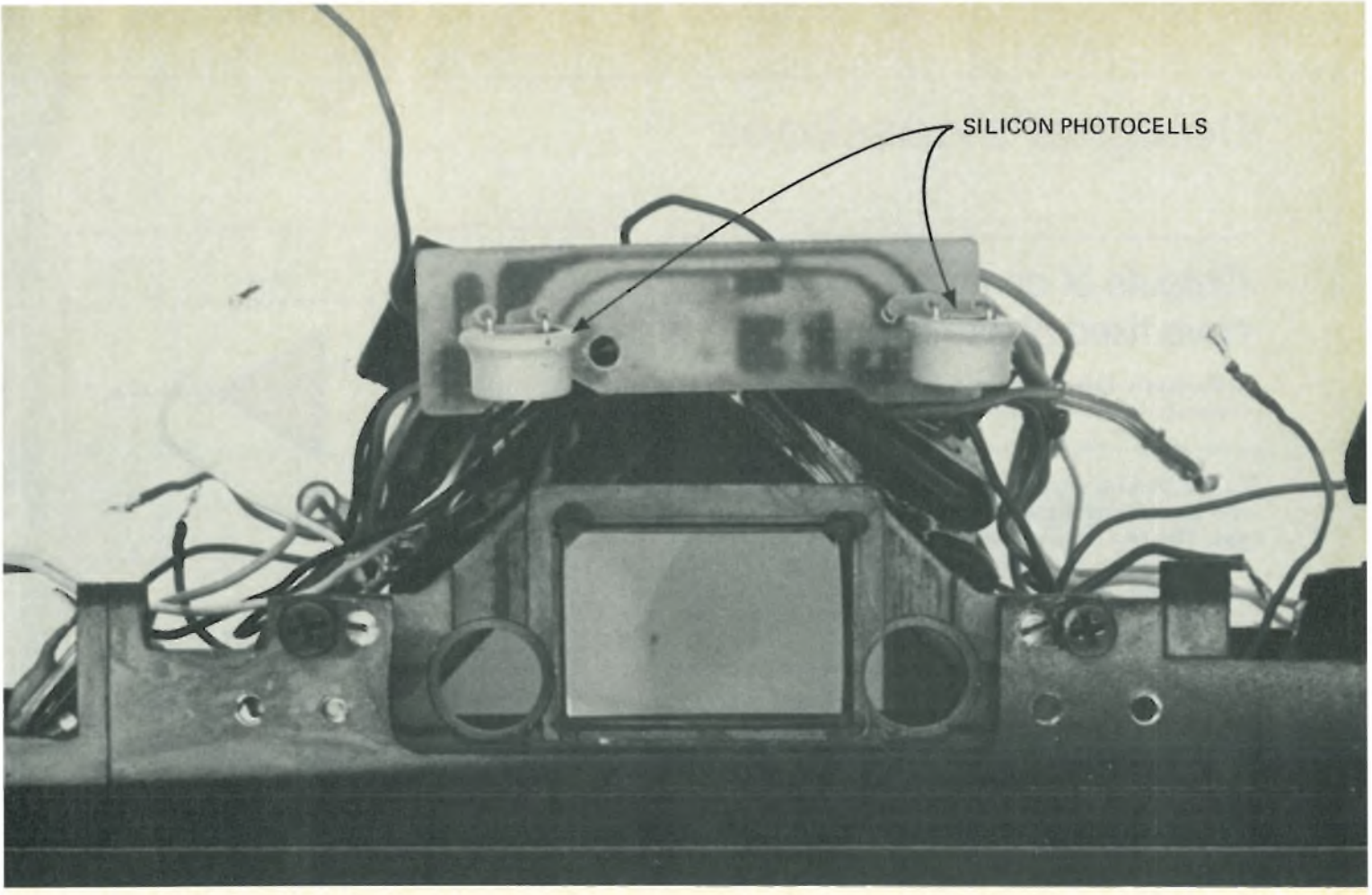
One drawback in photoflash systems is that the photographer is limited by the position of the flash unit, making it necessary in off-camera and bounce-flash techniques to switch to manual operation. Honeywell gets around this by separating the light-sensing element from the flash system. Then, with the sensor at the camera's position, the light reflected back to the camera shuts off the flash. The result is on-camera exposure control, no matter where the flash unit is pointed.

Selig Gertzis, president of Micro Components Corp. in Cranston, R. I., says electronic flash units accounted for only 3% of the total worldwide flash market last year. But he notes that while slightly over 30% of all non-instant pictures taken last year were with some type of flash system, at least 60% of all instant-pictures were snapped with supplemental flash. The significance of this, Gertzis believes, is that the introduction of Kodak's instant-camera should mean a lot more flash-circuit-device business for Micro Components and others.

Another factor in the components suppliers' favor—if true as photo industry sources believe—is that Polaroid is considering replacing its costly flashcubes on some models with an integral electronic photo-flash system. Polaroid's rationale reportedly is that with flashcubes averaging 6 cents per flash, and electronic photo-flash as low as 1/10th of a cent per flash, it stands to have a more marketable camera.

Now for I^2L

In the future, Gertzis foresees a major market in consumer cameras for integrated-injection logic (I^2L) because of its low power requirements, circuit density and versatility. At least his company is developing some prototype I^2L devices. And he anticipates the ability to combine functions on a single chip, such as shutter control and flash-duration control. Micro Components also plans to extend its experience in producing "flip-chips," a technique developed by IBM Corp. calling for face-



4. Shift to silicon. A recent innovation is the switch from cadmium-sulfide (CdS) light sensors in cameras to silicon blue cells, which generate their own current and are more reliable under extremely bright conditions. Silicon cells also are more sensitive in low light conditions.

down bonding rather than "chip-and-wire" face-up bonding and wire assembly of hybrid microcircuits, to camera devices. "It is a high-volume automated assembly method offering lower assembly costs and improved yields and reliability with complex functions," says Gertzis, an ideal combination for photographic applications.

A distant possibility is the complete elimination of aperture and shutter mechanisms, and their replacement by polarized lenses. Scientists at RCA Laboratories in Princeton, N. J. have developed a relatively simple liquid-crystal dynamic scattering technique in which the amount of light passing through the lens can be controlled by applying a certain voltage and thereby switching the materials from opaque to transparent. Since the degree of scattering, and hence the liquid-crystal cell's opaqueness, is directly related to the applied voltage, a grey scale is readily attainable. In actual use, a light-sensing photocell placed next to the lens could control the voltage source so that only the desired amount of light can pass through the lens.

Future cameras may also have automatic focusing systems. Polaroid and Kodak are known to be working with several schemes, and Nikon of Japan has already demonstrated completely automatic focusing from 3.3 feet to infinity with an 80 mm f/4.5 lens called AF-Nikkor. The prototype is part of a complex and compact electro-optical system based on the principle that an in-focus image contains more contrast than an out-of-focus image. A photocell reads contrast differences in a 3 mm image circle in the center of the 35 mm frame and "hunts" for the area of greatest contrast. A miniature electric motor drives the lens back and forth in response to the contrast-difference signals from the photocell's electronic circuit. Because of its cost and complexity, the Nikon system isn't slated for introduction any time soon. But it does serve as an indication of the desire of camera makers to automate virtually every important operating function of a camera.

Not surprisingly, electronics has caused at least some minor headaches among mechanically-oriented camera technicians. Samuel L. Love, president of National Camera Co., Englewood, Colo., which repairs cameras, trains camera technicians, and writes technical manuals for several camera makers, says, "As far as the technician is concerned, the electronics has really been a burden.

"He's being forced to learn things that he's been very reticent about learning over a number of years. Our campaign has been, 'Look fellas, this is the way it is and you're going to be seeing a lot more of it.' They're learning. And we're learning, too."

What is especially satisfying to quality camera makers is that many professional photographers who once swore never to touch "automatic" cameras, now see them as opportunities to concentrate more on the creative aspects of their work, and occasionally admit that even their pictures are improving. □

Outputs of op-amp networks have fixed phase difference

by Richard K. Dickey
California Polytechnic State University, San Luis Obispo, Calif.

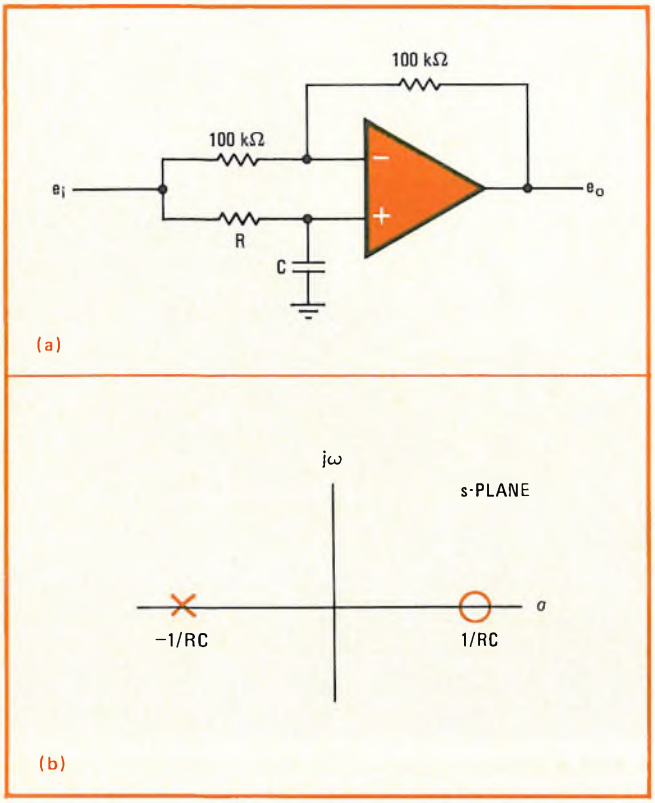
In the phasing method of single-sideband generation, two modulating signals are derived from the audio input. The two signals must have equal amplitudes, but must differ in phase by 90° at all frequencies in the audio band. A differential-phase-shift system that provides these two signals can be made from resistors, capacitors, and operational amplifiers.

The basic section of the constant-phase-shift system is the op-amp circuit shown in Fig. 1. The transfer function of this circuit is

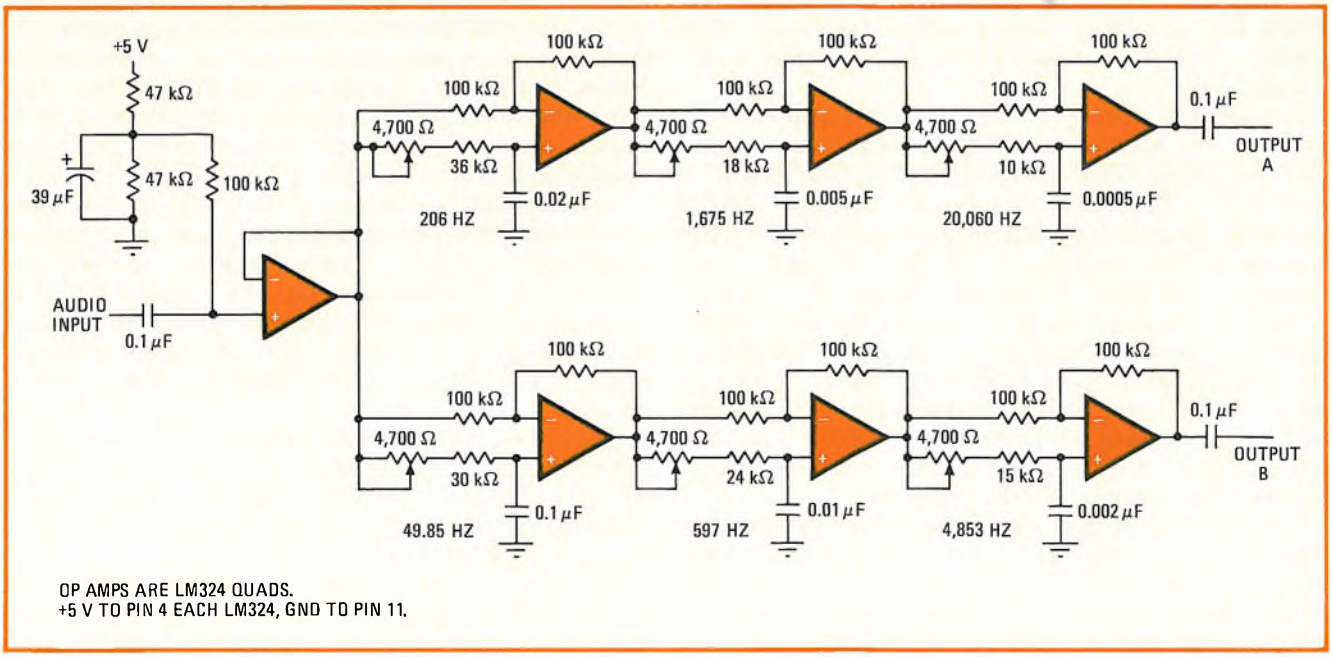
$$e_o/e_i = (1 - j\omega RC)/(1 + j\omega RC)$$
$$= 1 \angle -2 \arctan \omega RC$$

Thus the gain is always unity, and the phase shift decreases from 0 to −180° as frequency increases from zero to infinity. The shape of the phase-shift curve depends upon the time constant RC, i.e., upon the locations of the singularities in the s-plane plot that is included in Fig. 1.

If three of these basic sections are cascaded, the over-all gain remains constant at unity, and the over-all phase shift through the network falls from 0 to −540° at



1. Basic section. Op amp connected as shown (a) is a unity-gain phase shifter. Singularities of circuit are shown (b) in s-plane plot. Phase shift ranges from 0 at dc to −180° at infinite frequency; however, gain is unity at all frequencies.



2. Quadrature. Differential phase shifter converts audio-frequency input signal to two outputs, 90° out of phase, for SSB modulation. Simple transformerless circuit uses quad op amps driven by a single-ended 5-volt supply. The individual sections are adjusted for 90° phase shift at the frequencies indicated on the figure; the two outputs are then in quadrature to within 2° from 100 Hz to 10 kHz.

a rate that is determined by the three RC products.

Two such phase-shift networks, fed from a common input (as shown in Fig. 2), can be designed so that the phase shift through one lags behind the phase shift through the other by 90° over a substantial frequency range. The time constants are chosen so that the singularities of the two networks interlace.

The all-pass system in Fig. 2 provides two equal-amplitude outputs that differ in phase by (90 ± 2)° over the frequency interval from 100 hertz to 10 kilohertz. The various R and C values were calculated from the table published by S.D. Bedrosion, "Normalized Design of 90 Degree Phase Difference Networks," IRE Transactions on Circuit Theory, June 1960, pp. 128–136. In each section, RC = $\frac{1}{2\pi f}$, where f is the 90° frequency for that section as shown in Fig. 2. An exception is the 20,060-Hz stage, where R was decreased to compensate for the inherent phase shift in the op amp.

Each section of each network should be individually adjusted to an exactly 90° phase shift at the indicated frequency. This adjustment can be made by connecting the input and output of that section to the horizontal and vertical inputs of an oscilloscope, and then varying the 4,700-ohm potentiometer until the Lissajous figure is a circle. Alternatively, a phasemeter can be used.

Each op amp is one quarter of an LM324 quad amplifier. The input biasing network allows operation from a single 5-volt supply. □

Linear pot and op amp provide tapered audio volume control

by Robert C. Moore
Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Md.

Tapered potentiometers are used in audio amplifiers to compensate for the nonlinear response of the human ear. However, at a lower cost, a linear potentiometer and an operational amplifier can approximate the response of the tapered pot.

The audio taper for potentiometers is described by the gain function

$$V_{out}/V_{in} = f(\alpha) = 10^{2(\alpha-1)}$$

where the potentiometer displacement α can range from $\alpha = 0$ (in the full counter-clockwise position) to $\alpha = 1$ (in the full clockwise position). Signal attenuation through the potentiometer can be expressed in decibels as

$$Attenuation = 20\log(V_{in}/V_{out}) = 40(1-\alpha)\ dB$$

This expression shows that the attenuation in decibels is proportional to the potentiometer displacement from the full clockwise position. To obtain this reverse-logarithmic-gain function, special nonlinear potentiometers are usually used.

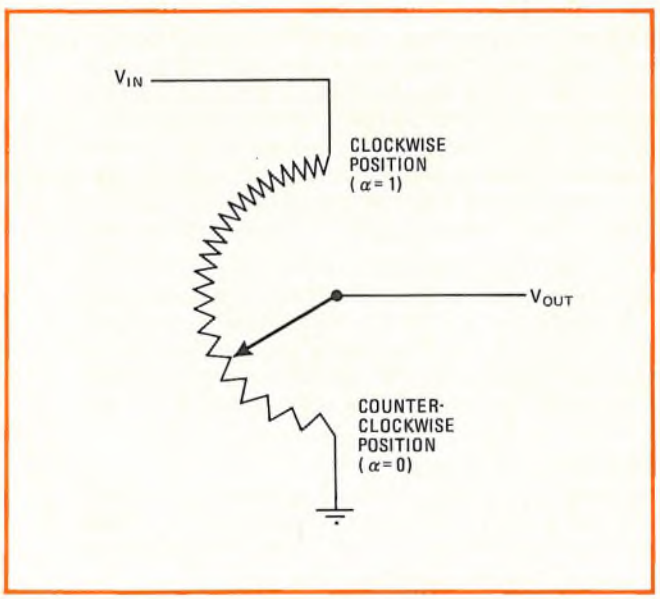
Because these potentiometers cannot be loaded heavily without distorting the gain function, in practical audio applications they are usually followed by a gain stage or a high-input-impedance voltage follower. However, the reverse-logarithmic-gain function can be closely approximated by using a linear potentiometer, a single operational amplifier, and one fixed resistor, as shown in Fig. 2. The operational amplifier adds the capability of voltage gain; in this circuit the maximum voltage gain is 8, or 18 dB. The voltage-transfer function for the circuit of Fig. 2 is

$$V_{out}/V_{in} = (-8\alpha)/(9-8\alpha)$$

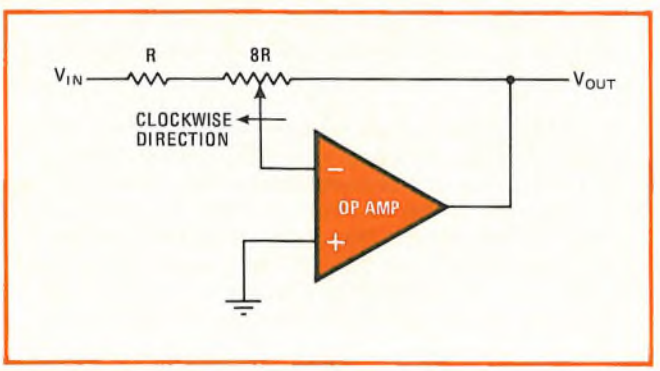
which closely approximates the attenuation function

$$Attenuation = 40(1-\alpha) - 18\ dB$$

over most of the range of α. As a desirable advantage,



1. Audio taper. Volume-level potentiometer for sound systems has tapered resistivity to compensate for exponential response of human ear. Expensive tapered pot (which should be followed by a buffer stage to prevent loading effects) can be replaced by a linear pot, fixed resistor, and op amp.



2. Replacement. Linear potentiometer, fixed resistor, and operational amplifier, connected as an inverting amplifier, provide transfer function that approximates performance of audio-taper pot plus 18 dB of gain. The minimum input impedance is R.

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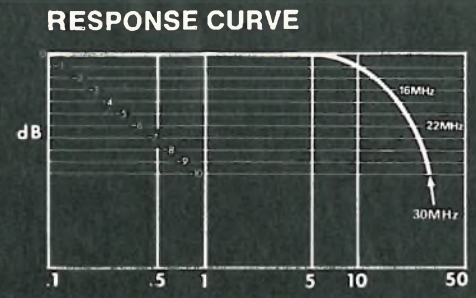

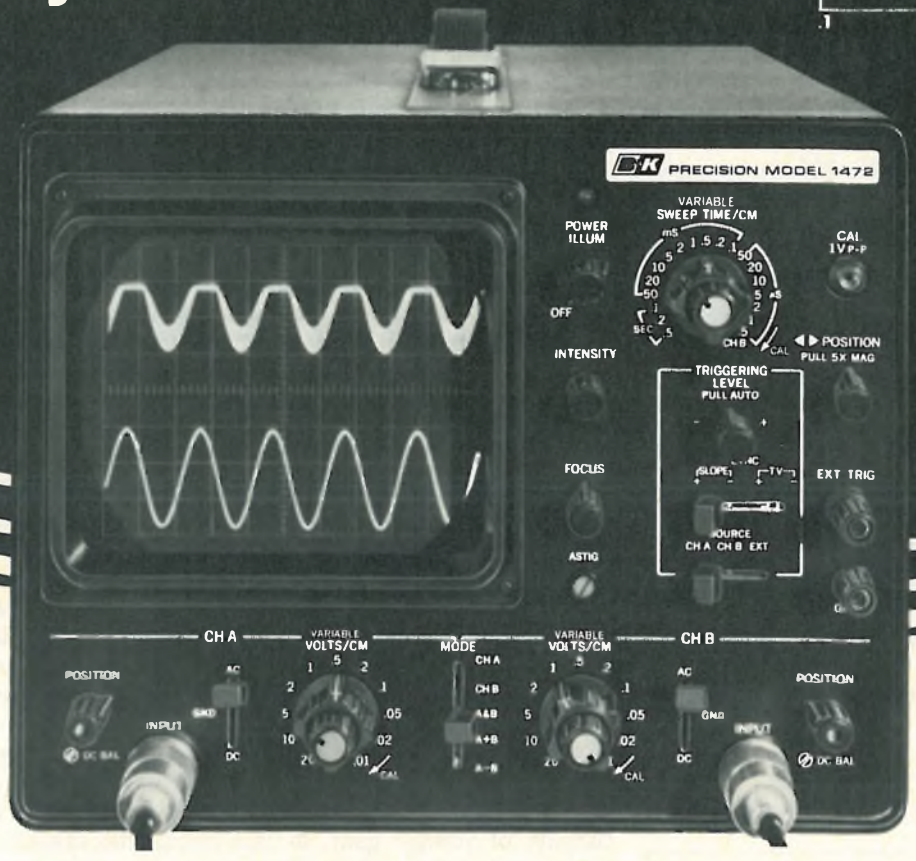

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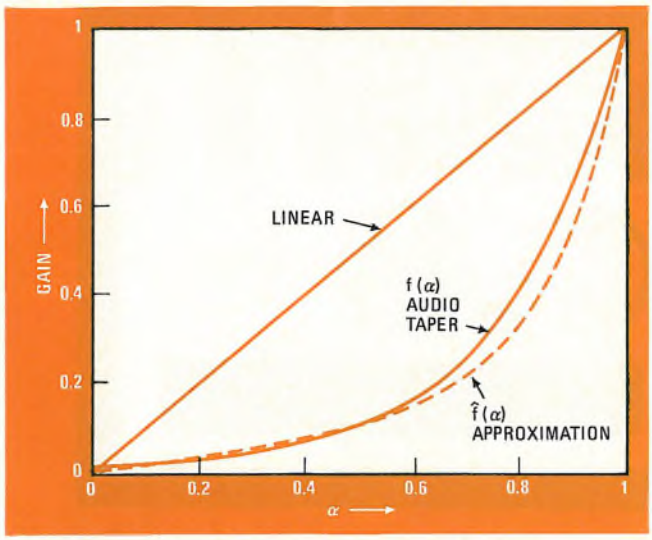


3. Comparison. Approximation to audio taper is excellent for potentiometer-displacement values α below 0.5 and good everywhere else. The approximation is exact at $\alpha = 0.5$.

the attenuation goes to infinity at $\alpha = 0$.

The transfer function of the circuit in Fig. 2 is normalized to

$$\hat{f}(\alpha) = \alpha/(9 - 8\alpha)$$

and compared to the true audio taper in Fig. 3. The approximation, which is good everywhere, is especially close at the low values of α, where compensation for the reduced hearing sensitivity at low sound levels is most important. The two functions agree exactly at $\alpha = 0.5$.

Because it uses a linear potentiometer, this circuit is less expensive than the normal audio-taper level-control, and it is much more convenient to use in new designs.

The value of R can easily be chosen to suit the op-amp and the circuit impedance; for example, a 100-kΩ pot and a 12.4-kΩ fixed resistor can be combined with a 741 op amp. □

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.

ECL tuned oscillators are voltage-stable

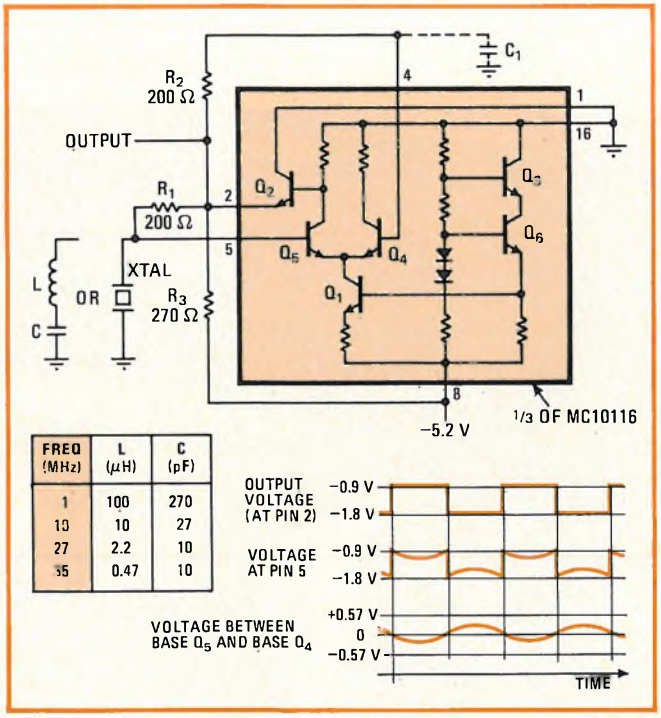
by Tom Hornak
Hewlett-Packard Co., Palo Alto, Calif.

A simple square-wave crystal oscillator or LC oscillator can be built by using one third of an MC10116 integrated circuit, which is a triple differential amplifier in the MECL 10,000 series. It has better frequency stability than a similar oscillator that uses a resistor and capacitor as the frequency-determining elements [*Electronics,* May 29, p. 106]. A 1-volt variation in supply voltage to the RC oscillator caused fractional frequency changes ranging from 0.09 at 10 megahertz to 0.02 at 50 MHz. The same voltage variation changes LC oscillator frequencies of 1, 10, 27, and 35 MHz by less than 0.003; and crystal oscillator frequencies of 10 and 20 MHz are changed less than 5×10^{-6}.

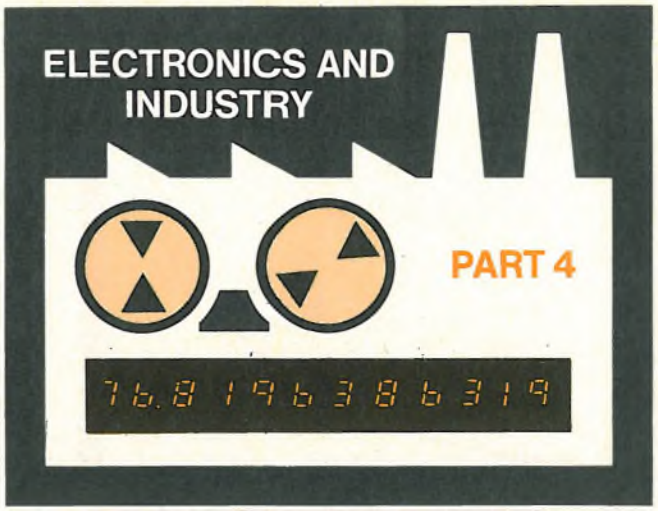
Details of the tuned oscillators are shown in the figure. Transistors Q_1, Q_4, and Q_5 form a differential amplifier. The output signal supplied by emitter follower Q_2 is fed back via resistors R_1 and R_2 to the bases of Q_4 (positive feedback) and Q_5 (negative feedback). If no crystal or LC combination is connected to the bases of Q_4 and Q_5, the feedback signals cancel each other because of the high common-mode rejection of the differential amplifier, and the circuit is thus quiescent.

When an LC circuit or a crystal is connected between the base of Q_5 and ground, the negative-feedback signal is attenuated by the divider consisting of R_1 and the low impedance of the LC circuit or crystal at the series-resonant frequency. Because positive feedback dominates, the circuit oscillates.

The top waveform represents the oscillator's output voltage, i.e. a square wave alternating between ECL logic levels. The middle waveform displays the idealized signal on the base of Q_5, i.e. the output square wave with its fundamental frequency component attenuated by the divider. The bottom waveform represents the difference between the other two waveforms, which is the voltage acting between the bases of Q_5 and Q_4. This voltage, clipped and amplified by the differential amplifier, constitutes the oscillator output voltage. □



Stable. ECL-oscillator frequency, determined by crystal or LC tank circuit, is insensitive to variations in supply voltage. Capacitor C_1 balances stray capacitances (e.g. from crystal holder) that might cause parasitic oscillations; its value is $(R_1/R_2)C_{stray}$.



Food industry takes a bite out of waste by tightening process control

Mounting pressures, both economic and Governmental, are speeding the transition to equipment that weighs on line, controls ingredient mixes, sorts vegetables, senses contaminants, and optimizes formulations

by Margaret A. Maas, *Industrial Editor*

☐ Rising cost of materials, eroding profits, consumer complaints, and increasing Government control. This litany of woes plagues the producers of every can of beans, box of cereal, and bottle of milk.

The biggest problems can be solved by electronic scales that weigh at high speeds with greater accuracy than mechanical units, analytical instruments that measure product composition for tighter quality control, and X-ray and color-sorting equipment that weeds out contaminants and blemished products. Added help is coming from digital controls that blend beer and dairy products and minicomputer systems that create meat formulas. And George Trearchis, manager of food-industry sales for Foxboro Corp., Foxboro, Mass., says "The trend throughout the industry is toward more advanced control techniques, such as feed-forward systems for evaporators and dryers."

Although electronics is growing in its influence on the industry, for the most part, food processing is largely an untapped market for electronic equipment. Pneumatic equipment, which always has been the dominant control in the industry, has been cheaper, as well as easier to understand and maintain. However, now, modular electronic systems offer lower installed costs—an important consideration to the food-processing industry with its historically low profit margin.

One of the major obstacles facing electronics in the food industry is the hostile environment. Federal and state regulations require food processors to outclean Mr. Clean, and a major cleanup usually involves washing down with nearly boiling water and a caustic agent. Still another consideration is that most food processors have never developed an in-house electronics expertise. "So electronics firms have to supply the technical know-how," explains Robert L. Morris, director of research and process development at ITT Continental Baking Co., Rye, N.Y.

Weighing on line

The most common problem facing food processors is weight control. "Fines for underweight can be astronomical," declares Ted Wuerthner, general manager of Acurex Icore Corp., Mountain View, Calif. "In New York City, for example, they can go as high as $100 a package."

To attain the speed and accuracy needed for production-line weighing, Campbell Soup Co. in Camden, N.J., had to design its own system. Campbell estimates that its scale could weigh 1,200 soup cans per minute—if the assembly line could only handle cans that fast. The scale is now check-weighing 350-gram Hungry Man TV dinners within ±2 grams at the rate of 300 per minute.

As a dinner travels down the conveyor line, it displaces an undamped flexure system to which is mounted a linear variable differential transformer. The signal indicating the LVDT displacement is electronically differentiated to produce velocity and acceleration. Using the values for displacement, velocity, and acceleration, the circuitry solves the equation of motion for an undamped vibrating system, and the resulting weight is displayed by light-emitting diodes. If the dinner is underweight, the circuit activates a solenoid-actuated air plunger that kicks the package off the conveyor.

To ensure that only one package at a time is on the weigh station, the package trips a photocell both as it enters and as it leaves the station. If the conveyor delivers more than one package at a time, the fault is indicated by improper timing between the two photocells.

Going whole hog. Employee at ITT Gwaltney, Smithfield, Va., checks bacon-production line where an electronic weighing system keeps tabs on weight. Prior to this point, a computer system had decided how the hog carcasses should be cut up for optimum yield.

Adding the label

One of the biggest impacts of the consumer movement has been made by the unit-pricing legislation that requires products to be labeled not only with total price, but also total weight and price per pound.

To comply with these requirements, Hi-Speed Checkweigher Co., Ithaca, N.Y., designed the Insta-Weigh Random Weigh Price Labeler. Built around a microprocessor, the Insta-Weigh weighs such products as frankfurters, cheese, and produce, calculates the price, and affixes a label on which is printed the total weight, price per pound, and total price. In addition, the system can be customized to sound an alarm when a predetermined number of packages or pounds is reached or to compile such statistics as production rates and percentage of overweight. The system can weigh as many as 70 packages a minute to within ±0.01 pound.

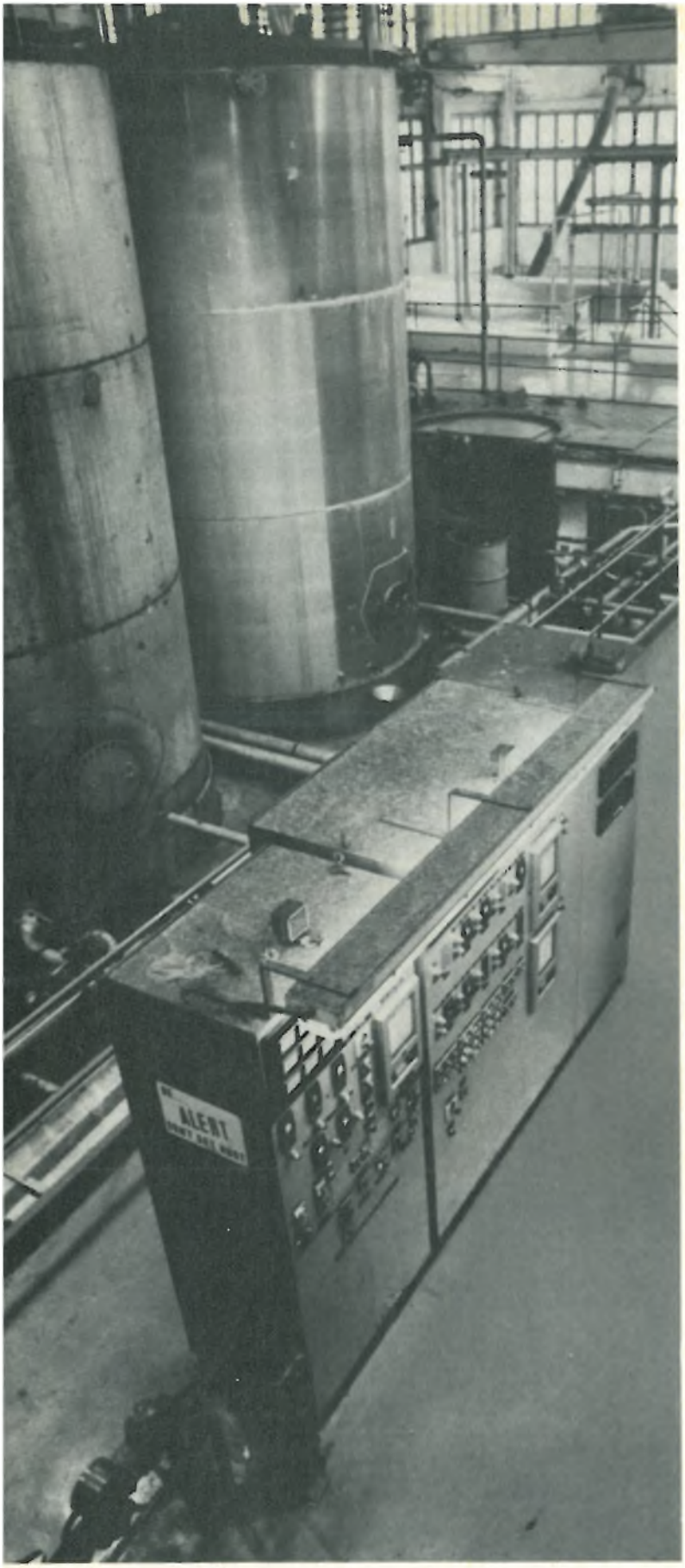
"We built the control around an Intel 4004 with 3-k bytes of memory so that we could customize units rapidly compared with hard-wired systems," says George Kavanagh, manager of computer-system design.

As the incoming product moves along a conveyor, it breaks a photoelectric beam that signals the microprocessor to start the weighing cycle. The circuit reads the weight of the empty scale, providing a zero reading for each package. This eliminates problems associated with scale drift or food accumulations on the scale.

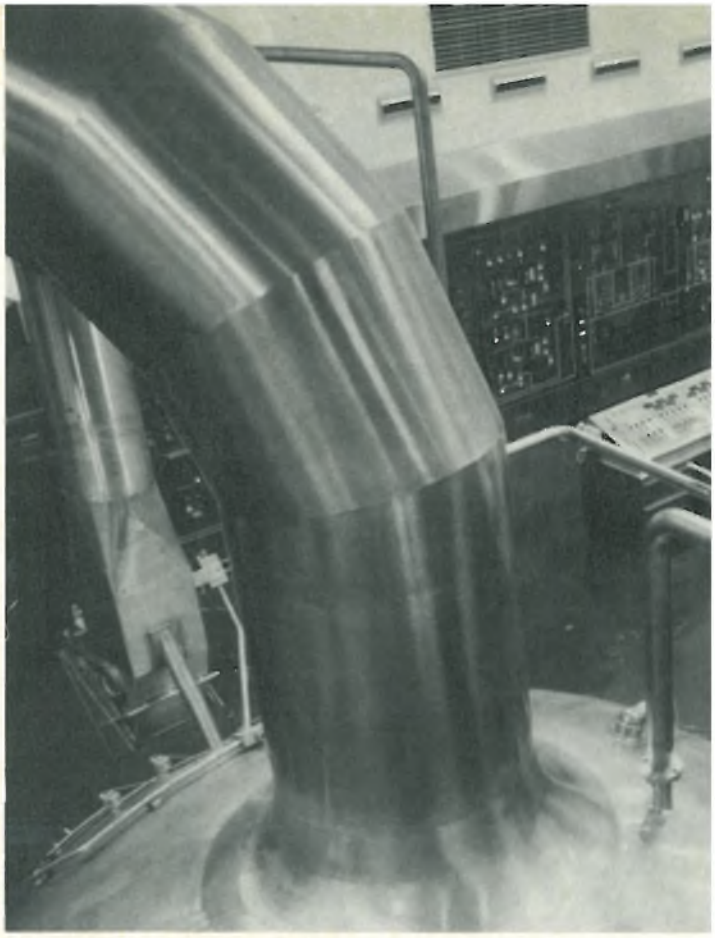
At the same time, the microprocessor activates two timers and signals a solenoid-actuated pneumatic valve, which lowers the lifters that support the conveyor. The conveyor is a lattice arrangement of chains, which drops and straddles the load cell, lowering the package onto the scale. When the first timer times out, the microprocessor reads the weight, subtracts the tare stored in memory, and displays the result. The result is also multiplied by the price per pound that was entered into memory, together with the tare, through the machine keyboard. The label is then printed with the weight and pricing information and applied to the package. When the second timer times out, the air valve opens, raising the lifters, and with them the package.

Weighing systems are also controlling some filling

This is the fourth in a five-part series dealing with electronics and industry. Part one, "Automating the machine shop," appeared in the May 29, issue. Part two, "Steel's special problems beckon control-system designers," appeared on June 12. Part 3, "Tight supervisory control boosts oil's output," appeared July 24.



1. Mixing syrups. At an Amstar sugar refinery, Arabi, La., Foxboro digital blending system withdraws up to four ingredients from the holding tanks, two of which are shown in the background, and delivers the blended syrup to either railroad or truck tank cars.



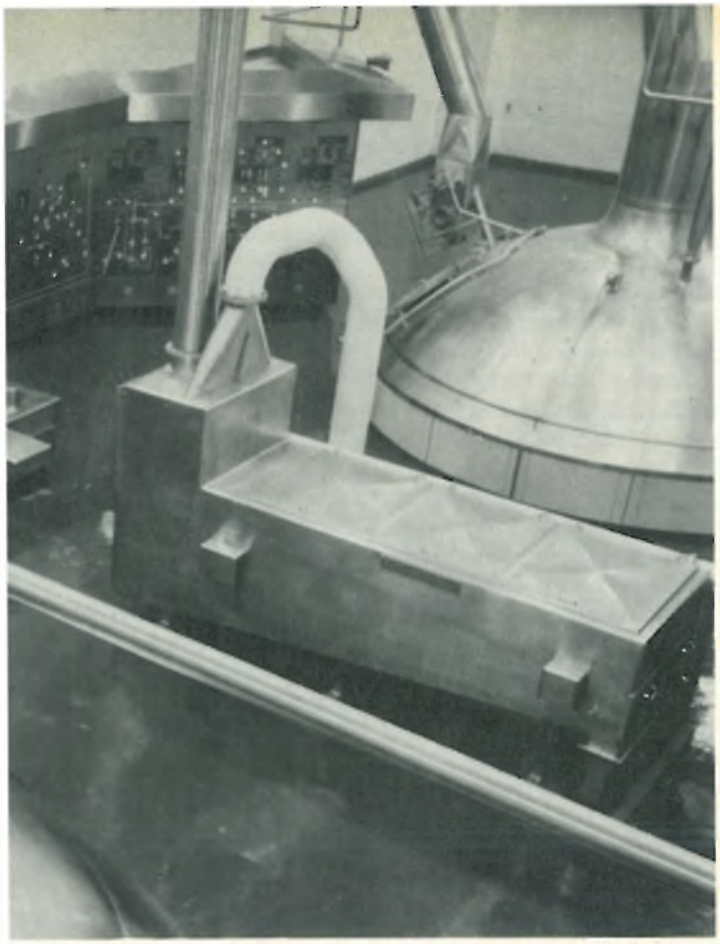
2. Something's brewing. At the Pabst Brewery in Houston County, Ga., the operator's control panel on the Fischer & Porter Co. Blend-Line system is reminiscent of an electric-utility panel. Although only two streams are blended, the digital system is kept busy sequencing flow into and out of the brewing vessels, timing agitators, controlling temperature, and signaling when conditions exceed setpoints.

and batching operations. At a major Midwestern bakery, a system built by Revere Corp. of America, Wallingford, Conn., is automatically batching prepackaged mixes with up to five ingredients in each. There are seven scale systems simultaneously under the control of a microprocessor.

Binary-coded-decimal setpoints for each ingredient are entered through thumbwheel switches. When the operator presses the start button, the microprocessor, designed by Comstar division of Warner & Swasey around the Intel 4040 with 4,096 words of programable read-only memory, sequences the system through the operation. The gate on the first storage bin opens, allowing the material to fall into the weigh hopper. Beneath the hopper are a load cell that determines the weight and an analog-to-digital converter that transmits the accumulating weight to the microprocessor.

The system also takes into account material in transit. When the load in the weigh hopper plus the weight of material in free fall from the storage bin equals the setpoint, the system closes the exit gate on the bin. The ingredient weight is registered on a gas-discharge display, then the system automatically rezeroes itself for the next ingredient, and the operation is repeated. When the last ingredient has been added, the system automatically dumps the batch.

In continuous-mixing systems, dry ingredients are of-



ten fed on conveyors, which, surprisingly enough, vary significantly in weight from section to section. K-tron Corp., Glassboro, N.J., has developed a technique for its digital continuous-weigh feeders to subtract out these conveyor variations.

Before the conveyor is used, the empty belt is cycled through its operation, and load-cell readings are taken at 64 equally spaced increments along the belt. The increments are measured by counting pulses from a magnetic pickup that measures belt-motor speed. An infrared sensor detects a reference hole in the belt and initializes the pulse count.

After the 64 load-cell readings are stored in the complementary-MOS memory, the system is ready for use. During normal operation, the logic circuit retrieves the stored value for the increment being weighed, subtracts it from the weight of the loaded belt, and delivers only the weight of the product.

Digitizing for that perfect blend

For products like beers, wines, and dairy products, blending is almost as important as weighing. "But there's not an analog controller made that successive operators will set in the same place for the same number," claims Oscar Soroko, food and drug industry marketing manager, Fischer & Porter Co., Warminster, Pa.

As a result, digital blending has become important (Figs. 1 and 2). In dairies, for example, the basic components—usually raw milk and skim milk—are mixed in various proportions to produce half and half, light and heavy creams, and other products. With digital blending, a variety of products can be made consistently.

Digital-blending systems operate on a flow-rate basis with the desired total flow rate set as an equivalent frequency. When the operator dials in the amount of each ingredient desired, he, in effect, multiplies the total flow-rate frequency by the ratio of that ingredient's flow rate to the total flow rate. Output pulses from flowmeters in the blending lines are fed directly into the digital controller. Usually the pulses are supplied by magnetic flowmeters because they present no obstruction to flow, and therefore, food does not accumulate on them.

Pulses from each stream are compared with the individual setpoints, and the difference is converted to an analog signal, which usually actuates a valve and regulates the flow rate until the difference between the pulse rates is zero. In this manner, continuous blending is regulated. For batch-blending, the pulses from the flowmeters are accumulated, and when the value from a line reaches the value set on a predetermining counter, the line valve closes.

Wisconsin Electrical Manufacturing Co., New Berlin, Wis., is installing a digital blending system controlled by a minicomputer at the Twin Cities Diary in Halifax, N.S., Canada. The system, which will control blending of various ice creams, will also monitor the entire operation from the point where the material is received by truck to the point where cartons are filled.

The system keeps tabs on 29 turbine flowmeters, 30 valve-position selectors and the production count at eight carton-filling lines. This information is used to calculate inventories for incoming ingredients and final products stored in tanks around the plant, and this information is displayed on a cathode-ray-tube terminal. At any instant, the operator knows how much is in each storage tank and the number of cartons that have been filled by each machine. Flow data can be called up on a teleprinter.

"The CRT proved to be less expensive and more flexible than using an individual display for each tank," says Tim Scott, supervisor of computer systems at Wisconsin Electrical Manufacturing Co.

The system is built around a 16-bit General Automation SPC-16 minicomputer with 8,192 words of core memory. The operator specifies the recipe and desired weight in pounds by entering them through a teleprinter keyboard.

Spotting the bad tomatoes

Electronics is sorting out unripe vegetables, detecting damaged products, and rejecting foods that are blemished, even though they may be edible. Campbell Soup Co., for example, electronically sorts by color every grain of rice that goes into its products.

During sorting, produce is illuminated by any one of a variety of light sources, depending on the product and the part of the color spectrum that is of interest. The light source may be incandescent, fluorescent or infrared. The reflected light may be merely measured for its intensity or it may be filtered and analyzed for its color components.

The most exciting activity in color-sorting now is sorting out in the field. Tomatoes, for instance, used to be sorted at the food-processing plant. Now agriculturalists have developed a tomato that can be mechanically har-

vested, and the crop will be sorted right at the harvester. Acurex Icore is competing for this market with a design based on the ratio technique. Reflected light is viewed through red and green filters. If the red/green ratio is too low, the system operates a solenoid-operated plunger that kicks the offending tomato onto the ground.

Another sorting problem is the weeding out of contaminants. Despite precautions, bits of glass from containers, slivers of steel from mixers, and other foreign particles inevitably find their way into products. "And if one item in 10 million is found to be contaminated, somebody can make enough noise about it to get the whole product line recalled," points out Glenn Woodmancy, manager of special projects at the Borden Inc. Can & Machinery Operations in Randolph, N.Y.

Metal detectors are widely used, but they are ineffective for non-metallic contaminants. X-ray scanning is probably the most common technique for detecting non-metallics, and it's often used for metallics, too. The size of particle that can be detected with X rays depends on the material; the greater the ratio of the particle density to the product's density, the easier it is to find.

With the aid of an electronics supplier, Borden has developed a relatively inexpensive machine that it is now selling to other food processors. In operation, a conveyor line feeds the product into a sheet-metal tunnel that protects the operator from X rays. A photoelectric sensor detects the edge of the incoming package and initiates the operating cycle. The product is illuminated for a few milliseconds by a low-level X ray, which penetrates the product and falls on an image-intensifer tube. The intensifier converts the X-ray field into a visible image, which is scanned by a modified high-grade industrial-television camera. As the camera scans, the image is broken into a video signal that is analyzed by comparing one TV-scan line with the preceding line. This technique compensates for normal variations in containers and products. Unless there is a contaminant present, one scan line will look like the preceding line. If a contaminant is spotted, the system actuates a reject mechanism, usually a solenoid, to kick the product off the conveyor line.

Looking at size and shape

Hamamatsu Corp., Middlesex, N.J., is offering a microprocessor-based system with a variety of illuminating sources—X-ray, infrared, ultraviolet, polarized light, and visible light—to monitor food-processing activities. These light sources can illuminate a vidicon camera, image-dissector camera, self-scanned array, or other device. Because of the many possible hardware and software combinations, the system has many applications, which include checking for size, shape, color, number, position, and movement as well as detecting contaminants. A soft-drink manufacturer, for example, checks for strains in its glass bottles by viewing the bottle with polarized light, while another manufacturer uses X rays to make sure raisins are evenly distributed throughout its cereal.

Unlike other systems that must scan the entire product, the Hamamatsu unit can be commanded to go to a particular point and do only a partial scan in a known problem area. The TV camera is addressed digitally, moving from point to point both horizontally and vertically across the target of the vidicon or across the cathode of the image-dissector tube. The field is broken up into 1,024 by 1,024 elements. Each point has its own light level, which can be converted to an analog signal. In the vidicon, for example, the system measures the current of the electron beam traveling from the cathode to the target; this current is a measure of the light intensity at that point. After analog-to-digital conversion, this data can be processed by the microprocessor.

Essentially, the system recognizes contaminants and other shapes by sudden increases or decreases in light level. A running average of several scan lines cancels out background noise.

The system is built around four Intel 8080s. One 8080 serves as the master processor performing the general housekeeping functions and selecting the type of scan. The second 8080 controls the TV camera, while the third interfaces with such output devices as printers and CRTs. The fourth 8080 is used when other information is to be processed with the scan—for example, it may normalize thermocouple or strain-gage signals. To shorten computing time, calculations are performed in a bipolar-arithmetic unit, rather than in a microprocessor.

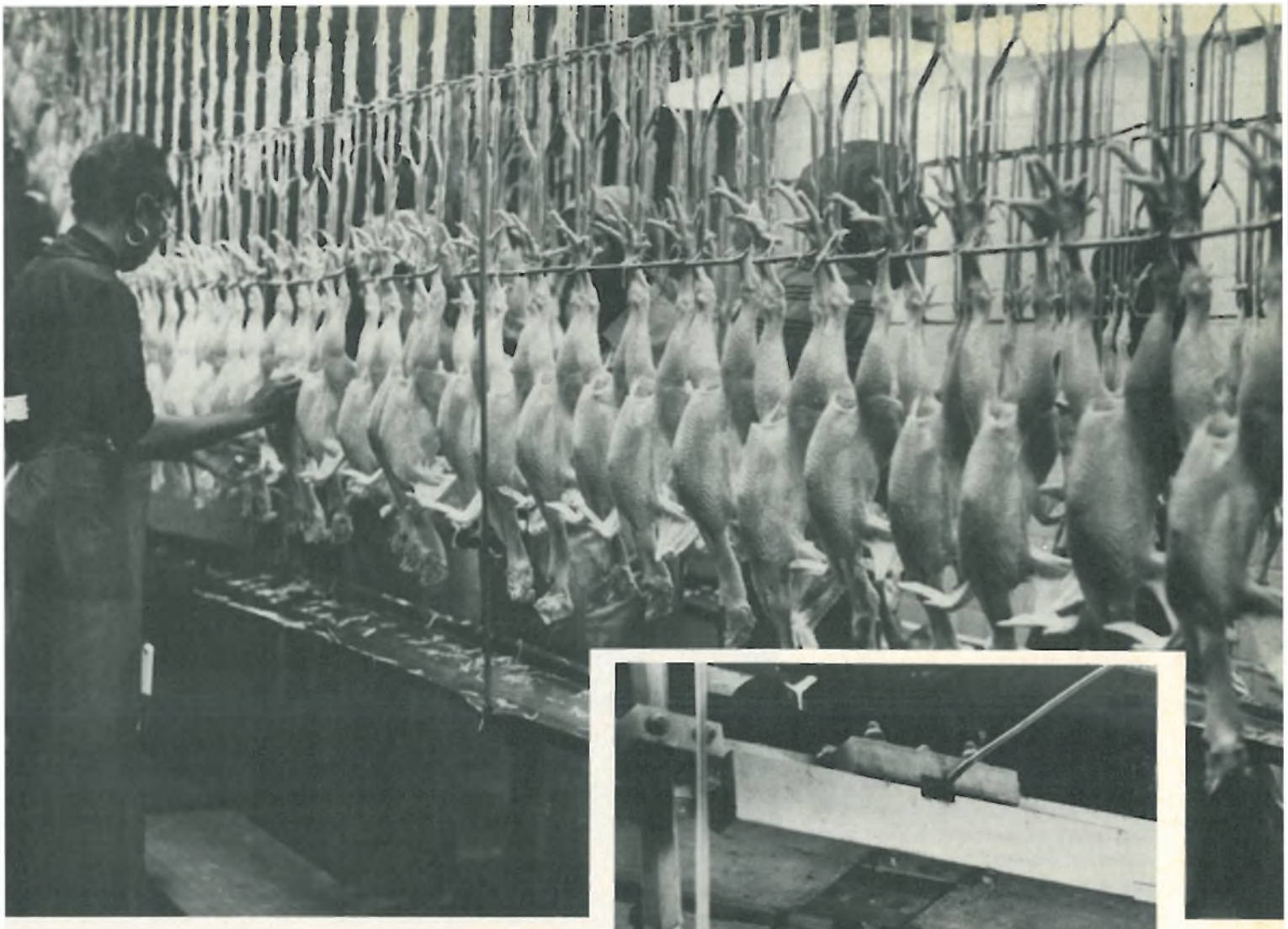
Processing for the birds

Another microprocessor-based system, designed for a poultry processor by Gamco, Gainesville, Ga., sorts chickens according to specified weight limits and drops them into the appropriate packing areas (Fig. 3). Customers who resell by the piece—usually fast-food chains—are willing to pay a premium for chickens that have been accurately sorted by weight because it gives them a good idea of the number of legs, breasts, and wings in a box.

On the sorting line, the chickens are mounted to shackles attached to an overhead conveyor that carries them across a load cell at the rate of two per second. To determine the chicken's weight, the shackle weight has to be subtracted from the load-cell reading. Unfortunately, the shackles are constantly being repaired and replaced so that the weights change almost daily.

At the beginning of each day, the operator runs the empty conveyor once around its circuit, weighing every shackle. This weight is stored in memory along with the shackle's position, as determined by its distance from a head pin. Later, when the shackles are loaded and they travel across the load cell, the combination is weighed. The microprocessor, a National Semiconductor Corp. 16-bit IMP-16C, searches memory for the shackle weight that bears the index number of the one passing over the load cell. It subtracts this number from the gross weight and compares it with the limits set in the memory through thumbwheel switches on the control panel. The chicken's weight range determines the position from which it is to be dropped. When the conveyor reaches that position, the shackle releases the bird, which drops into a packing bin.

Still another control device that has found a ready market in the food industry is the programable control-

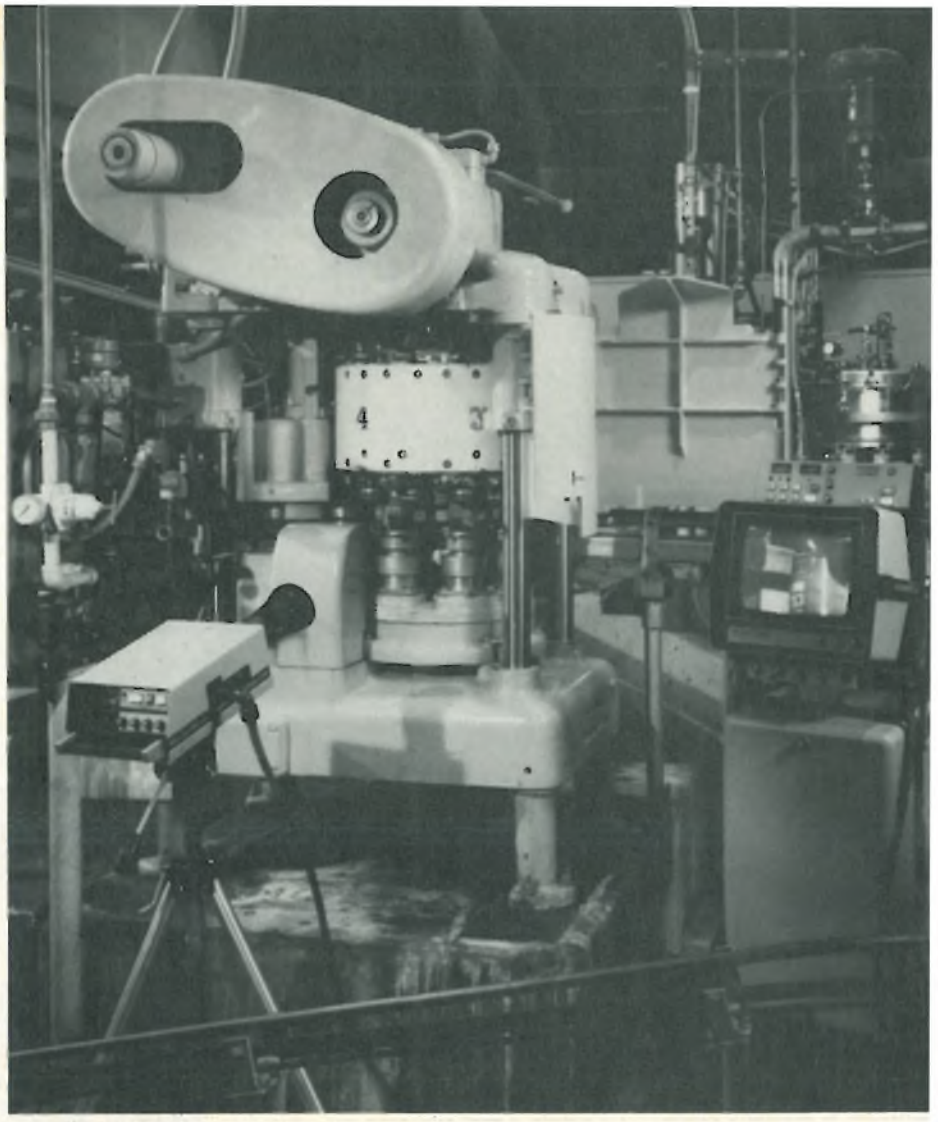


ler, which is being used to mix biscuits, operate candy conveyors, and sequence the stuffing of sausage skins. At General Mills, the biggest application is the interlocking of motor controls for food-processing lines.

"We must have 30 or more programable controllers installed in places where a shutdown on one part of the line necessitates shutting down lines feeding that area," explains Herbert Kraemer, manager of engineering economics at General Mills in Minneapolis. "A typical line may have as many as 100 motors, though at any one time, we may only want to interlock five. A programable controller makes it easy to select any five out of the 100. This is particularly useful during startup of a new line or a new product."

Jim Otis & Associates of Moline, Ill., has designed a clean-in-place system around a programable controller for a processing dairy. The system is built around a Controlpac II from Gulf & Western Industries Inc. Eagle Signal divisions. There are 11 blending stations, which the programable controller cleans by stepping through approximately 200 sequential operations. The controller supervises the mixing of detergent and water, then closes off one section of the pipeline and steps through the cleaning cycle in that section. The cleaning solution is pumped through, the line is flushed, then cleaned and flushed again. Flow through the pipes is metered by a turbine meter, and the length of the washing cycle is determined by a timer. After one section is

3. Fast sort. Shackle-mounted chickens speed across load cell (bottom picture) at the rate of two per second. Because shackles are constantly being repaired or replaced, their weights change almost daily. Gamco designed the system around a National Semiconductor IMP-16C microprocessor that memorizes the weight of each shackle and subtracts it from the total weight as the shackle passes over the load cell. Based on net weight, the system decides into which packing bin the fowl should be dropped. Certain customers pay a premium for chickens sorted according to narrow weight ranges.



4. Slow peek at a fast process. Mechanical problems that turn up in a high-speed beverage line are difficult to spot because the machinery moves too fast for the eye to see. With its video-tape system, Video Logic Corp. offers an electronic solution to the mechanical problem. The system provides easy viewing with variable slow-motion and stop-action instant replays. Effective shutter speed is 0.00001 second.

cleaned, the programable controller closes off the cleaned section and steps to the next, repeating the sequence until all of the 11 blending lines are cleaned.

Processing to specifications

For bologna, sausage, and frankfurters, Federal regulations limit the percentage of fat and water they may contain, and place a minimum level on the protein content. Yet these factors vary from animal to animal. At the same time, the types of cuts available to the processor from the slaughterhouse vary daily, as do their prices. This situation requires the meat processor each day to develop a formula that will meet Government regulations, take advantage of the cuts available, and still make a profit.

A computerized formulation system developed by Computer Concepts Corp., Knoxville, Tenn., does this task. By means of thumb-wheel switches, the operator sets the fat, water, and protein values established by analytical measurements. Next, he dials in the ingredients. There are 100 possible ingredients, but only 16 can compete for any one formulation.

The linear program is processed by a Digital Equipment Corp. PDP-8/M that is mounted in the operator's console, together with a Dectape, 4 kilowords of core memory, and a printer. Based on the 16 or so selected ingredients, the computer develops the lowest possible cost formulation that meets the fat, water, and protein constraints.

The system prints out the formulation, the amount of each ingredient, the price of that ingredient, and the price at which it becomes too expensive to participate in the formulation. If the ingredient is already too expensive for the formulation, the computer prints the price to which it has to drop before it should be used. If the producer must use an overly expensive cut because that is the only cut available, the system tells him how much of his profit margin he is sacrificing.

"We can save a food processor 1 to 3 cents a pound on his formula, and some of the processors use a quarter-million pounds a week," says Ross Duncan, Computer Concepts' director of technical research. "In the past, the processor generally had to add 'a little extra' of an expensive cut of meat just to make sure that he was on the safe side of the specifications."

One of the newer analytical instruments uses conductivity of meat as the basis for ensuring compliance with specifications on fat content. "Red tissues conduct electricity about 20 times better than white," says Wes Harker, president, Electronic Meat Measuring Equipment, Phoenix, Ariz.

The company checks 100-pound boxes of meat that are headed for hamburger and sausage. In the system, a box is conveyed through a coil of copper tape excited by

a radio-frequency current. The rf oscillations induce oscillating currents in the meat, and by measuring the inpedance change in the coil, the instrument can determine the percentage of fat.

Since conductivity is also a function of temperature, the temperature can either be manually dialed into the calculation through the control-panel thumbwheel switches or received directly from an ir temperature sensor. Temperature and impedance changes are converted to digital form and entered in a four-function calculator chip. A timing generator advances the address, which the chip seeks in the read-only memory (a pin matrix), and sequences the chip through the calculation. The percentage of fat is then digitally displayed.

Keeping food within specification not only applies to Government regulations, but also to a company's own concept of a satisfactory product. Some companies have enlisted to the aid of minicomputers in the analysis as well as in the formulation of food. The Coca-Cola Co., for example, wants to make sure its beverages taste the same, whether they are purchased in India or Indiana. To ensure consistency, samples from around the world are shipped to Atlanta, Ga., for testing at the company's Corporate Quality Standards Laboratory.

There, the samples are processed through a wide variety of instruments—gas chromatograph, high-pressure liquid chromatograph, spectrophotometer, precision density meter, electronic thermometer, electronic balance, and pressure transducer—all of which are tied directly into a DEC PDP-8. The PDP-8 analyzes and records the results for as many as 12 instruments simultaneously. The software program performs such tasks as peak-analysis, plateau-sensing, and reading the instrument output at preset intervals. The operator can establish such parameter limits as sugar content and acidity, and if the sample exceeds them, an alarm light flashes. At the end of testing, results from approximately 20 tests on each sample are printed out.

Pushing to increase production

To combat rising costs, food producers are pushing for higher and higher production rates. Production can be aided by something as simple as a production-rate monitor or as sophisticated as video-tape recorder or high-speed photography.

The production-rate monitor designed by Industrial/Marine Electronics Inc., Londonderry, N.H., operates on the basis of two successive inputs, such as switch or solenoid actuations, triggered by machine operation. The monitor measures the time interval between the two, figures the inverse, and displays the results as a production rate, such as cans per minute or bottles per hour. The unit updates its calculation with each successive pulse, and rates up to 400 hertz can be monitored. At Beatrice Foods, Chicago, the production-rate monitor is matching production-line output with the capacity of a sterilizing oven on a pickle-making line.

As production speeds are increased, mechanical problems may develop in the machinery. High-speed photography can locate the problem but first, the film must be developed. On the other hand, videotape recording permits instant viewing, instant replay, and a longer viewing time than high-speed photography.

Video Logic Corp., Sunnyvale, Calif., with its Instar video-tape system offers an effective shutter speed of 0.00001 second, which is equivalent to a film camera operating at 40,000 frames per second (Fig. 4). The Instar is being used to isolate breakage of baby-food bottles at Beech-Nut Inc., it has solved filling-machine problems at Ralston-Purina, and it identifies difficulties in filling, closing, and packaging bottles at Joseph E. Seagram & Sons Inc.

Watching the future growth

In food processing, the greatest potential application for electronics growth is analytical instrumentation. Food measurements are becoming increasingly important part of the effort to produce consistent products.

Nutritional labeling—one of the newer consumer-movement efforts—is spurring the market for analytical instrumentation. If a label lists an ingredient and its percentage, the company must maintain that percentage to an accuracy established by the U.S. Government.

"One of the big problems," claims Paul Wilks, president, Wilks Scientific Corp., affiliate of EG&G Inc., South Norwalk, Conn., "is that labels are often printed months ahead of time. Yet ingredients may vary daily. Food processors are going to have to watch their ingredients carefully in order to meet regulations."

Foxboro's Trearchis adds, "There's a whole host of analytical measurements that the industry would love to be able to make on line, such as protein and density. Some techniques are great on some foods, but don't work too well on others."

In addition to the common problems facing nearly every manufacturer, each of them has a problem or two that particularly interests him. Warren Egee, director of engineering research and development at Campbell Soup Co. would like to be able to measure vacuum in a sealed can. Existing techniques that infer vacuum by the depression of the lid are not accurate enough to satisfy him. Because of variations in the can itself, equal depressions do not mean equal vacuum levels.

Selwyn Jones, consulting engineer for control systems at Pillsbury in Minneapolis, would like to find a temperature sensor that foods won't stick to. "I think ir is the way to go," comments Jones. "but it's too expensive." Herbert Kraemer of General Mills would like to do a better job of measuring the thickness of dough. Existing thickness sensors are essentially devices that ride along the dough and only give the thickness at one point. "Beta gages like those used to measure thickness in a paper mill are good, but expensive," says Kraemer.

Taylor Instrument Process Control division, Sybron Corp., Rochester, N.Y., is one of the companies looking into the food industry's measurement problems. "Lasers seem to offer some potential in the measurement of food properties such as density and molecular weight," remarks Harold Hendler, food-industry manager.

Over the next few years some dramatic changes will be made in analytical instrumentation. New sampling techniques will enable units to measure on line, and as on-line measurements are proven reliable, they will eventually be used to control the processing itself. □

Phase-modulation techniques simplify analysis of phase-locked loops

In determining a PLL's frequency response with a phase-modulated-signal generator, the loop need not be opened, and troublesome variations in loop response are eliminated; three test methods are described

by Robert Rands, *Hewlett-Packard Co., Stanford Park Division, Palo Alto, Calif.*

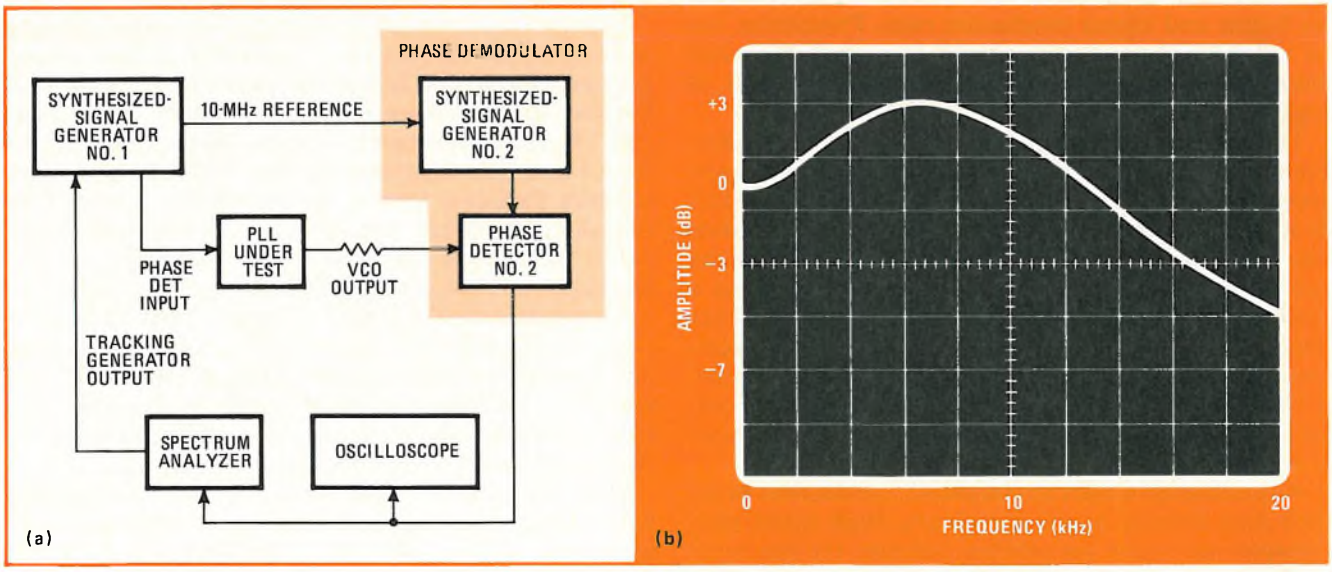
☐ Analyzing the operation of a phase-locked loop has been hard to do without either opening the loop or altering the signal level within it. But with the recent introduction of signal generators with calibrated phase modulation, the use of previously impossible techniques based on phase modulation enables the design engineer to test PLLs without interfering to a significant degree in their normal functioning. What's more, the test procedures can handle a wide range of PLL bandwidths.

The phase-modulation approach helps the engineer to cope with the demands of testing PLLs for a growing range of applications. These circuits are used as fm discriminators and stereo demodulators, in TV receivers to synchronize vertical and horizontal scans and in digital systems for bit synchronization, as tone decoders in push-button telephones and as filters in oscillators, where they clean up noise and increase long-term stability. Frequency multipliers or dividers also use PLLs, and many frequency synthesizers are based on them.

Regardless of the application, every phase-locked loop operates on the same principles (see "Phase-locked-loop basics," p. 95). But there are several inherent properties of phase-locked loops that make them hard to test:

- Following the input phase detector stage, all signals are based on phase error and not the input signal itself—no direct correlation exists between the rf input signal and what happens in the loop.
- Since the phase detector must have two input signals to operate, either the loop must be closed to check out the system or an additional test signal is needed.
- Since frequency is the derivative of phase, the phase of the VCO is proportional to the integral of the filtered error voltage, so that the loop has an integrated rather than a constant feedback function—which makes it hard to base an analysis of the total closed-loop response on some open-loop parameter.
- Because loop components such as the phase detector are often nonlinear, input signals with a varying peak phase deviation cause varying loop response—a problem that can only be avoided with phase-modulation techniques.

The different techniques presently used to analyze PLLs all have limitations. One, in which an input signal is frequency-modulated and the resulting input at the VCO is monitored, is very useful for testing PLLs in frequency demodulators, where the voltage into the VCO is monitored. But for other applications the technique as-



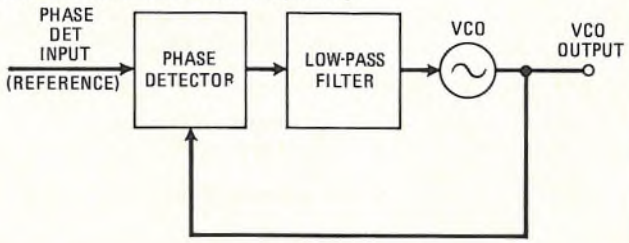
1. Real-time information. The test setup detailed in (a) provides instant visual feedback when adjusting PLLs. The resulting display (b) shows the relative amplitude versus the frequency response of a phase-locked loop that has about 3 decibels of peaking.

Phase-locked-loop basics

The phase-locked loop is a feedback system where the error signal is a function of a phase difference between an input signal and some reference. Actual designs show literally infinite variations, but all basically comprise three fundamental components: a phase detector, a low-pass filter, and a voltage-controlled oscillator (VCO).

The phase detector compares the phases of the input and VCO signals and generates an error-correction voltage that is proportional to the difference in phase between the two signals. This phase-error voltage passes through the low-pass filter, which suppresses noise and any high-frequency signal components and helps to determine the loop dynamic performance. The filtered error voltage adjusts the VCO frequency, which is again compared with the incoming signal at the phase detector. Any error voltage that's generated again passes through the loop, adjusting the VCO signal until it and the input signal are locked together in a fixed phase relationship.

The frequency response of a PLL is determined by how accurately the VCO tracks the modulation at the input of the phase detector. As the modulation frequency or rate is increased, the PLL is less and less able to respond because of bandwidth limitations and so the VCO peak phase deviation decreases. Thus, the PLL's frequency response is simply a measure, in terms of phase deviation, of the loop's ability to track the modulation as a function of modulation frequency.



sumes that the VCO has a constant gain, independent of modulation rate or signal amplitude, and this assumption may cause errors in the analysis.

With fm signals, too, the peak phase deviation depends on the modulation frequency. Consequently, when an fm signal is used to evaluate a PLL, the signal amplitude inside the loop will vary with frequency, independently of loop characteristics, possibly causing the PLL to operate in nonlinear regions and distorting its response characteristics.

Other techniques involve opening the loop to insert signals and analyzing the resulting response. But care must be taken to prevent the injection of the test signal from altering loop performance. Finally, any method of analyzing each loop element separately is of course valuable in diagnosing faulty loop operation, but the loop interactions are difficult to predict accurately, and determining actual closed-loop performance is, at best, difficult.

Closed-loop response

Phase-modulation techniques, however, greatly ease the design engineer's job of analyzing PLLs. Phase-modulated signals do not need the loop to be opened for them and, unlike fm signals, they maintain a constant peak phase deviation, regardless of the modulation frequency or rate, so that the signal level inside the loop does not change. Signal generators, like the HP8660 synthesized-signal generator with its calibrated phase modulation at rates from dc to 10 megahertz, now make it possible to evaluate PLLs with very small or very large bandwidths. In addition, a calibrated rf signal level is needed to test PLLs in which the frequency response depends on input amplitude. Phase-modulation techniques are also useful for phase detector characterization and can be extended to subsystem testing where other phase demodulators are already available in the system.

There are three ways to use phase modulation to determine the closed-loop frequency response of the PLL (see table). Involving a low-frequency spectrum analyzer or a phase-gain meter or a rf spectrum analyzer, the three approaches can easily be modified to suit a wide variety of PLL types and can accommodate limited substitution of test equipment. Which is the right method to use will depend on the PLL to be tested, the kind of information desired, and the equipment available.

In the first phase-modulation measurement technique, a swept display of amplitude as a function of frequency makes it easy to monitor a PLL's frequency response while adjusting the loop. Such a setup (Fig. 1) can be used to analyze PLLs at modulation rates that depend on the frequency range of the spectrum analyzer being used.

In this setup the spectrum analyzer's tracking generator phase-modulates the first synthesized signal generator at rates from as low as 5 hertz to some frequency higher than the PLL bandwidth capability. (Many spectrum analyzers have built-in tracking generators, but if they don't, companion boxes that provide the function are usually available.)

The signal generator's rf output drives the input of the PLL under test. Another synthesized-signal generator and a phase detector serve as a phase demodulator. This second signal generator, however, need only be a simple frequency synthesizer. The VCO output is demodulated, and the amplitude versus frequency response is displayed on the linear frequency scale of the spectrum analyzer.

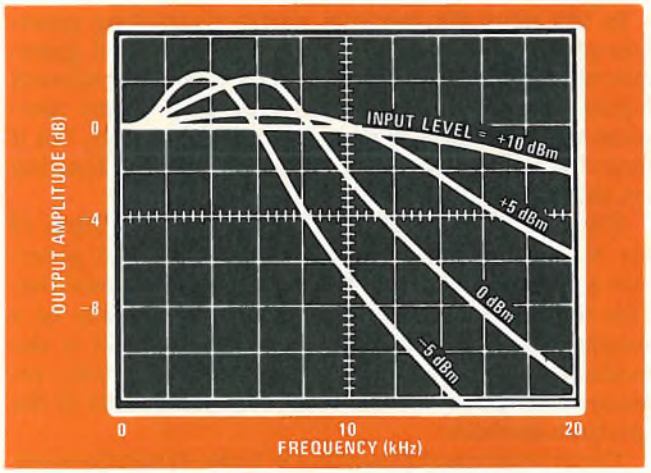
The measurement procedure is quite straightforward. The first step is to connect both the signal generator and the phase demodulator (modulation off) to the same reference frequency to ensure frequency coherence. In the setup in Fig. 1, the 10-megahertz reference signal is obtained from the first generator, but several other frequencies will also work. The resistor value is chosen so that the VCO and the PLL phase detector operate into the proper load impedance.

The next step is to set the first signal generator to the

SUMMARY OF FREQUENCY-RESPONSE METHODS

Technique	Major Equipment Required	Test Rates	Comments
Low-frequency spectrum analyzer display	2* HP 8660 synthesized-signal generators 1 phase detector 1 oscilloscope 1 low-frequency spectrum analyzer (HP3580, HP8556)	5 Hz – 300 kHz	Though this method requires the most equipment, the almost instantaneous swept display of amplitude response is ideal for viewing changes in response while making loop adjustments. Noise rejection is good.
Phase-gain meter (HP 3575A)	2* HP 8660 synthesized-signal generators 1 phase detector 1 oscilloscope 1 HP 3575A phase-gain meter 1 audio oscillator	1 Hz – 10 MHz	Though the slowest of the methods, it provides phase as well as amplitude information displayed on meters. Noise can be more of a problem in this setup.
Rf spectrum analyzer	1 HP 8660 synthesized-signal generator 1 rf spectrum analyzer 1 audio oscillator	Resolution of spectrum analyzer to 10 MHz.	The easiest to set up, it also requires the least equipment. But only amplitude response is visually displayed. Substituting a square-wave generator for the audio oscillator provides setup for transient analysis.

*A synthesizer can be substituted for the second signal generator.



2. Level-sensitive. Since the operation of many phase-locked loops is affected by the input-signal amplitude, it's important to check PLL response curves at several different input signal levels.

input frequency of the PLL and the second generator to the corresponding VCO frequency and then to adjust the phase relationship between the second generator and the VCO so that the phase detector operates in its most nearly linear region. (At this point, the dc output from the phase detector is generally in the center of its output range—for mixers it's usually 0 volt. To make the adjustment, the second signal generator must be stepped 1 Hz or 2 Hz in frequency and quickly back again. This results in a momentary sweep of the phase detector's characteristic. By repeating this procedure several times, it is usually possible to stop the generator at the detector's optimum operating point. (Even at a 1-Hz sweeping rate it's sometimes difficult to stop exactly at the optimum phase relationship.)

It may be necessary to repeat this procedure periodically to maintain the proper phase relationship between the VCO and the second signal generator because of the phase drift (a few degrees per minute at most) between HP8660 generators.

The last step is to phase-modulate the first signal generator and adjust the peak deviation such that both the PLL under test and the phase detector/demodulator operate within their linear regions. The deviation must be kept small enough to operate in the linear region but large enough to avoid problems with noise. When using a mixer as the detector, about 30° peak deviation is maximum.

If the loop under test peaks significantly, as shown in Fig. 1, a peak deviation of no more than 10° should be

used, to prevent gain compression. And when the VCO output frequency is a multiple of the input frequency so that the peak deviation also gets multiplied, then the peak deviation applied to the input must be reduced accordingly.

Many PLLs are sensitive to input amplitude variations (Fig. 2) so that testing them at various input levels may also be desirable.

Measuring amplitude and phase

Using a phase-gain meter in the second method makes it easy to obtain phase as well as amplitude versus frequency information (Bode plot) for the PLL under test. The test setup (Fig. 3) is similar to the first, except that an audio oscillator and phase-gain meter replace the low-frequency spectrum analyzer.

With the phase-gain meter, measurements can be made at modulation rates of 1 Hz all the way up to 10 MHz. The phase information that results is the difference between the phase of the modulation at the first signal generator's input and the PLL's output. At high modulation rates, any phase shift that is caused by the generator can be eliminated by first calibrating the circuit without the PLL under test and then subtracting those readings from the results obtained with the PLL in the circuit. At low frequencies the phase shift due to the generator is extremely small, but it increases as the modulation rate approaches the modulation bandwidth of the generator.

The digital readout of the phase-gain meter makes it convenient to plot, point by point, the phase and amplitude response of the PLL. For a hard copy of the results, or when many loops must be plotted, an X-Y plotter can be used.

Since the filtering provided in the first method by the spectrum analyzer is not available with the phase-gain meter, more attention must be given to the signal-to-noise ratio of the measurement system. Power line interference, for instance, can significantly affect both amplitude and phase measurements if steps are not taken to reduce it by using only short lengths of interconnecting signal cables and a common power line receptacle.

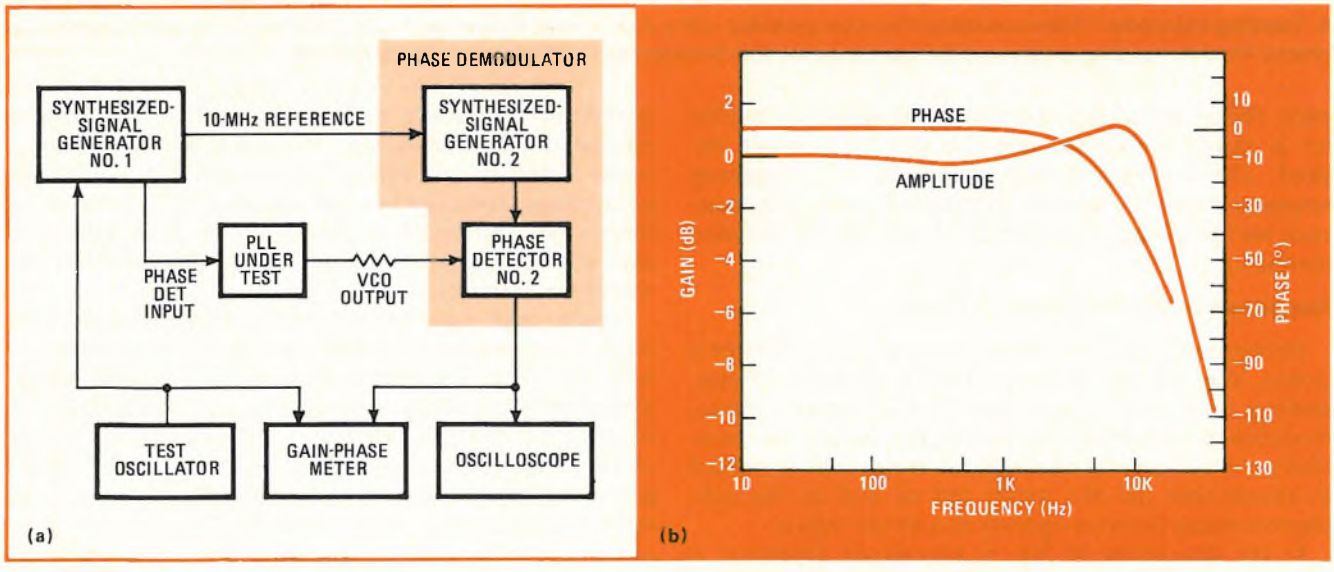
The test procedure for this setup is almost exactly the same as before, with one minor exception. When the second signal generator is stepped up and down in frequency to establish proper phase relationship, there's a risk of introducing a 180° phase difference because some phase detectors, such as mixers, may operate on either a positive or a negative slope. This additional 180° phase shift, which is most obvious at very low frequencies, can be eliminated by simply reversing the phase reference switch located on the phase-gain meter.

The third method of obtaining the frequency response of PLLs uses the fewest instruments of all—one signal generator, a test oscillator, and an rf spectrum analyzer (Fig. 4). This method can also be used to test at modulation rates up to 10 MHz, and it's limited at low modulation frequencies only by the resolution of the spectrum analyzer.

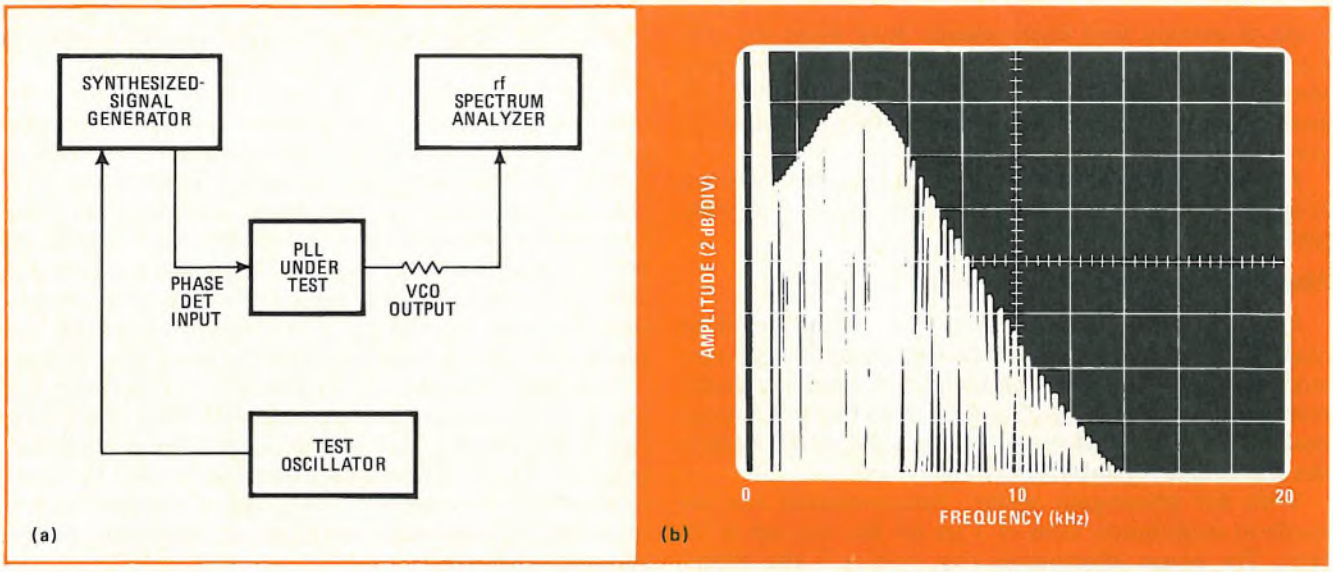
In this setup, the signal generator is phase-modulated using a test oscillator, and as the modulation rate is varied, the PLL amplitude versus frequency response is displayed by the first sideband levels.

This technique is possible because in phase modulation the level of the sidebands is independent of the modulation rate, and for small modulation deviations (less than 30°) the amplitude of the first sideband is almost directly proportional to the phase deviation. Thus the amplitude of the first sideband essentially tracks the closed loop's frequency response.

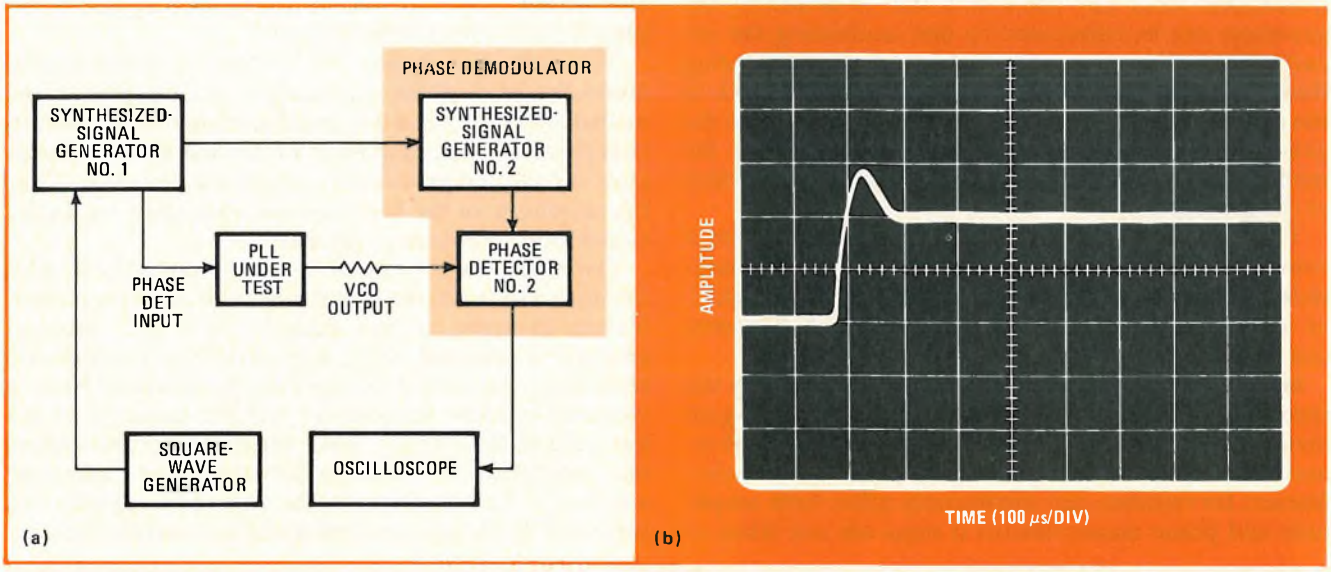
The measuring procedure is quite simple. First, with the modulation on, the signal generator is set for a modulation deviation of less than 30°, and the spectrum analyzer is adjusted for an appropriate scan width and resolution, depending on the loop parameters. Next, a spectrum analyzer is tuned so that the carrier is on the left edge of the display. Since the first sideband carries the frequency-response information, the spectrum analyzer's i-f attenuation can be adjusted to display this sideband. If the spectrum analyzer has variable persist-



3. Bode plot. If the spectrum analyzer of the test setup shown in Fig. 1 is replaced with an audio oscillator and a gain-phase meter as shown in (a), information (b) is provided about the relative phase as well as amplitude of a phase-locked loop's transfer function.



4. All in the sidebands. In phase modulation the first sideband level is independent of the modulation rate. Therefore the test setup of (a) can be used to track closed-loop frequency response of PLLs (b) as the modulating frequency is increased.



5. Tracking transients. Phase-modulating the signal generator with a square wave causes the rf output to alternate between two discrete phases. From the resulting display such parameters as rise time overshoot and settling time can be determined.

ence, this is turned to maximum, and the audio oscillator is slowly varied through the frequency range desired. The resulting display plots the PLL frequency response across the cathode-ray tube. If variable persistence isn't available, the sideband level may be recorded manually.

Response to step changes in phase

Determining such transient response parameters of a closed loop as rise time, overshoot, damping factor, settling time, and so on requires a calibrated phase-modulation capability, including the ability to accurately control the size of the phase steps. This is needed to ensure that the PLL under test as well as the subsequent phase detector operate in a linear region.

In the test setup of Fig. 5, the signal generator is phase-modulated with a square wave that makes the rf output alternate between two discrete phases. The amplitude of the square wave is adjusted for the desired amount of phase deviation. A rule of thumb is that most phase detectors will remain in the linear region if the peak phase deviation is kept less than 30°. However, if there's any concern about the possibility of overshoot as also shown in Fig. 5, the peak deviation must be reduced even further.

Again, both signal generators must be connected to the same reference frequency source for frequency coherence. With the modulation off, the second signal generator's frequency is varied up and down until it's determined that the detector is operating at the center of its range. With the modulation input of the signal generator set to the external dc position, the transient response of the loop will then be displayed on the cathode-ray tube. The phase deviation is set to an amount small enough to ensure linear operation of the PLL and the phase detector. □

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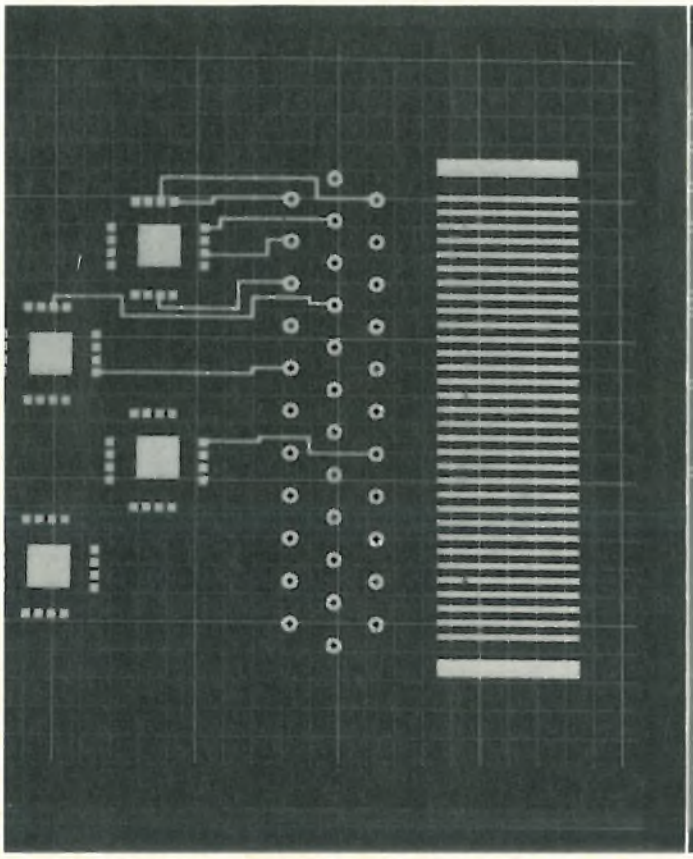
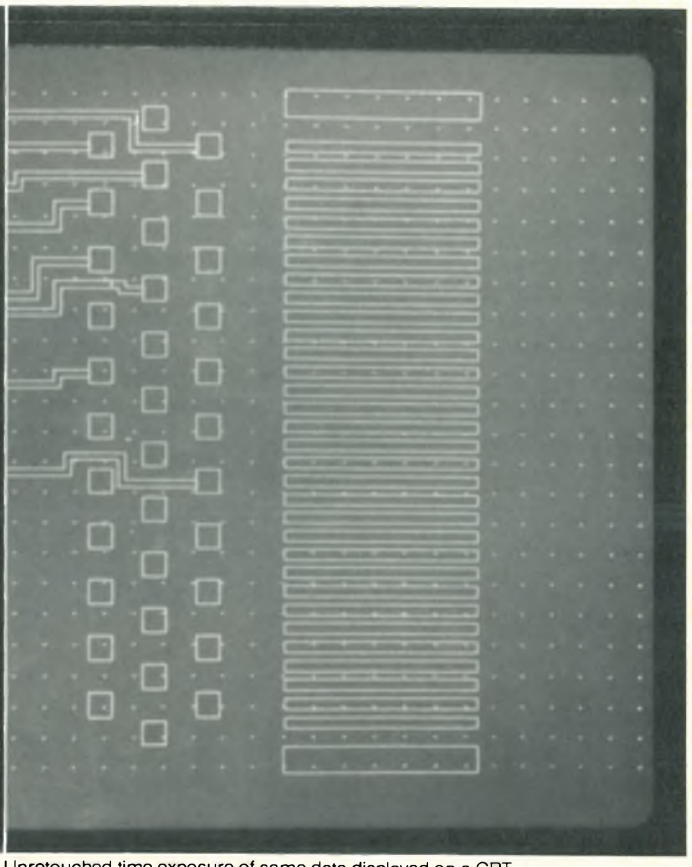


Unretouched time exposure of data displayed on a Digivue unit. Note high contrast picture, precise graphics.



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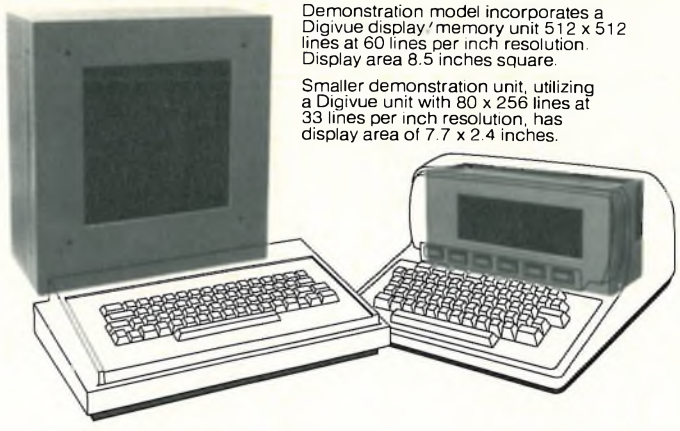

Demonstration model incorporates a Digivue display/memory unit 512 x 512 lines at 60 lines per inch resolution. Display area 8.5 inches square.

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Toledo, Ohio

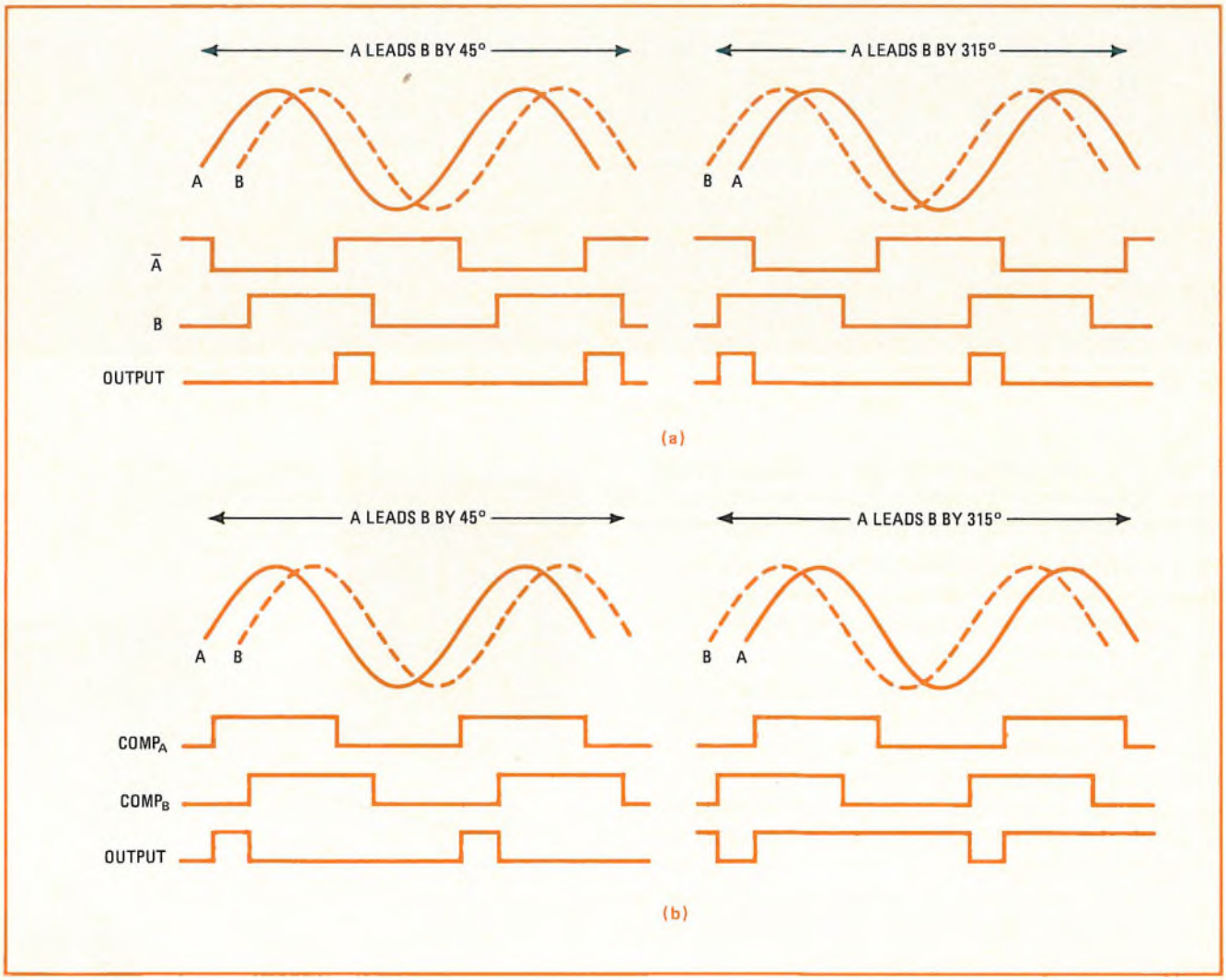
Edge-triggered flip-flops make 360° phase meter

by James C. Hager Jr.
Columbia Gas System Service Corp., Columbus, Ohio

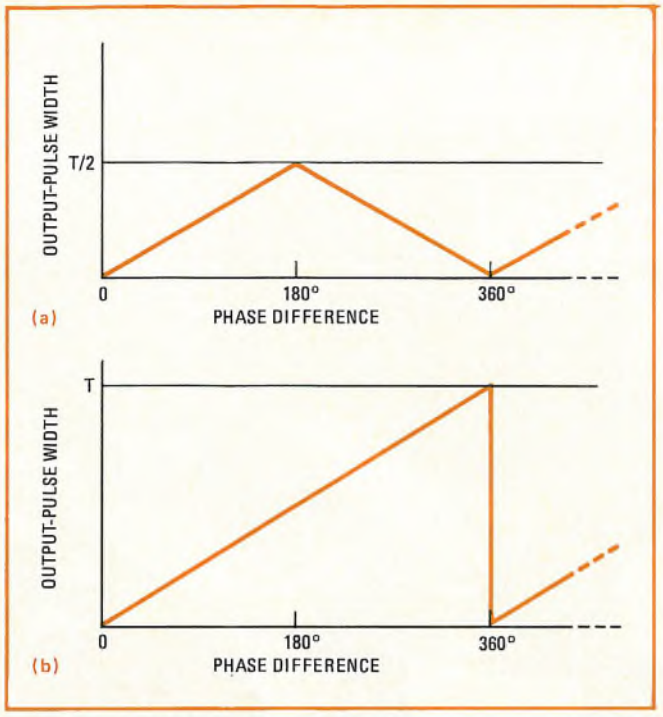
Many phase detectors measure the amount of overlap of two waves to determine the phase difference between the waves. Often designed around some form of AND gate, they can measure a maximum phase difference of 180°, because, for example, they cannot distinguish between a phase difference of 20° and a phase difference of 340°. To measure differences up to 360°, a detector must use circuit elements that respond to the sequence in which the waves arrive. A pair of edge-triggered flip-flops provides this capability.

A representative AND-type circuit by D. K. Kostopoulos appeared on page 119, in the Dec. 20, 1973, issue of *Electronics*. In this circuit, two signals are applied as inputs to comparators. The resulting square-wave outputs become the inputs to an AND gate, with one comparator output inverted with respect to the other. The AND-gate output is a pulse produced by the positive coincidence of the two signals. This pulse has a width proportional to the phase difference between the two input signals; maximum width occurs for a phase difference of 180°, as shown in Fig 2(a). The output pulse can enable a counter for a digital phase measurement, or it can be filtered with an RC network to give an analog signal proportional to the phase difference.

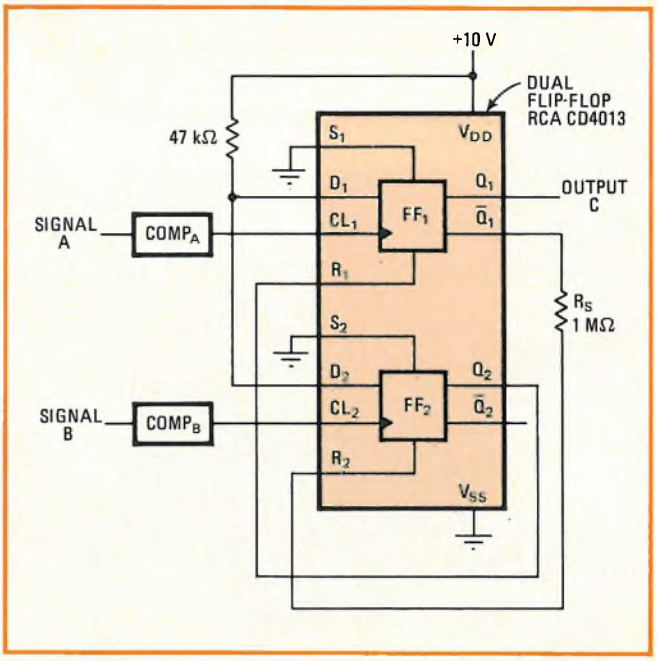
The Kostopoulos circuit can be modified to provide a



1. Two techniques. Performance of phase detector that operates on basis of overlap of two waves is shown in (a). Output is high only while both $\bar{A}$ and B are high. Performance of phase-detector circuit that operates on basis of sequence of leading edges is shown in (b). Output goes high when A goes high, and output does not go low again until B goes high.



2. Output. An AND-gate type of phase detector (a) has maximum output-pulse width at a phase difference of 180°. An edge-triggered phase detector (b) has maximum output pulse width at 360°.



3. Full circle. Use of edge-triggered flip-flops permit this phase detector to measure phase differences up to 360° between signals A and B. This C-MOS circuit can replace the AND gate used in a digital-logic circuit that reads phase difference [*Electronics*, Dec. 20, 1973, p. 119], and thus convert that circuit to full 360° capability.

full 360° phase-measurement capability. The AND gate is replaced with an inexpensive C-MOS CD4013 dual flip-flop, which eliminates the requirement to invert one signal and permits identical comparators to be used (Fig. 3). The CD4013 is configured for 360° phase detection by connecting $\bar{Q}_1$ output of FF_1 to the reset (R_2) input of FF_2 and connecting the Q_2 output of FF_2 to the reset (R_1) input of FF_1. The set inputs (S_1, S_2) of both flip-flops are effectively removed by returning them to ground. The "D" inputs (D_1, D_2), are hard-wired high via a pull-up resistor to +V. The clock inputs (CL_1, CL_2) serve as the inputs to the edge-triggered phase detector, and the output is present at Q_1.

The positive transition of the $COMP_A$ output signal transfers D_1's hard-wired 1 to the output, which causes Q_1 to go high and $\bar{Q}_1$ to go low. With $\bar{Q}_1$ low, the reset level is removed from R_2. Q_1 remains high until, as in FF_1, the positive transition of the $COMP_B$ output causes Q_2 to go high, which resets FF_1 and forces Q_1 low.

The positive transition of the $COMP_A$ output is the leading edge of the output pulse at Q_1, while the positive transition of the $COMP_B$ output becomes the trailing edge. This output pulse has a width directly proportional to the phase difference between the input signals to the two comparators; maximum pulse width occurs for a phase difference of 360°, as shown in Fig. 2(b). Both signals must be of the same frequency, and signal B is assumed to lag behind reference signal A.

The maximum reset-pulse width required for the CD4013 is less than 0.5 microsecond. Assuming at least 2 picofarads input capacitance at the reset terminal (R_2), a value of 1 megohm for R_s ensures that the minimum pulse-width requirements are met. □

Graphs give aperture time required for a-d conversion

by Eugene L. Zuch
Datel Systems Inc., Canton, Mass.

The time required for an analog-to-digital converter to make a conversion is known as "aperture time," and depends on both the resolution and the particular conversion method employed. For commercially available a-d converters that use the successive approximation method, the aperture time may be 40 microseconds for a relatively low-cost 12-bit converter, or as little as 4 μs for a more expensive high-speed 12-bit converter. In many cases a sample-hold circuit is used ahead of an a-d converter to effectively reduce the aperture times; the sample-hold can take a very fast sample of the analog signal and then hold the value while the a-d operation is performed. (The time interval during which the signal-hold circuit turns off is then the aperture time, and determines the conversion accuracy. The time for actual a-d conversion can be longer.)

It is important for the designer to know what aperture time is required to keep the system error to a tolerable value in terms of the resolution of his a-d coverter. The

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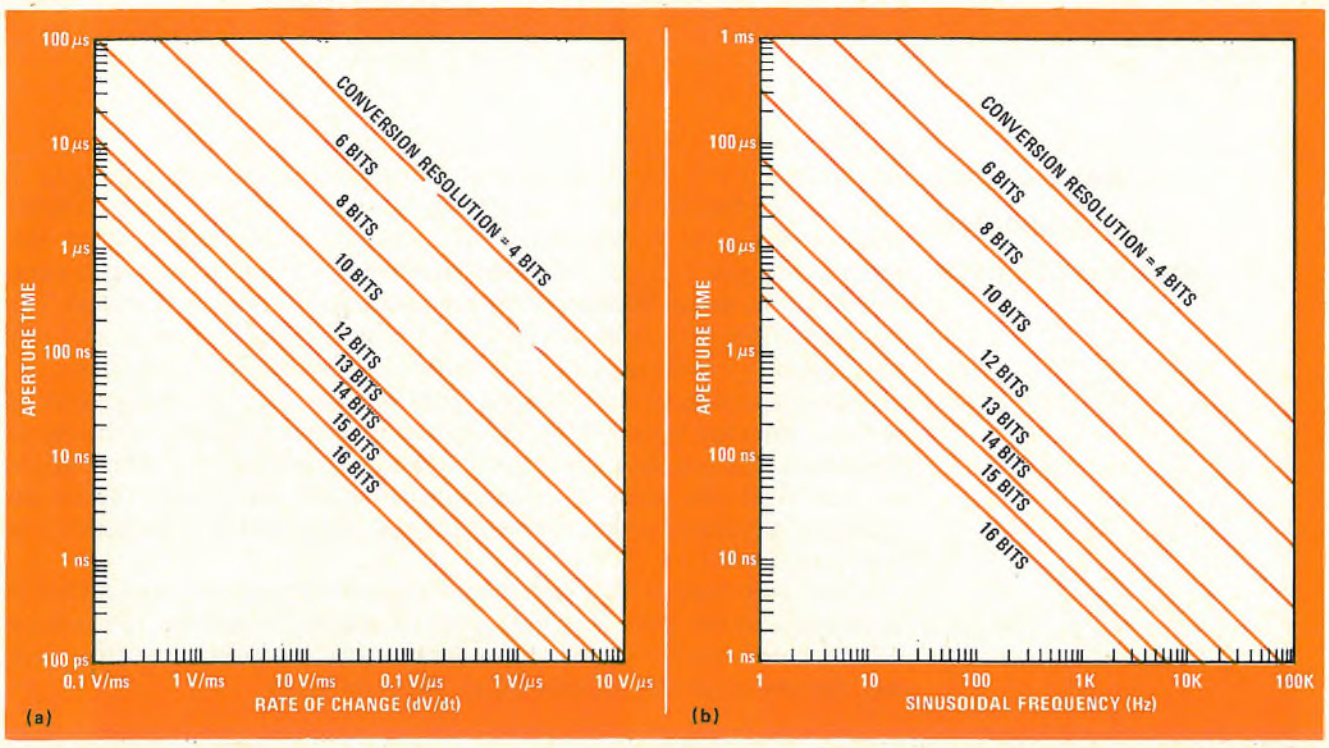
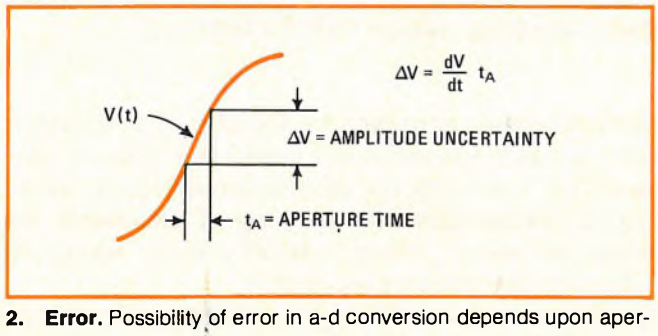


1. Sampling time. Aperture time for 1-bit accuracy at various resolutions in a-d conversion are shown here. Graph (a) gives aperture time as a function of signal rate of change for signals that are 10 volts full scale or 10 volts peak to peak. Graph (b) gives aperture time as a function of frequency for sinusoidal signals. Aperture times for larger allowed error can be found by reading on line for lower resolution, e.g., a 2-bit error and 8-bit resolution requires the same time as a 1-bit error and 7-bit resolution. Equations for these graphs are found in text.



2. Error. Possibility of error in a-d conversion depends upon aperture time. The greater t_A is, the greater the uncertainty in value of an analog voltage that has been converted to digital level.

maximum aperture time that allows 1-bit accuracy in conversion of an analog signal to 4 bits, 6 bits, . . . or 16 bits is given here in two useful graphs. The graph in Fig. 1(a) shows this aperture time as a function of signal rate of change, for signals that are 10 volts full scale or peak to peak. Fig. 1(b) gives the aperture time as a function of the frequency of a sinusoidal signal.

The two graphs are derived with reference to Fig. 2, which shows a time-varying signal and the amplitude uncertainty ΔV associated with an aperture time t_A

$$t_A = \Delta V/(dV/dt)$$

If the fractional error ε is the ratio of ΔV to full-scale voltage V_{FS},

$$t_A = (\varepsilon V_{FS})/(dV/dt)$$

If ΔV is held to 1 bit, and V_{FS} is resolved into n bits, then $\varepsilon = 1/(2^n)$, and

$$t_A = V_{FS}/2^n(dV/dt)$$

This is the equation for the family of lines in Fig. 1(a), with $V_{FS} = 10$ volts and $n = 4, 6, \ldots 16$.

For a sinusoidal signal, which has a maximum rate of change at its zero crossing,

$$\Delta V = t_A\,[d/dt(\tfrac{1}{2})(V \sin \omega t)]_{t\text{-}0} = \omega V t_A/2$$

where V is peak-to-peak signal value. This gives

$$t_A = (2\Delta V)/(\omega V) = \varepsilon/\pi f = 1/(2^n \pi f)$$

for a 1-bit error and n-bit resolution. This is the equation for the family of lines in Fig. 1(b).

If the allowed error is to be 2 bits instead of 1 bit, then $\varepsilon = 2/(2^n)$, so aperture times are doubled. An error of 3 bits gives $\varepsilon = 4/(2^n)$, and so on; thus a 1-bit increase in error is equivalent to a 1-bit decrease in resolution on the graphs.

As an example of the usefulness of these graphs, assume that a 1-kilohertz sinusoidal signal is to be digitized to a resolution of 10 bits. What aperture time must be used to give less than 1 bit of error? The answer, readily found from Fig. 1(b), is 320 nanoseconds. For ½ bit error the aperture time would have to be 160 ns. This is surprising, because a 1-kHz signal is really not very fast, and a 12-bit/320-ns converter is not to be found commercially available as a module. Therefore, a sample-hold circuit would be required ahead of a slower a-d converter. □

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.

Delay element reduces noise entering TTL gate

Improving the noise immunity of a transistor-transistor-logic gate is easy, says Shlomo Waser, a system design engineer at Monolithic Memories Inc. in Sunnyvale, Calif.—just add a compatible delay element at the gate's input. **Any positive noise spike that is shorter in duration than the delay introduced by the element will now be rejected.** The amount of filtering is determined by the delay element used, and any noninverting combinatorial logic will do to implement the element.

Suppose you have a dual-input type-7408 AND gate. Putting a pair of series-connected type-74L04 low-power inverters in series with one of the inputs will produce a 60-nanosecond delay. (Each low-power inverter has triple the delay of a standard inverter.) The gate's inputs are then tied together so that the input signal is applied simultaneously to both gate inputs.

Now, only signals that last longer than 60 ns will be transmitted to the output of the gate. The delay can of course be increased by means of additional double inversions—a single type-74L04 hex inverter package, for instance, can provide up to 180 ns of delay.

Displays need not flicker in the dark

Ever been bothered by a gas-discharge display that began flickering as soon as you darkened the room though it had been fine till then? Well, the room's light was helping to energize the gas, explains John Watson of Weston Instruments. So if you're going to run your instrument in the dark, **adjust the display's operating voltage with the lights off.**

A functional-block approach to LSI design . . .

While the bit-slice microprocessor approach to digital-system design is getting all the attention, another LSI technique could give you an edge in certain applications. That's the concept of functional blocks, where **the system is partitioned horizontally into a group of commonly occurring circuit functions** instead of being vertically sliced along bit lines, as is characteristic of today's microprocessors.

Semiconductor manufacturers have already identified such common system elements as multiplier chains, divider and adder registers, memory pointers, storage buffers, and I/O control registers, and they are beginning to supply these on single system-wide LSI chips—8-by-8-bit multipliers for 8-bit systems, 16-by-16-bit multipliers for 16-bit systems, and so on. Of course, as in the microprocessor approach, the system designer doesn't lose customizing capability—he can still program his system to his needs with programable logic arrays or PROMs to control memory access and I/O peripherals.

. . . is useful for systems that must compute a lot

The advantage of functional blocks is that they allow a manufacturer to optimize the performance of a single function on a single chip. This makes the approach especially useful in **systems requiring large computational capability, such as business data systems or large storage systems.** On the other hand, since the bit-slice microprocessor approach probably offers more configuration flexibility, it is better for data management systems that require fast throughputs but little computation, as in process control, or where many of the inputs and outputs must be handled, as in communications systems. **—Laurence Altman**

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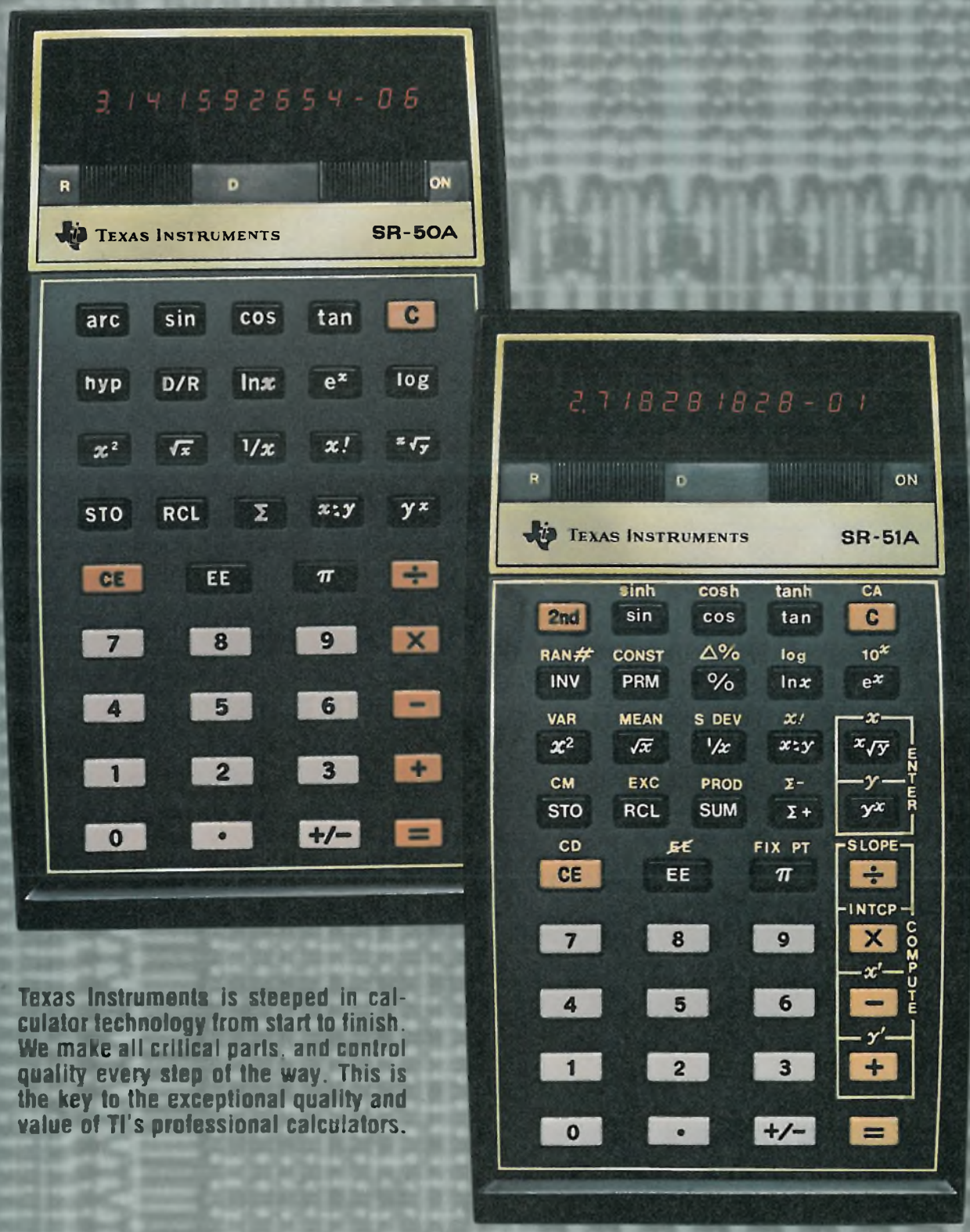

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Decimal degrees to deg.min.sec.	yes	no
Polar-rectangular conversion	yes	no
y^x	yes	yes
e^x	yes	yes
10^x	yes	no
x^2	yes	yes
$\sqrt{x}$	yes	yes
$\sqrt[y]{}$	yes	yes
1/x	yes	yes
x!	yes	yes
Exchange x with y	yes	yes
Exchange x with memory	yes	no
% and Δ %	yes	no
Mean, variance and standard deviation	yes	no
Linear regression	yes	no
Trend line analysis	yes	no
Slope and intercept	yes	no
Store and sum to memory	yes	yes
Recall from memory	yes	yes
Product to memory	yes	no
Random number generator	yes	no
Automatic permutation	yes	no
Preprogrammed conversions	20	1
Digits accuracy	13	13
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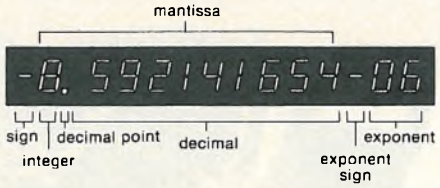

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inches	centimeters
feet	meters
yards	meters
miles	kilometers
miles	nautical miles
acres	square feet
fluid ounces	cubic centimeters
fluid ounces	liters
gallons	liters
ounces	grams
pounds	kilograms
short ton	metric ton
BTU	calories, gram
degrees	gradients
degrees	radians
°Fahrenheit	°Celsius
deg.min.sec.	decimal degrees
polar	rectangular
voltage ratio	decibels

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CCD memory system stores megabits

Intel's charge-coupled-device memory is first semiconductor challenge to disk and drum types; system is expandable from 1.1 million bits

by Bernard Cole, San Francisco bureau manager, and Stephen E. Scrupski, Computers Editor

In a bid to establish a significant foothold for semiconductors in the disk- and drum-memory market, Intel Corp.'s memory systems division is introducing the industry's first commercially available charge-coupled-device memory system.

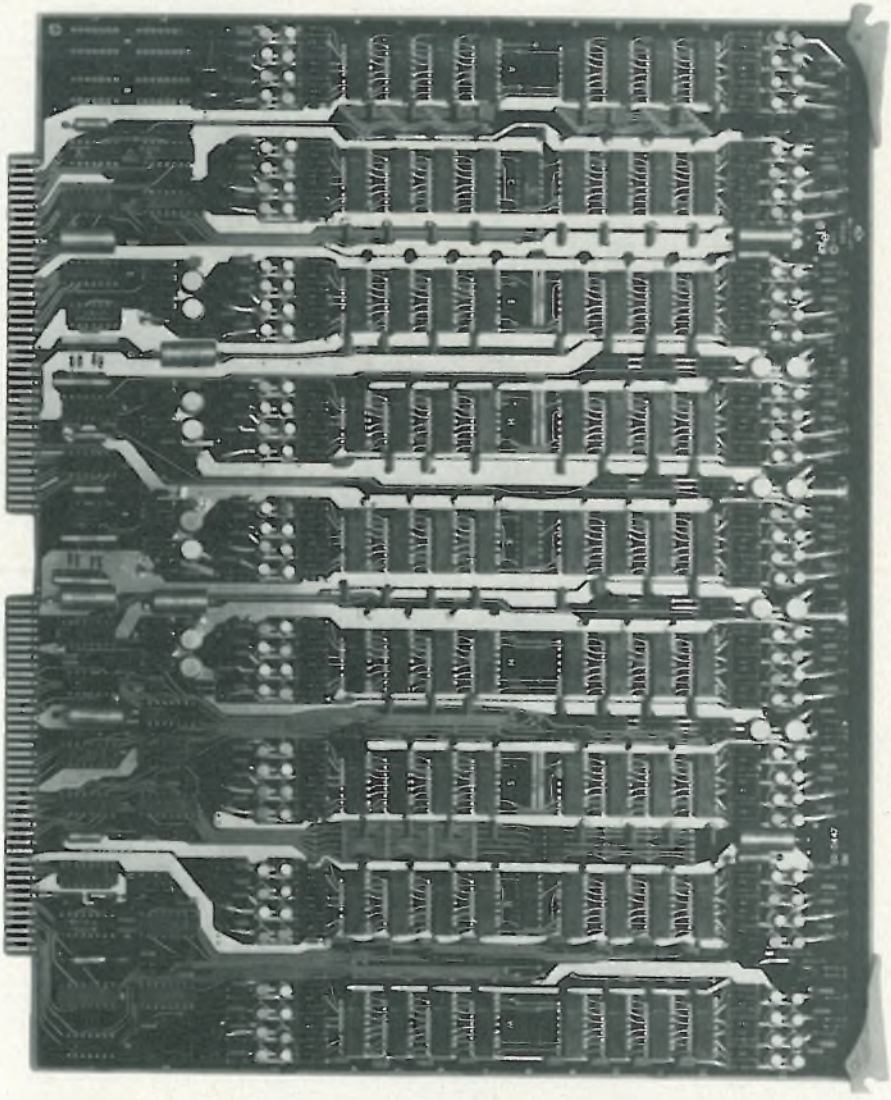
Expandable from 1.1 million bits on a single memory board, the block-oriented random-access-memory (Boram) system—designated the in-65—has a latency time—the worst-case time to any random address in the memory—of 193 microseconds. According to systems engineer Peter Tobias this is 40 to 80 times faster than existing disk memories of the same capacity. Since it is modular, the system can be expanded to almost any capacity.

Fast transfer. The system uses the Intel 2416, a 16-k CCD memory with 64 serial registers of 256 bits each and a maximum data transfer rate of 1.8 megabytes per second. Since it is a dynamic device, the information in the shift register must be refreshed by shifting at least once every 9 microseconds or the information will be lost. When searching for a given word, the information can be transferred as fast as 750 nanoseconds per shift, controlled by a four-phase shift clock. But it is also possible to access the data at the end of each register without shifting the data.

The memory chip's effective logical organization is eight shift registers, each 2,048 bits long. Read, write, or read/write operations are performed during a 550-nanosecond-per-bit cycle. Thus, an 8-bit word is handled in 4.4 μs. Each memory board is organized into two 64-kilobyte banks in which shift and access times are interleaved to hide the 9-μs shift-cycle times.

The system consists of three types of 12-by-15-inch boards the memory unit (MU); the control unit (CU); and the buffer unit (BU). The MU has a capacity of 1,179,648 bits and comes in two system organizations: 128-k words by 8 bits in the MU-65-8 and 128-k words by 9 bits in the MU-65-9.

The CU is a single printed-circuit



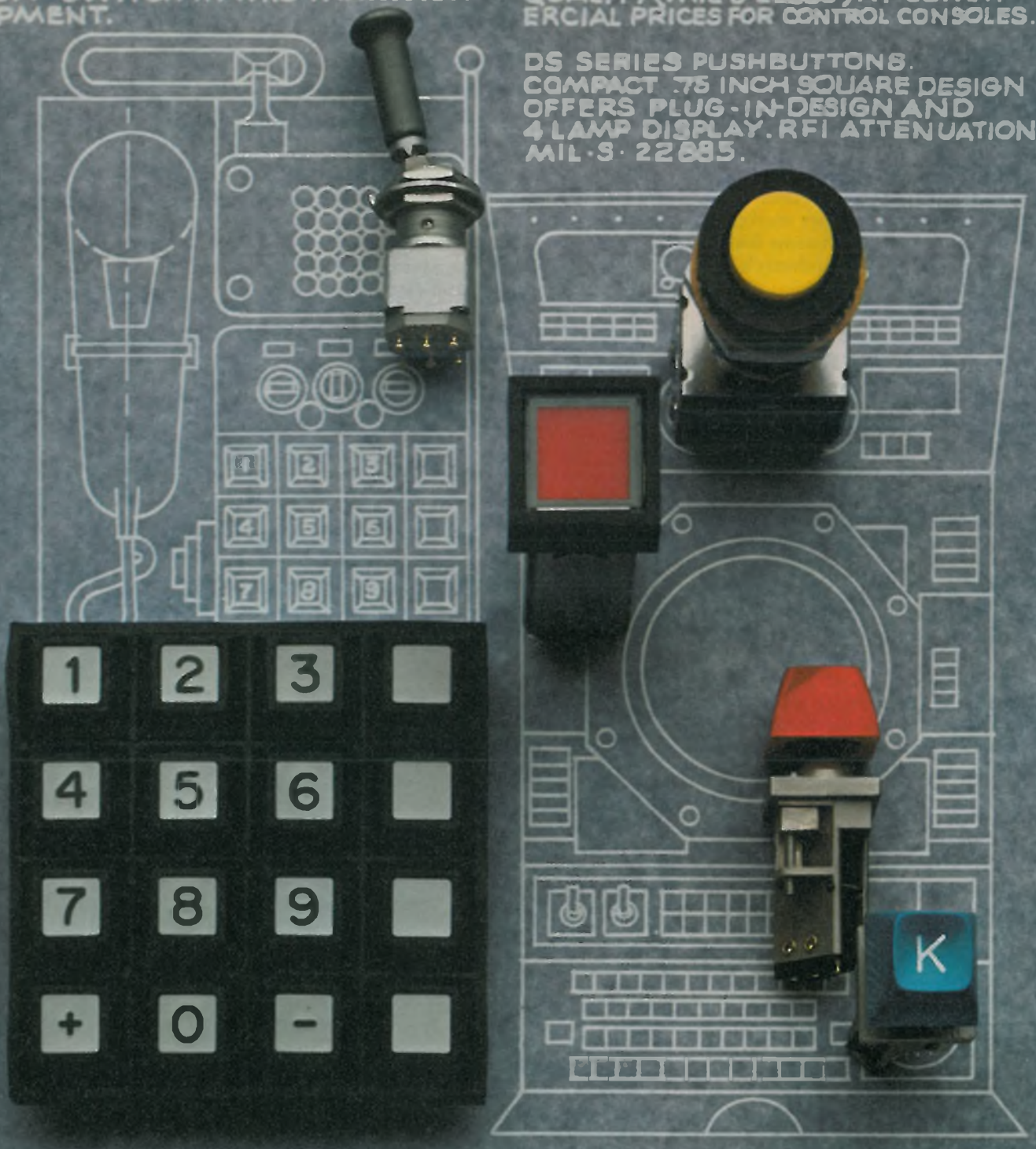
First of a kind. Memory board measuring 12 by 15 inches uses Intel's charge-coupled-device chips to store 1.1 million bits. Board is part of company's in-65 system.

They're good... no matter how bad

TW MEETS MIL-S-83731. OFFERS SWITCHING VERSATILITY OF LARGER TOGGLES WITH ADVANTAGE OF SMALL SIZE, PANEL SEALING. IDEAL FOR APPLICATIONS LIKE ON/OFF SWITCH IN THIS MANPACK EQUIPMENT.

SERIES 1 ROUND LIGHTED PUSHBUTTONS OFFER FLUSH MOUNTING, PANEL SEALING AND VERSATILE SWITCH CIRCUITRY; INCLUDING SOLID STATE. MIL SPEC QUALITY (MIL-S-22885) AT COMMERCIAL PRICES FOR CONTROL CONSOLES.

DS SERIES PUSHBUTTONS. COMPACT .75 INCH SQUARE DESIGN OFFERS PLUG-IN-DESIGN AND 4 LAMP DISPLAY. RFI ATTENUATION. MIL-S-22885.



PX KEYBOARDS. TOTALLY SEALED WHEN MOUNTED, WITH ZERO DEPTH BEHIND PANEL, PX IS A NATURAL CHOICE FOR MANPACK EQUIPMENT SWITCH MATRICES.

PANEL SEALED KS KEY SWITCHES. USE OF SPDT SNAP-ACTION SWITCHES (MIL-S-8805) AND FRONT-OF-PANEL REPLACEMENT, MAKE KS IDEAL FOR RUGGEDIZED CONTROL PANEL KEYBOARD APPLICATIONS.

board that contains a four-phase clock generator, a high-speed shift clock, a time-out clock, an address counter, address-compare circuitry, address register and address-decode circuitry, a data register and a data-shift register. The CU will drive up to eight MU-65 boards, so that an 8- or 9-bit system with one CU board and from one to eight MU boards is expandable up to 9,437,184 bits.

Adding boards. In some applications, long words will be required (for example, a system with 128-k words by 18 bits). While the CU does not incorporate the facilities to expand the system from 9 to 18 bits, the CU in conjunction with a BU does. The BU, says Tobias, is a simple board containing a data register, a shift register and the necessary gating to handle the second 9 bits of an 18-bit word and will handle up to 8 additional MU-65 memory boards. Therefore, a system consisting of 1,024-k words by 18 bits would contain one CU, one BU, and 16 MU boards, with additional BUs for each 9-bit increment.

The in-65 has a block-transfer mode. Given a beginning address, says Tobias, it will continually load or unload data (or mix load and unload cycles) in consecutive addresses, without a new address for each cycle. This is accomplished, he says, by activating the block transfer line and providing the system with continuous-cycle requests.

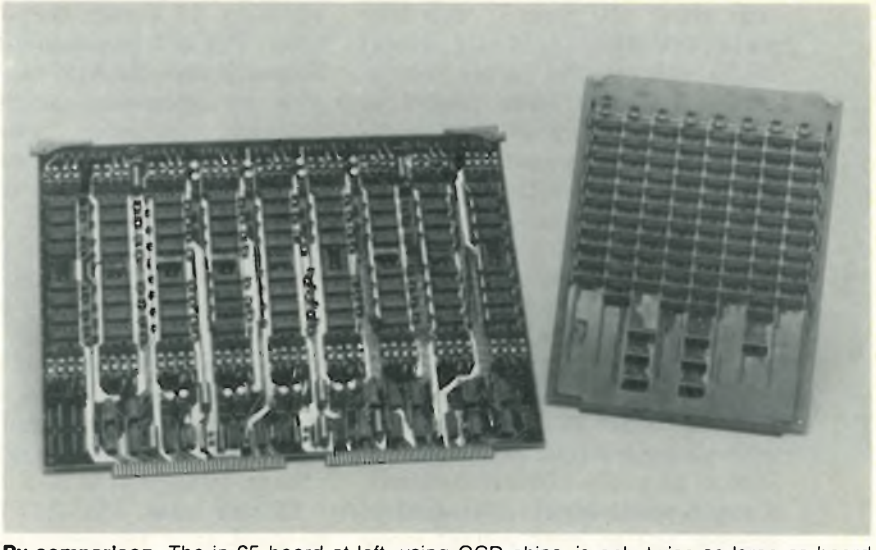
In addition to its bit-parallel data-handling capability, the in-65, by means of its CU and BU, has the ability to handle serial data. This can be loaded bit-serially into a register on the CU or BU, and it will then be loaded into memory, says Tobias. When read, it can be unloaded, bit-serially. This is done under the control of a shift clock provided by the central processing unit. Longer words can be unloaded or loaded bit-serially by chaining CUs and/or BUs together.

The in-65 has the capability of checking and storing parity on incoming data using 8 bits of data and one bit as parity and can also check parity on data read from memory. If an error is noted, an error signal will be sent to the processor.

In addition to replacement of disks and drums, says Tobias, the in-65 is ideally suited for replacement of magnetic-tape loops and for refresh applications for large cathode-ray tubes.

In single quantities, an MU board with 128-k words by 8 bits costs $2,600; a BU board, $250; and a CU board, $490. An 18.8-million-bit system with one CU, one BU, and 16 MUs with a mounting rack, power supply, and fans is priced at about $38,000 to $40,000.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051 [338]



By comparison. The in-65 board at left, using CCD chips, is only twice as large as board containing MOS shift registers, yet CCD board packs almost 14 times as much memory.

IC converts voltage to frequency

Commercial version of monolithic circuit offers linearity to ±1% and bandwidth of 100 kilohertz, sells for $3 each in 100-lots

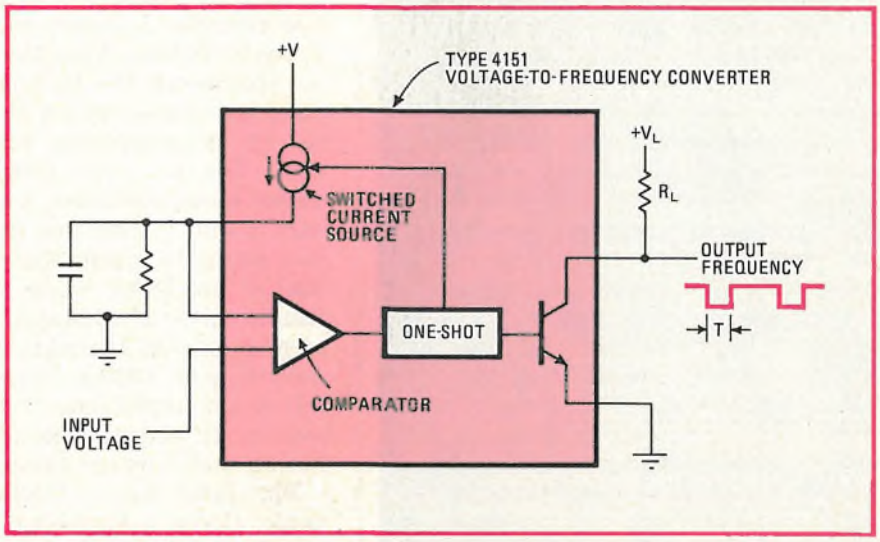
by Bernard Cole, San Francisco bureau manager, and Lucinda Mattera, Components Editor

Only a short time ago the traditional rack-mounted voltage-to-frequency converters costing $200 to $500 were displaced in many applications by small modules that cost one tenth as much. As a result, the range of v-f applications expanded beyond data conversion and remote-sensing, extending particularly into low-cost instrumentation. Now, another major advance has been made with the introduction by Raytheon Co.'s Semiconductor division of a monolithic v-f converter.

Designated the model 4151, the monolithic device (see figure at right) contains a voltage comparator, a one-shot, and a precision switched current source on a single chip measuring 45 by 61 mils. In quantities of 100, the commercial version is priced at about $3 each.

The output frequency of the 4151 is proportional to the input voltage over a six-decade range. The device's conversion accuracy drifts only about ±50 ppm/°C with temperature and typically about ±0.2%/volt with the supply voltage. Linearity ranges from ±0.05% to ±1%, depending on whether an external integrator is used.

Featuring a resistance-programmable full-scale frequency, the 4151 is capable of operating over a bandwidth of 10 to 100 kilohertz, product manager James Schmook points out. Other features, he adds, include: single-supply operation from +8 to +22 V at 4 to 6 milliamperes; a pulse output that is compatible with all logic forms; high noise rejection; an easily trimmable output; a single-ended input, referenced to ground; and an input voltage range of from -0.2 V to supply.



As a stand-alone v-f converter (as shown in the figure), the 4151 has a linearity within ±1%. In a typical application, where the input voltage range is 0 to +10 V, the output frequency varies from 0 to 10 kHz. Full-scale frequency can be fixed by adjusting the current-output-set resistor. But as a precision v-f device, Schmook says, the 4151 can be used with an operational-amplifier integrator, connected between its comparator and current source, to provide a typical linearity to ±0.05% over a 10-V input range. The op-amp integrator improves the linearity of the 4151 by holding the output of the internal current source at a constant zero voltage. "Unlike many v-f converter designs that lose linearity at inputs of less than 10 mV," he adds, "this circuit retains linearity over the full range of input voltage, all the way to zero."

Or vice versa. The 4151 can also be used as a frequency-to-voltage converter, both in the stand-alone and precision modes. A resistor-capacitor differentiator network is tied to the inputs of the on-chip voltage comparator to hold it in the off state. A negative pulse to one input, or a positive pulse to the other, will cause the comparator to fire the internal one-shot. For proper operation, the input pulse width to the comparator must be less than the period of the one-shot. Or, instead of a differentiator network, an external comparator can square up sinusoidal input signals before they are applied to the internal comparator.

With a typical supply current of 4 mA, the 4151 has an internal power dissipation of 500 milliwatts. It comes in three versions: the military RM4151, which operates over a range of -55°C to +125°C; the commercial RC4151, 0°C to +75°C; and the RV4151, -40°C to +85°C.

Raytheon Company, Semiconductor Division, 350 Ellis St., Mountain View, Calif. 94042 [339]

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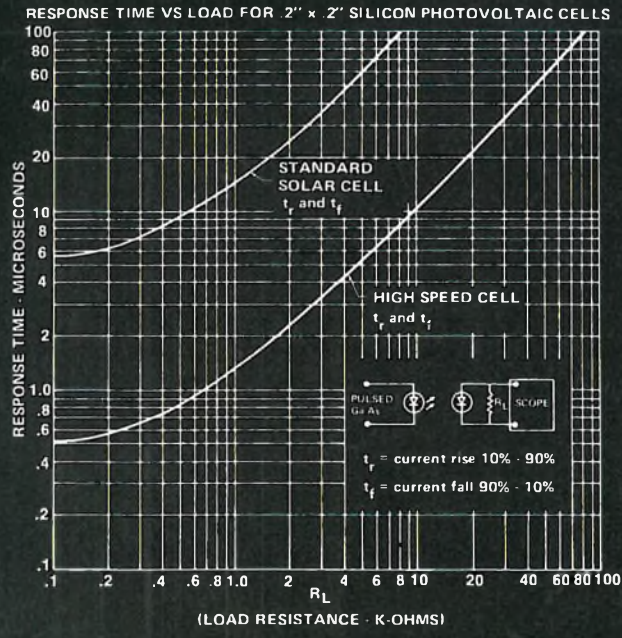

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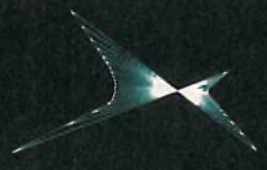

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Phone (314) 872-8300

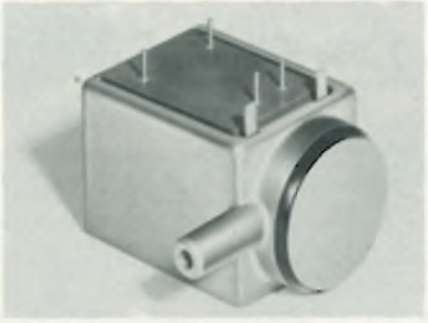
Circle 113 on reader service card

Industrial

Pressure sensor won't drift

Computerized calibration and high-volume casting keep price down to $30

High transducer prices have long been a subject of complaint from high-volume users in the petroleum, chemical, and other industries. Now the Gulton Industries Inc. Servonic/Instrumentation division has,



at least for a pressure-transducer, chopped the price down to a level that many users will probably consider acceptable. Its GS-2, selling for $30 per transducer in quantities of 5,000, is offering greater accuracy (typically ±1% of full scale) and longer operating life than designs costing three to 10 times as much, claims John Hayer, vice president of marketing.

Based on these over-all characteristics, Gulton says that the unit is suitable for OEM instrumentation applications ranging from automotive and truck-engine control to stationary processing and diagnostic systems.

Although the pressure-measuring principle is not new—it is the basis for other Gulton transducers—the construction and calibration techniques for the GS-2 have cut costs significantly below those of previous models. The transducer housing is produced by high-volume casting, and the instrument is calibrated in the company's computer-controlled test facility.

In the basic design, deflection of a welded aneroid capsule under pressure is detected by a linear variable differential transformer. The LVDT provides a full-scale output of 0 to 7.5 v dc for nine pressure ranges of 0–15 to 0–300 pounds per square inch (absolute or gage). Input to the sensor is also a dc voltage—9.0 to 15.0 v dc at a maximum of 30 milliamperes. The input power is converted by the sensor's solid-state circuitry into a high-frequency ac voltage to excite the LVDT.

Both the LVDT and the sealed aneroid pressure capsule are long-life components, and the combination gives the transducer a rating of 2 million operating cycles at a temperature of -40°F to 250°F, vibration of 10 g, and shock of 50 g. The circuitry, LVDT, and capsule are housed in a specially treated aluminum die-cast case that is suitable for use with most liquids and gases. The entire package weighs less than 3 ounces.

Exhibiting long-term drift-free operation, the GS-2 can operate for years without recalibration. Other advantages include the high-level, infinite-resolution output and input/output electrical isolation. Isolation resistance between input and output is 50 megohms. Other specs include a maximum output impedance of 5,000 ohms and a nominal load impedance of 50,000 ohms.

Gulton Industries Inc., Servonic/Instrumentation Division, 1644 Whittier Ave., Costa Mesa, Calif. 92627 [371]

High-output system measures static and dynamic pressures

A pair of piezoresistive pressure transducers and a companion amplifier together form a pressure-measuring system with a full-scale output of 500 millivolts and a rise time of less than 10 microseconds. The KIAG-SWISS system, made in Switzerland by Kistler Instrumente AG, can measure static and dynamic pressures from 2 bars full scale up to

200 bars full scale. (A bar is approximately equal to an atmosphere of pressure.) The transducers are excited by a calibration current supplied by the amplifier. The current can be adjusted to a value specified for each individual transducer so that the full-scale output is always exactly 500 mV. For this purpose, the current can be varied from 2.000 to 4.999 milliamperes.

Kristal Instrument Corp., 2475 Grand Island Blvd., Grand Island, N. Y. 14072 [373]

Preset counter has built-in triac and relay

A six-digit predetermining counter counts up from zero to a preset number and then actuates either a 10-ampere double-pole double-throw relay or a 9-A triac. To minimize radio-frequency interference, the triac circuitry includes a zero-crossing detector that turns it on at a zero crossing of the ac line. The counter includes a 110 V ac power supply and a display made up of light-emitting-diode digits measuring 0.29 inch high. In its automatic recycling mode, the counter keeps the relay or triac energized for an adjustable period of from 20 milliseconds to 1 second. In its non-recycling mode, the counter keeps them energized until

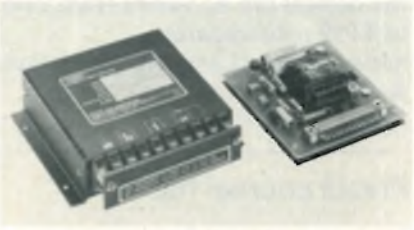
New products

the unit is reset by either a front-panel push button or a remote signal.

Kessler-Ellis Products Co., Atlantic Highlands, N. J. 07716 [375]

Converter linearizes resistance thermometers

Designed to work with resistance thermometers such as platinum RTDs (resistance temperature devices) and linear thermistors, Thermivolt systems are temperature-to-millivolt converters that produce an analog output voltage proportional to the sensor temperature. Moreover, the output is scaled so that an output of 23.8 mV, for example, corresponds to a temperature of 23.8° (either fahrenheit or celsius). Thermivolt units are offered in both open and enclosed models that cover the temperature range from −40° to 600°C. Prices range from $130 to $200, deliveries are from stock.



Yellow Springs Instrument Co., Inc., Box 279, Yellow Springs, Ohio 45387 [374]

Digital linearizer works with any thermocouple

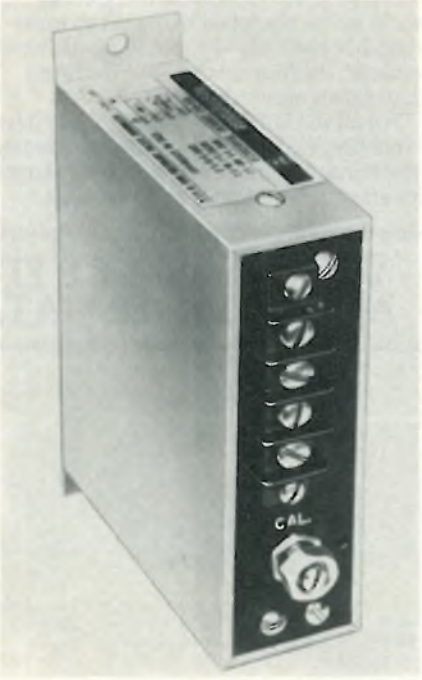
The Sanlab 201 digital thermocouple linearizer is a completely digital device that accepts input data from an analog-to-digital converter and processes it in accordance with NBS thermocouple tables to provide a linearized digital output. The unit accepts input data in parallel binary or binary-coded decimal form and generates output data in either or those two forms. Full-range linearization to within a reso-

lution of 1° is offered for type J, K, T, E, R, S, and B thermocouples. Delivery is from stock.

The San Diego Instrument Laboratory, 8098 Engineer Rd., San Diego, Calif. 92111 [376]

Transducers convert voltage and current

Designed to convert the outputs of potential transformers and current transformers to proportional dc signals, the VE4 and VI4 transducers produce outputs that are independent of load resistance. This makes them especially valuable for remote instrumentation applications in which the circuit resistance is unknown or subject to change. The devices are made in half-modules that measure 1.5 inches wide and 5.25 in.



Straight talk about IC sockets.

Integrated-circuit sockets are becoming such a household item, people are starting to forget something.

They're not all alike. And the differences can have a major impact on the performance and profitability of the products they're used in.

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

THE REASONS... AND THE RISKS.

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

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

CHOOSING THE RIGHT SOCKET.

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

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

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

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

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

SMALL POINTS MAKE A BIG DIFFERENCE.

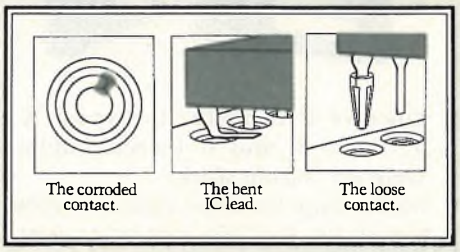
It's amazing how the finer points of socket construction can affect reliability.

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

The Augat method since 1965.

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

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



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

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

A SUPPLIER YOU CAN COUNT ON.

As the pioneer and leader in the IC interconnection industry, Augat has always been the world's prime supplier of IC sockets.

Now, after completing a multi-million dollar program of vertical integration, we're better equipped than ever to maintain that position—by providing the best sockets, the best service, and the finest distributor network in the world.

For all the facts, send today for our new brochure. We're convinced that the more you know, the more you'll come to Augat for all your IC interconnection needs.

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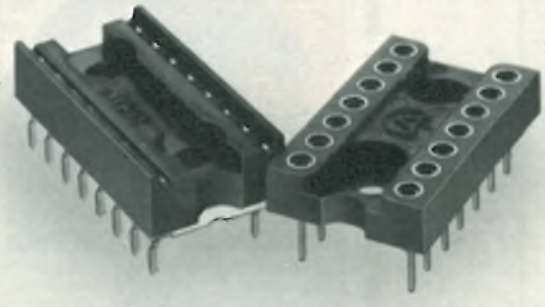

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New products

high. A 19-inch rack can hold a full set of watt, var, current, and voltage transducers for a three-phase line.
Westinghouse Electric Corp., Westinghouse Building, Pittsburgh, Pa. 15222 [377]

Servo-input recorder monitors up to 10 inputs

Developed primarily for water-quality monitoring, the model 35-1542X servo-input recorder converts a voltage or current input signal into digital form and records the data on a 16-channel binary punched tape. Able to handle up to 10 remote inputs, the recorder can be battery-powered and left at a remote location for extended periods. The unit can be set to record at intervals of as little as one minute or as much as 60 hours. In addition to storing the data on a punched tape, the recorder is offered with an option that allows it to be interrogated from a central location and to telemeter the data back on command.
Fischer & Porter Co., 567 Jacksonville Rd., Warminster, Pa. 18974 [378]

Level controller works with conductive materials

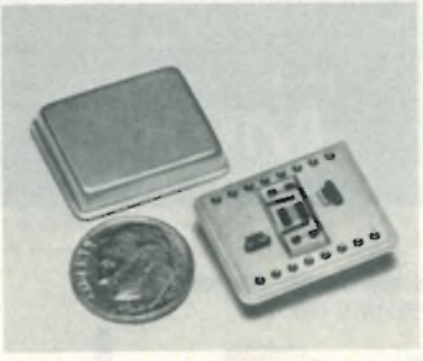
A solid-state level controller for use with conductive fluids, solids, or semi-solids is expected to find application in food processing, environmental control, and general manufacturing. The unit exploits the conductivity of the material being monitored to carry a weak current. When the level drops below a preset level, a circuit opens and activates the device, which refills the container. A built-in time delay eliminates chattering caused by sloshing of liquid during refill. Life expectancy is 1 million cycles.
Industrial Controls Division, General Time, Thomaston, Conn. 06787 [379]

Communications

Acoustic filters offer linearity

Low phase-deviation featured in device for cable TV and one for satellite nets

Although good shape factors are attainable for eight-pole lumped-constant bandpass filters, they must be equalized for both phase and amplitude in many demanding circuit applications. Surface-acoustic-wave



filters, on the other hand, are inherently linear-phase devices that don't need equalization networks to ensure low phase- and group-delay deviation throughout the passband—two critical parameters for communications circuits.

With this in mind, Andersen Laboratories has developed two SAW filters—the model 44-5, aimed principally at the cable-television market, and the 150-3, designed for portable, satellite, and missile communications systems. Model 44-5 is priced at $239 each for quantities of less than 10; the model 150-3, $295. Delivery time for both is 30 days.

In production quantities, Andersen Labs points out, SAW filters cost 20% to 40% less than equivalent LC types. Other attractive features, the company adds, are stability, compactness, and absence of the need for adjustment, a costly process. Also, design techniques for surface-acoustic-wave filters allow independent control of major parameters like bandwidth, stop-band rejection, ripple, and shape factor.

Model 44-5, for example, is centered at 44 megahertz, has a 1-decibel bandwidth of 4.8 MHz and a 40-dB bandwidth of 5.85 MHz. Passband ripple is ±0.5 dB, and the stop-band rejection is greater than 48 dB. Phase deviation is ±8° from 41.7 to 46.5 MHz and ±4° from 42.7 to 45.75 MHz. Group-delay deviation is ±50 nanoseconds and ±40 ns, respectively, over the same bandwidths. Insertion loss is less than 25 dB, and the impedance is 75 ohms. The device is housed in a flatpack measuring 1.4 by 1 by 0.125 inches for mounting on circuit boards.

The model 150-3 (shown at left), is a smaller, lightweight filter available in a standard flatpack. It is a small-bandwidth device, weighs less than 10 grams, measures 1 by 0.875 by 0.25 in., and is available in a military as well as a commercial version. Its impedance is 50 ohms; insertion loss, less than 20 dB; and maximum temperature coefficient, 1 part per million/°C. Phase linearity over a 0.5-dB bandwidth of 8 MHz is ±3°, and group delay deviation is ±20 ns. Phase tracking filter-to-filter is less than ±5°. The 32-dB bandwidth is 8 MHz.

Andersen Laboratories Inc., 1280 Blue Hills Ave., Bloomfield, Conn. 06002 [401]

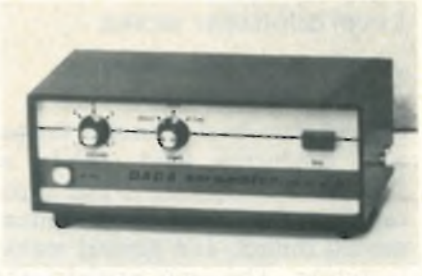
Computer controls telephone branch exchange

A computer-controlled telephone branch exchange uses time-division multiplexing to reduce cabling requirements from as many as 100 pairs to no more than three pairs for key telephones and call directors. The Rolm CBX (for computerized branch exchange) is intended for business and institutional applications having between 80 and 800 telephone stations. Its principal features, in addition to a need for no more than three-pair cabling, include up to 16 different classes of service that can be assigned on an individual telephone basis, automatic identification of outgoing dialing, on-line diagnostics, automatic selection of the cheapest route by which to make outgoing calls, and use with standard telephones. The company is quoting 90-day delivery time on new orders.

Rolm Corp., 18922 Forge Dr., Cupertino, Calif. 95014 [403]

Scrambler made for radios and telephones

Designed primarily to allow confidential speech over the radio, the Daca scrambler can be used by police, fire, and similar government



agencies as well as by such private users as truck drivers and ship operators. Made in the Netherlands by Conte B. V. of Lelystad, the scrambler is a digital device that uses several carrier frequencies. It feeds these frequencies into its modulator in a random order selected by the user through a series of thumbwheel controls. By making only eight random connections, the user can select one of 40,000 programs—a number large enough to make unauthorized unscrambling very difficult. The Daca scrambler conforms to all appropriate FCC regulations. A tele-

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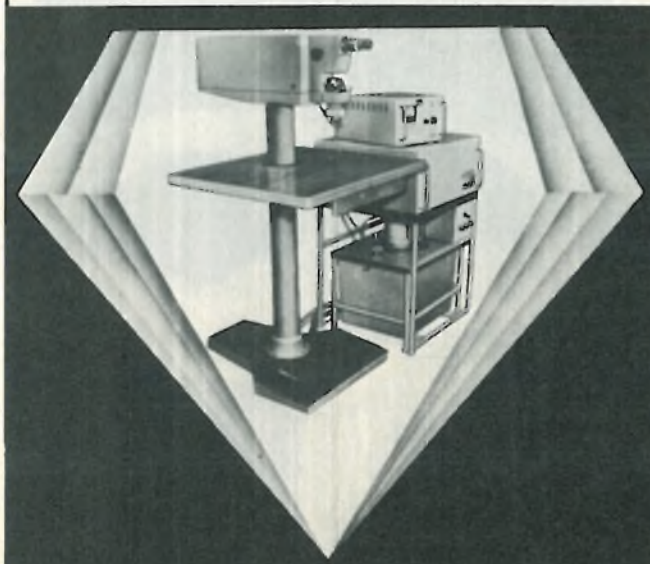

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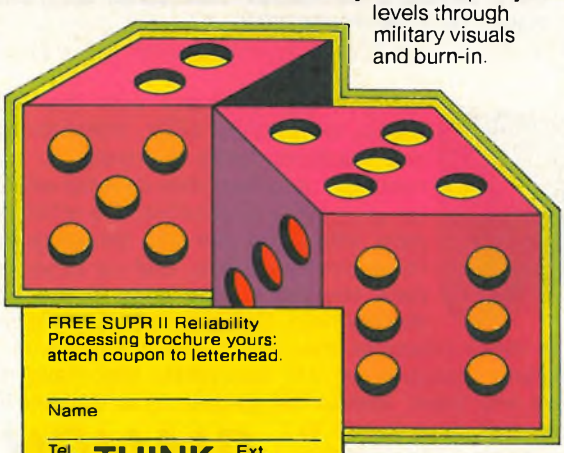

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122 Circle 122 on reader service card

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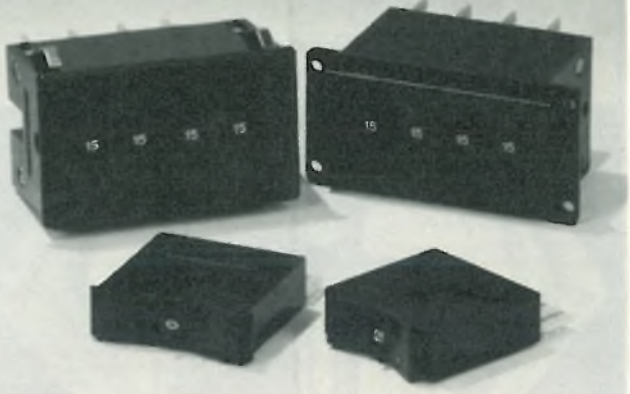

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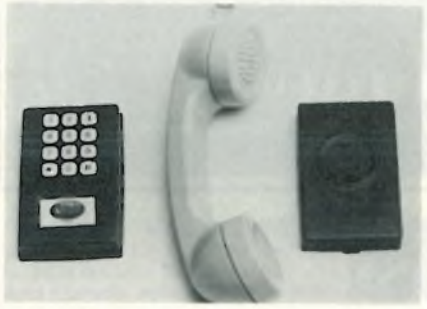
phone version is also available.
The Netherlands Consulate General, Commercial Div. 5832, One Rockefeller Plaza, New York, N. Y. 10020 [405]

Tone generator works with any telephone

Designed to permit any telephone to serve as an access port to a call diverter, central computer, or similar equipment, the model TG-402 tone generator is a pocket-size, battery-operated device with a stan-



dard 12-button keyboard. The unit has a built-in speaker that can be applied to the mouthpiece of any telephone. The output tones are standard Touch-Tone signals with frequency errors of no more than 1.5%. The TG-402 sells for $100 in small quantities.
The Candela Co., 2224 Old Middlefield Way, Mountain View, Calif. 94043 [406]

Multiplexed system controls 7,000 pieces of equipment

A multiplexed communications system for the control and monitoring of electrical equipment can handle as many as 7,140 separate pieces of equipment in its fully expanded form. The System 1A uses digital transmission at a rate of 1.544 megabits/second, and so is compatible with the Bell System's well established T1 transmission links. It can accept inputs from a variety of devices such as security and fire alarms, badge readers, and teletypewriters, and it can deliver outputs for controlling pumps, lighting,

Where can you find a remote controlled cassette tape transport for under $100?

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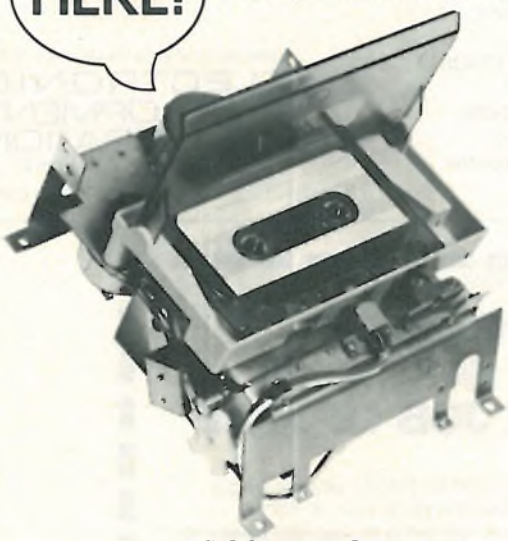

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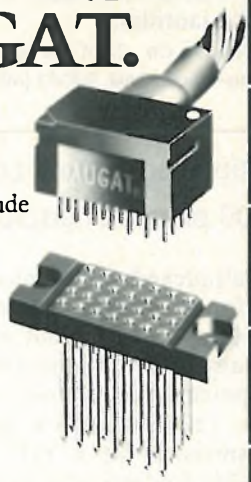

Our 28-pin, high-density cable plug assembly and socket offer twice the I/O density of conventional assemblies. Features include Augat's exclusive two-piece machined contact assembly, plus compatibility with other Augat boards, P.C. boards, or chassis mounts.

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air conditioners, access doors, etc. A single basic remote unit, which can handle 28 inputs and outputs, sells for $1,665 in small quantities. Master-unit pricing begins at $1,400. A single system may contain as many as 255 remote units.

Futronix Inc., 940 East Arques Ave., Sunnyvale, Calif. 94086 [407]

Correed matrices can switch even eight-wire circuits

A line of high-speed crosspoint switches intended for voice and data circuits, line concentrators, and the like comes with as many as 10 contacts per crosspoint, allowing it to

switch two-, four-, and even eight-wire circuits. The eight-by-10 matrix shown is for two-wire circuits. The correed matrices are noteworthy for their low insertion losses, minimal crosstalk, and low noise levels.

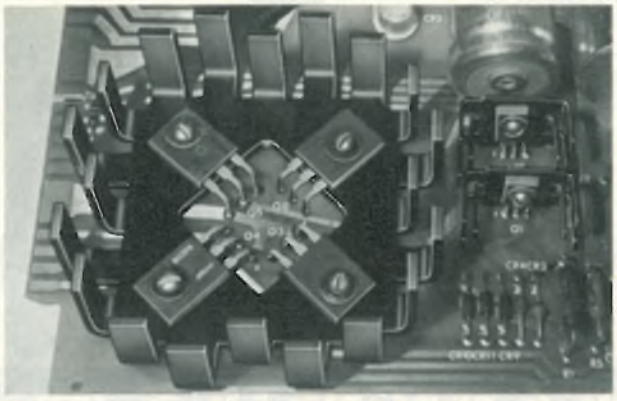
GTE Automatic Electric, Northlake, Ill. 60164 [404]

Cable video-transmission system uses fm for low noise

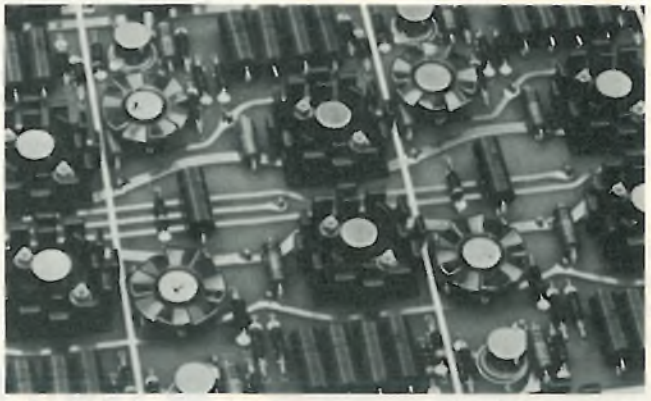
A video-transmission system for use over coaxial cables uses frequency modulation for good resistance to both thermal and impulse noise. The VFMS-2000 is offered with carrier frequencies from 19 to 260 megahertz, and with basebands from 10 hertz to 500 kilohertz up to 10 Hz to 5 MHz. The modular system is expected to find application in the long-distance transmission of high-

These ideas for cooling board-mounted semis could improve your circuit's performance

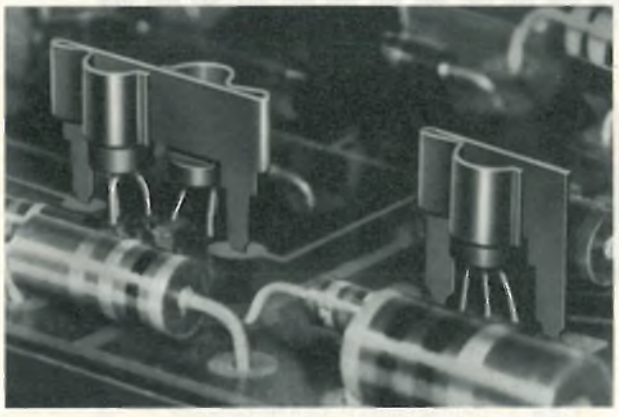
Thermal management is a highly versatile and valuable circuit design tool that can be used to increase semiconductor power, increase circuit density (or reduce the number of semiconductors), improve switching and temperature-related rise and fall characteristics, increase small signal gain and DC beta, match operating characteristics of two or more devices, improve reliability and cut costs. Here are some ways circuit designers have used IERC heat sinks/dissipators to beat printed circuit board-mounted semiconductor heat problems in order to improve their circuits, ideas that may be of help to you.



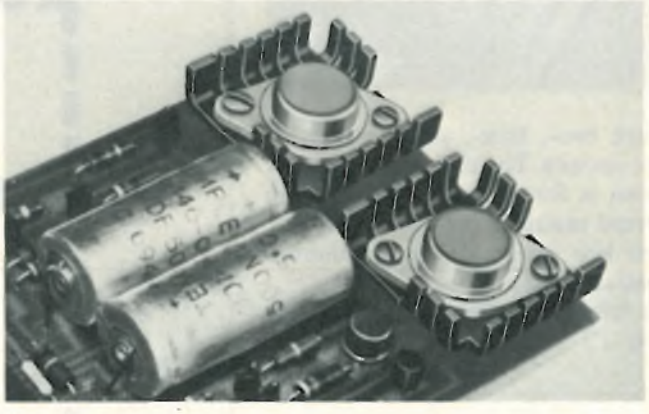
Four times the power from four power plastics took just one IERC dissipator. Bare transistors were capable of only 2 watts with 102°C substrate rise above ambient so designer used modified HP3 dissipator and got 8 watts from each at the same temperature rise. Or you could improve transistor life — roughly 7 times — by operating the devices at 2 watts and letting the same dissipator keep the substrate temperature rise to 32°.



Temperature matching at varying power levels is easy with the wide variety of IERC dissipators. On this board problem was to keep TO-5s at approximately equal case temperatures although some were operated at 2.2 watts and others at 1 watt. Press-on Fan Tops costing pennies kept 1 watters at 55°C case rise above ambient while LP dissipators held 2.2-watt devices at nearly identical case temperatures. IERC Insulube® coating permits mounting LPs directly on printed circuit lines.



Dissipators protect circuit — Designer of this TV circuit made sure dissipators would stay when D-case devices needed replacing. He designed dissipators as a part of the circuit, making it impossible to fire the circuit without them. In addition to this circuit protection the dual "Universals" gave him some other benefits: excellent retention in shock/vibration environments, good heat sinking during solder operations, and they cost just pennies.



Lower cost per unit was result of replacing four TO-3s used in this 10-watt power supply with two TO-3s in UP3 dissipators. Dissipators allow two TO-3s to operate at 5 watts each with same 65°C case rise above ambient as four devices operated at 2.5 watts each. Low profile dissipators plus TO-3s were assembled in less space allotted to four transistors. New design saved money, improved reliability.

For more information
on heat sinks and dissipators for milliwatts to kilowatts, send for the IERC Short Form Catalog today. It covers the most complete line of thermal problem solving devices available anywhere.

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New products

quality television, multiplexed PCM signals, high-speed facsimile, and data.

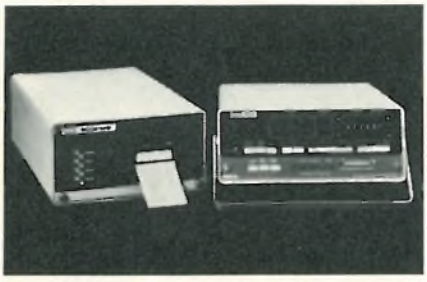
Catel, 1400-D Stierlin Rd., Mountain View, Calif. 94043 [408]

Low-cost test set checks data equipment

A versatile telecommunications test set, the Checktran model 350A, is capable of testing and monitoring all the synchronous and asynchronous components of a data-communications network as well as the network itself. The tester, which uses a broad range of plug-in interface modules to test and monitor modems, multiplexers, transmission facilities, and terminals, provides virtually every nonstandard and standard data rate from 45 to 9,600 bits per second in its asynchronous mode, up to 2 million b/s when it operates as a synchronous device.

In synchronous-device testing, the 350A can either provide the system clock or accept the clock from the device under test. Thus it can handle any odd data rate, even that of a terminal that is running out of tolerance. The unit's programable data rate feature gives it this capability for asynchronous systems, too. The Checktran has a basic price of $1,510 plus the price of an interface. A companion digital event recorder is available for $1,900.

Computer Transmission Corp., 2352 Utah Ave., El Segundo, Calif. 90245 [409]



The HP 436A. A very accurate power meter for people who can't afford to make mistakes or waste time.

Digital display for high accuracy. Its big, four-digit, LED display makes reading unambiguous. Accuracy is ± 0.5% in the "Watt" mode, ± 0.02 dB in the "dBm" mode on four ranges. Display range and decimal point are set automatically according to sensor being used. Uses HP 8480 Series of low SWR power sensors which results in very low measuring uncertainties. High accuracy is further assured by an internal 1 mw, 50 MHz calibrator.

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The right sensor. Choose from a family of sensors which feature wide dynamic range, broad frequency coverage, good burnout resistance, and the low SWR necessary for overall measurement precision. 8484A (−70 to −20 dBm), 8481A (−30 to +20 dBm), and 8481H (−10 to +35 dBm) cover 10 MHz to 18 GHz. Other sensors for 100 kHz and 75 ohm use.

Build a mini-system. The 436A Power Meter is programmable with BCD or HP Interface Bus. You can easily assemble a small-scale system for automatic measurement. Ask for Application Note 196 to learn more about it.

Call or write. The 436A costs just $1,800* sensors begin at $400* For full specifications contact your nearby HP field engineer.

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Data handling

Disk system is 'intelligent'

Microprocessors control system that can store total of 864 megabytes

Calling it "the first intelligent disk system," IMS Associates of San Leandro, Calif., has introduced a storage unit that uses interacting microprocessors to remove much of the control burden in data-base access functions from central processing units or terminals. The microprocessors, Intel type 8080s, control the input/output communications lines and the disks. They also perform the central data-base management function.

Called the IMSAI 108, the system can handle 54 megabytes of data with a single spindle or, according to IMS director of marketing William H. Millard, it could be expanded to handle up to 16 drives—864 megabytes—"without any trouble at all." The system uses standard IBM type 3336 disks and can transfer data at 806 kilobytes per second. Maximum track-to-track access time is 6 milliseconds.

With the data-base management system, the user's computer and intelligent terminals can communicate with the disk file through high-level commands, while the intelligent disk system carries out the detailed commands for indexing, searching, and deblocking operations required to access or store the needed data. Thus, the communications lines almost exclusively carry requested data, while a minimum of control information flows back and forth between the terminal and the disk system.

Since the system communicates through the EIA standard interface RS-232-C, it can be easily connected to many different types of host computers or terminals. "And the use of a high-level language for communications means that any computer or terminal that can talk to another computer or terminal can also talk to the disk system," says Millard. "The programer does not have to worry about where data is—he just says 'get me this record' or 'store that record.' "

The key to the system, according to Millard, is the architecture of the distributed processors. Each microprocessor can access one 450-nanosecond semiconductor cache memory holding between 16,000 and 128,000 words. (Each processor also has its own control memory.) The work is doled out with a "mailbox" concept—when one microprocessor is ready for more work, it accesses a mailbox to get its next task.

The distributed nature of the architecture allows extra communications interfaces or disk control units, or additions to the data-base management system, to be made simply by plugging in another microprocessor card, according to Millard. All cards are identical. For example, he says, if one customer wants to run the system with several host computers talking to a few disks, extra communications cards are added; if another customer wants to expand the data-base management function, extra cards are added there.

The single-spindle model costs $29,500, and a dual-spindle (108 megabytes) model is priced at $47,500.

IMS Associates Inc., 1922 Republic Ave., San Leandro, Calif. 94577 [361]

Printer/plotter can run at 1,200 lines per minute

A 22-inch-wide printer/plotter from Varian Data Machines is capable of plotting speeds as high as 2.75 inches per second or printing rates as high as 1,200 lines per minute. The Statos 4122 interfaces with most popular minicomputers, and can be used as an off-line device with large systems. The machine is built around a Bi-Scan writing head

New products

which contains 100 styli per inch. This head, in combination with a dynamic toning system, gives the printer/plotter 100% charge coverage even in solid areas. This ensures uniform development of the image under all conditions. The 4122 plots with a maximum absolute error of 0.5% and repeatability within 0.3%.

Varian Data Machines, 611 Hansen Way, Palo Alto, Calif. 94303 [364]

Magnetic core memory designed for microprocessors

Believed to be the first magnetic core memory designed especially to match the capabilities of National Semiconductor's microprocessors, the LM-416-N is compatible with the IMP-16P, IMP-16C, and PACE microprocessors. The principal advantages of the LM-416-N over semiconductor memories are its greater reliability in industrial environments and the protection it offers from loss of data caused by power swings or uncontrolled shutdown. The memory comes in two sizes, 4,096 words of 16 bits each or 8,192 16-bit words. Cycle time is 1.4 microseconds, and access time is 550 nanoseconds. The memory contains its own temperature-compensation circuitry, and measures 11 by 8.5 by 1.0 inches.

Litton Memory Products division of Litton Industries, Canoga Park, Calif. [363]

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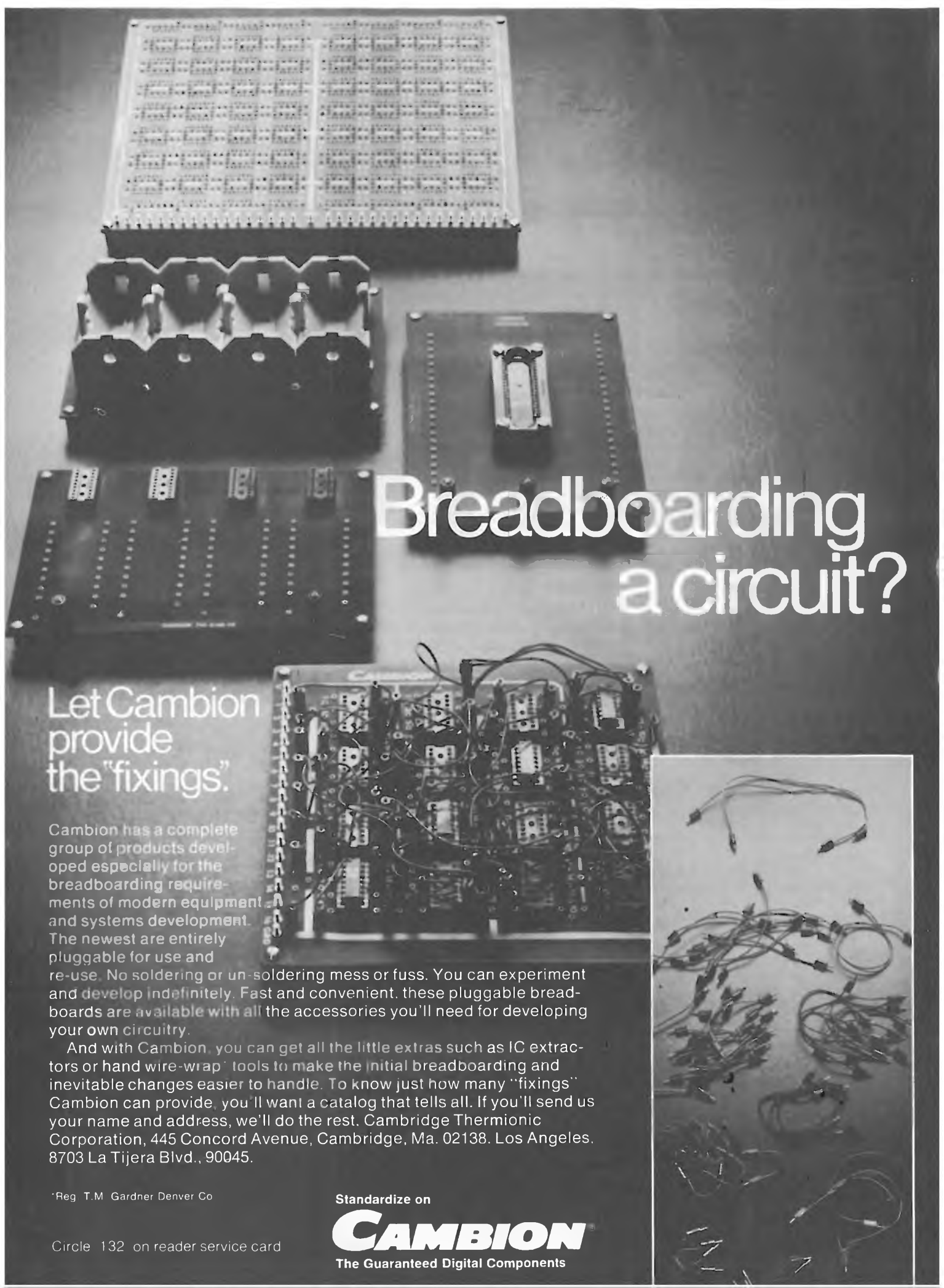

Breadboarding a circuit?

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Cambion has a complete group of products developed especially for the breadboarding requirements of modern equipment and systems development. The newest are entirely pluggable for use and re-use. No soldering or un-soldering mess or fuss. You can experiment and develop indefinitely. Fast and convenient, these pluggable breadboards are available with all the accessories you'll need for developing your own circuitry.

And with Cambion, you can get all the little extras such as IC extractors or hand wire-wrap* tools to make the initial breadboarding and inevitable changes easier to handle. To know just how many "fixings" Cambion can provide, you'll want a catalog that tells all. If you'll send us your name and address, we'll do the rest. Cambridge Thermionic Corporation, 445 Concord Avenue, Cambridge, Ma. 02138. Los Angeles. 8703 La Tijera Blvd., 90045.

*Reg. T.M. Gardner Denver Co.

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The Guaranteed Digital Components

Circle 132 on reader service card

Instruments

Analyzer covers 10 to 1,000 MHz

Network diagraph shows curves in either polar or rectangular coordinates

An important asset in network analysis is the ability to separate the measured quantity into magnitude and phase or, alternatively, into real and imaginary parts, and to display the corresponding curves in either

polar or rectangular coordinates.

The type ZWD sweep diagraph from Rohde & Schwarz can measure complex characteristics of components and assemblies over a frequency range of from 10 to 1,000 megahertz and display them in a variety of ways.

The network analyzer can present a complex display of reflection coefficient in polar or Smith chart form, a complex display of transmission factor in polar form, a magnitude display of reflection coefficient and transmission factor versus frequency, or a magnitude display of transmission constant versus frequency, as well as displays of phase versus frequency or real and imaginary components of measurable vector quantities.

Two independent test channels permit simultaneous display of two quantities, and phase-tracking circuitry within the receiver allows the use of any appropriate external signal generator.

The basic ZWD system consists of the two-channel tracking receiver and the mixer. With externally mounted directional couplers and attenuators for complex transmission-factor measurements, the system is priced at $14,750. A test setup for measuring reflection coefficients is priced at $16,500, and adding facilities for measuring s-parameters increases the price to $18,500.

Overall dynamic range of the system is 120 dB, and up to 90 dB can be displayed. Characteristic impedances of 50, 60, or 75 ohms can be achieved by changing directional couplers.

The test channel of the heterodyne receiver has a bandwidth adjustable from 1 Hz to 200 kHz. Maximum input level is 50 milliwatts.

All displayed quantities are available as analog voltages at the outputs of the ZWD for use in automatic measuring systems. For programed selection of display, mode, sensitivity, bandwidth, and frequency, a separate module is being prepared that can be controlled with transistor-transistor-logic levels and uses ASCII code.

A sweep generator specifically designed for use with the ZWD system, as shown, is priced at $10,000. It can sweep from 10 to 1,000 MHz in one band and includes a marker generator with selectable spacings of 1, 10, or 100 MHz.

Rohde & Schwarz Sales Co., Inc., 14 Gloria Lane, Fairfield, N.J. 07006 [351]

Dumont introduces four new scopes

Four models from Dumont mark the firm's re-entry into the commercial scope market.

The most advanced unit, model 1100P, has dc-to-100-megahertz bandwidth and is priced at $1,895. The three other products have bandwidths to 10 MHz.

The 1100P, shown in the photo, has calibrated sweep speeds from 0.05 microsecond per centimeter to 1 s/cm with an accuracy to within 3%. A times-ten magnifier increases

the maximum sweep to 5 ns/cm.

Calibrated delayed sweep is standard. Mixed sweep provides a display with the main timebase driving the first portion of the sweep and the delayed time base completing the sweep at the faster delayed sweep rate. Trigger signals are derived ahead of the position controls to eliminate instabilities caused by changes in trace position.

Vertical deflection factors are from 5 mV/cm to 10 V/cm at full bandwidth. The CRT has an 8-by-10-centimeter display and an internal, edge-illuminated graticule.

The lower-priced line includes the model 5111, a single-channel 10-MHz scope with 10 mV/cm sensitivity, priced at $495.

The $795 model 5100 is a two-channel unit with a passband of dc to 10 MHz and a sensitivity of 2 mV/cm.

The $1,040 model 3100 weighs less than 9 pounds and operates on 100, 117, 200, or 234 V at 50-400 Hz, or 9-14 Vdc. The dual-trace unit has a bandwidth of dc to 10 MHz at 4 graticule divisions deflection, dc-7 MHz at 8 divisions. Sensitivity is 10 mV/div.

Dumont Oscilloscope Laboratories, Inc., 40 Fairfield Place, West Caldwell, N. J. [352]

Bare-bones oscilloscope kit sells for $119.95

Some oscilloscope applications—service and repair or production-line checking, for example—require a monitor that does little more than display a waveform.

The Heath model IO-4560, priced at $119.95 in kit form, is designed to

New products

do these jobs, as well as for standby duty in service and repair shops. Though lacking calibrated horizontal and vertical sweep controls, its dc-to-5 megahertz bandwidth and 100-millivolt sensitivity make it more than adequate for many tasks.

Horizontal deflection is controlled by a two-position switch and a potentiometer, and vertical deflection by a three-position switch and pot. A horizontal input with frequency response from dc to 100 kHz allows X-Y displays on the 8-by-10-centimeter CRT screen.

A version with calibrated sweep speeds and vertical deflection is also available, priced at $275 in the factory-wired model SO-4540 and at $179.95 in the kit model IO-4540.

Heath/Schlumberger Instruments, Benton Harbor, Michigan 49022 [355]

Lock-in analyzer spans 0.1 Hz to 200 kHz

Lock-in analyzers—essentially narrow-band ac voltmeters—are useful in measuring the amplitude, phase, and frequency of signals that may be obscured by electrical noise or interference. Ithaco's Dynatrac 3 uses heterodyne detection techniques to measure signal strengths from picovolts to volts at frequencies from 0.1 hertz to 200 kHz, with selectable

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One good turn...

deserves another.

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PA **PRACTICAL AUTOMATION, INC.**

Circle 181 on reader service card

measurement bandwidths from 0.001 Hz to 100 Hz. Signals 100 dB below an interfering signal can be detected.

The measurement frequency is determined either by an external reference signal to which the instrument is synchronized, or by a calibrated internal oscillator which can be used to modulate the signal source. In the signal-tracking mode, the analyzer phase-locks to the signal itself, useful when the signal is drifting or no reference signal is available.

A phase option measures the phase of noisy signals with an accuracy to within ±1° with resolution and stability of 0.1°. The price of the analyzer is $2,695.

Ithaco Inc., 735 W. Clinton St., Ithaca, N.Y. 14850 [356]

Sweeper covers 1 to 1,500 MHz in two bands

The model 9063 half-rack sweep generator spans the frequency range from 1 to 1,500 megahertz in two overlapping bands. Putting out 0.5 V rms flat within 0.5 dB across its entire spectrum, the sweeper has built-in rotary attenuators that provide up to 80 dB of continuously variable attenuation. Sweep rate selection includes variable 1 to 100-Hz rates, manual sweep, and line-lock modes. The model 9063 will be on display at Wescon next month.

Kay Elemetrics Corp., 12 Maple Ave., Pine Brook, N. J. 07058 [358]

Probes make time-interval measurements easier

A pair of low-capacitance active probes and their associated electronics have eliminated several of the problems commonly encountered in the measurement of short time intervals. For one thing, the

The sub-priced subminiature: TRW/Cinch Burgun-D connector

You'll have to look closely to tell a TRW/Cinch Burgun-D* Subminiature Connector from the other four types of D-Subminiatures in our line. But there's a whale of a difference in price.

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The new Burgun-D series comes in 9, 15, 25, 37 and 50 contact sizes which are intermateable with all D-Subminiatures of the same size. A variety of selective gold-plated stamped and solid-plated machined contacts are available in bulk or on reels to satisfy your design requirements. They all utilize standard assembly and crimping equipment.

Don't fish for additional information on TRW/Cinch Burgun-D's, phone your nearest stocking distributor or TRW/Cinch Connectors, 1501 Morse Avenue, Elk Grove Village, Illinois, 60007. (312) 439-8800.

*Trade Mark ITT Cannon CC-7503A

TRW CINCH CONNECTORS

Circle 137 on reader service card

probes bring preamplifiers to the test point, making cable-length determination unnecessary. For another, the model 5363A automatically equalizes the time delays through its two channels, thus allowing increased accuracy. And for a third, the probes have an input impedance of 1 megohm in parallel with 10 picofarads, which reduces the problem of circuit loading.

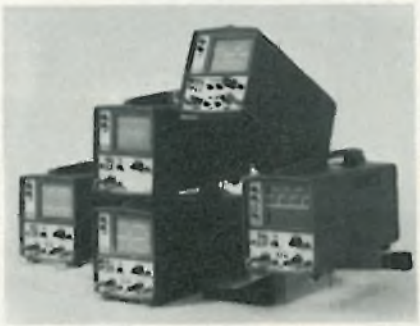
The electronics box that comes with the probes allows the trigger point for each channel to be set to any level from −10 V to +10 V in 10-millivolt steps. Although the 5363A can be used with any electronic counter, units with input passbands of at least 100 megahertz and single-shot resolutions of better than 10 nanoseconds are required to get full benefit from the probes. The probe assembly, which will be shown at Wescon, sells for $1,500.

Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [357]

Tektronix scopes aimed at industrial, service needs

Designed to provide good basic performance and high reliability in modestly priced scopes, the T900 series from Tektronix consists of five models with bandwidths of 15 or 35 megahertz for the real-time units and 10 MHz in a storage scope, at prices from $695 to $1,250.

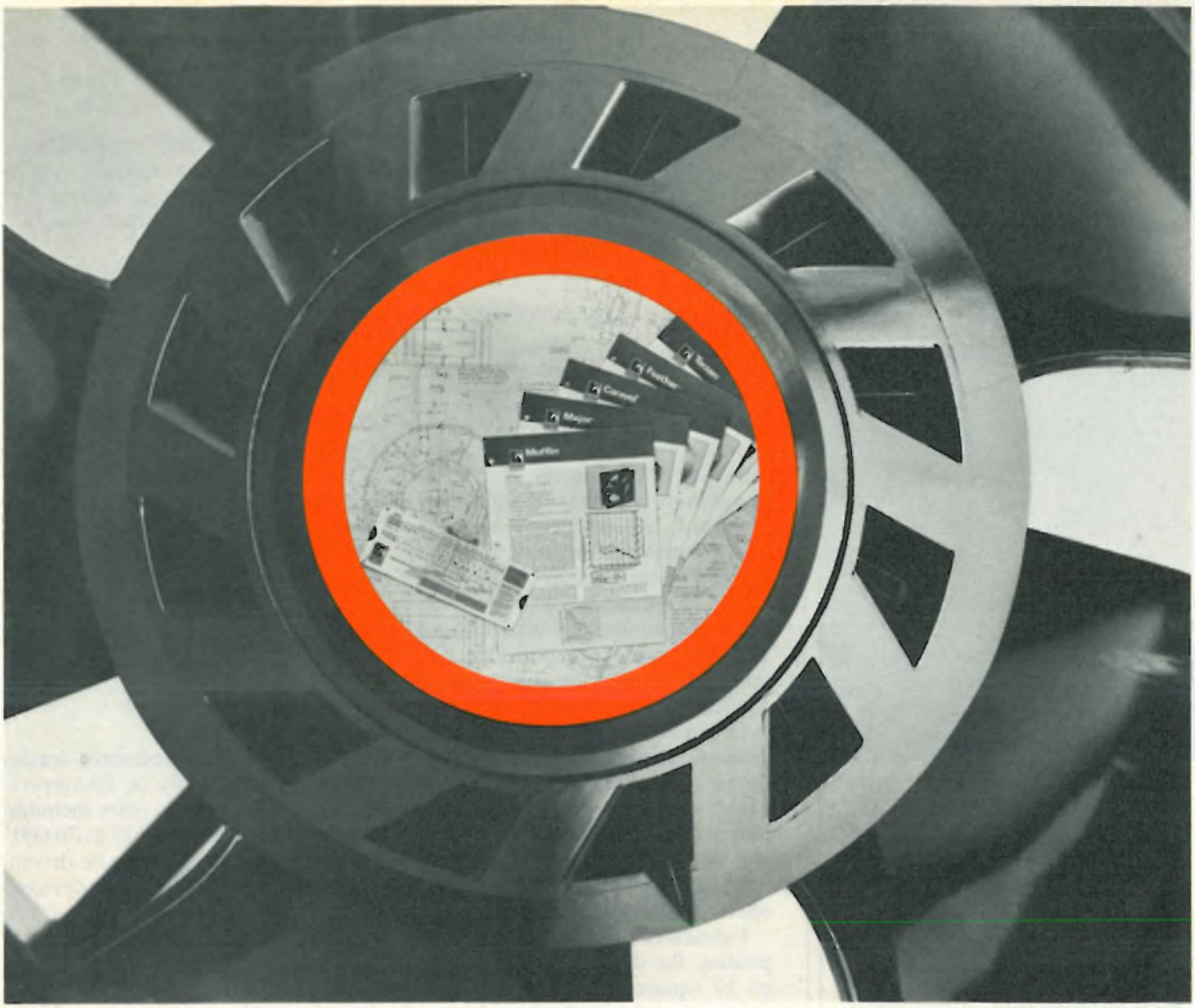
Housed in cabinets of the same



plastic material used in Tektronix' 200 series miniscopes and the model 455 [*Electronics*, March 20, p. 139], the T900 family offers a choice of single or dual trace instruments with vertical deflection factors from 2 millivolts to 10 V per division. Accuracy is within 3% for both vertical and horizontal deflection.

The real-time scopes use a 12-kilovolt-potential, post-accelerated CRT similar to that in the company's model 465. The 15-MHz, single-trace model T922 is priced at $695 and the dual-trace version at $850; the 35-MHz dual-trace T932, at $995; and the 35-MHz, dual-trace, delayed-sweep T935, at $1,250. The 10-MHz, dual-trace T912 bistable storage scope sells for $1,195.

Tektronix Inc., P.O. Box 500A, Beaverton, Ore. 97077 [359]



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Circle 139 on reader service card

New products

Semiconductors

Fairchild C-MOS Macrologic bows

LSI units are pin-compatible with company's bipolar line, perform same jobs

Expanding its standard complementary-MOS family, Fairchild Semiconductor has developed a series of LSI devices to perform data-processing functions primarily for industrial, military, and aerospace applications. The units are pin-to-pin compatible with, and perform the same functions as, Fairchild's line of Macrologic bipolar circuits [*Electronics*, July 10, p. 85].

Organized in 4-bit slices, the new devices operate over a power-supply range of 3 to 15 volts with bus-oriented, three-state outputs. Power requirements are about 10 milliwatts per device operating at about 2 megahertz, and almost zero at low operating speeds.

Fabricated by the Isoplanar-C process, the devices have gate areas of 10 square mils, 15-nanosecond delays at a drain-supply voltage of 10 V and 30-ns delays at 5 V. Included in the family are:

- The 4704, a data-path switch (DPS) for closing data-path loops around arithmetic logic units, combines the functions of a dual 4-input multiplexer, a true/complement/1/O generator, and a shift-left/shift-right array.
- The 4705 arithmetic/logic register stack (ALRS) is a 4-bit slice of a multi-accumulator index register that contains a 4-bit ALU, an 8-word-by-4-bit random-access memory, an edge-triggered output register, and associated logic.
- The 4706 program stack, a 16-word-by-4-bit push-down, pop-up program stack, stores program counters and return addresses for nested subroutines in programable digital systems.
- The 4707 data-access register (DAR) contains three 4-bit registers, a 4-bit adder, a three-state address output buffer, and a separate output register with three-state buffers for providing register output on the data bus.
- The 4710, a 16-word-by-4-bit RAM with output register, contains an edge-triggered 4-bit output register to allow new input data to be written while previous data is held.

Prices, in quantities of 100, are $6.60 for the 4704, $12 for the 4705, $11.65 for the 4706, $8.75 for the 4707, and $5.50 for the 4710. Delivery is from stock.

Fairchild Camera and Instrument Corp., Integrated Circuits Group, 464 Ellis St., Mountain View, Calif. 94602 [411]

Power Darlingtons drive inductive loads

Designed to drive inductive loads, the SCA0108 family of 10-ampere Darlington transistor pairs includes units with betas of 10,000 to 70,000. The transistors, which can be driven by most integrated-circuit devices, have a secondary breakdown of 5 A at 70°C (at rated breakdown voltage), a cutoff frequency (F_t) of 60 megahertz, and a leakage current of less than 10 nanoamperes at 25°C. They can drive 20 millihenries at 2 amperes or 50 mH at 1 A. Available in a variety of packages, some of which can dissipate up to 25 watts at 75°C, the transistors are priced as low as $18 each in lots of 100. Production quantities are available from stock.

Semicoa, 333 McCormick Ave., Costa Mesa, Calif. 92626 [413]

High-performance one-shot has delay range of 1,300:1

The 96S02 dual monostable multivibrator is a retriggerable and resettable device whose output pulse width can be varied over a 1,300:1 range by means of an external resistor control. The device has a propagation delay of only 12 nanoseconds, a maximum duty cycle of

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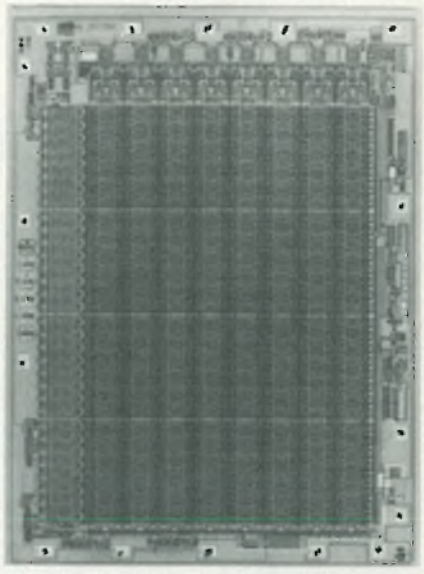
"Demonstration Only" circle 193 on reader service card

100%, and a maximum pulse-width variation of less than 0.3% for temperatures from 0°C to 75°C and supply voltages from 4.75 to 5.25 v. The one-shot requires only a 0.1-microfarad capacitor to achieve a 100-millisecond delay at maximum resistance. It has both positive and negative trigger inputs, and a Schmitt trigger on the positive input is provided for decreased sensitivity to noise. The price of the 96S02, for 100 to 999 pieces, is $1.56. This price is for units housed in a plastic dual in-line package.

Digital Products Division, Fairchild Camera & Instrument Corp., 464 Ellis St., Mountain View, Calif. 94042 [414]

C-MOS RAM pulls only 200 nanoamperes per bit

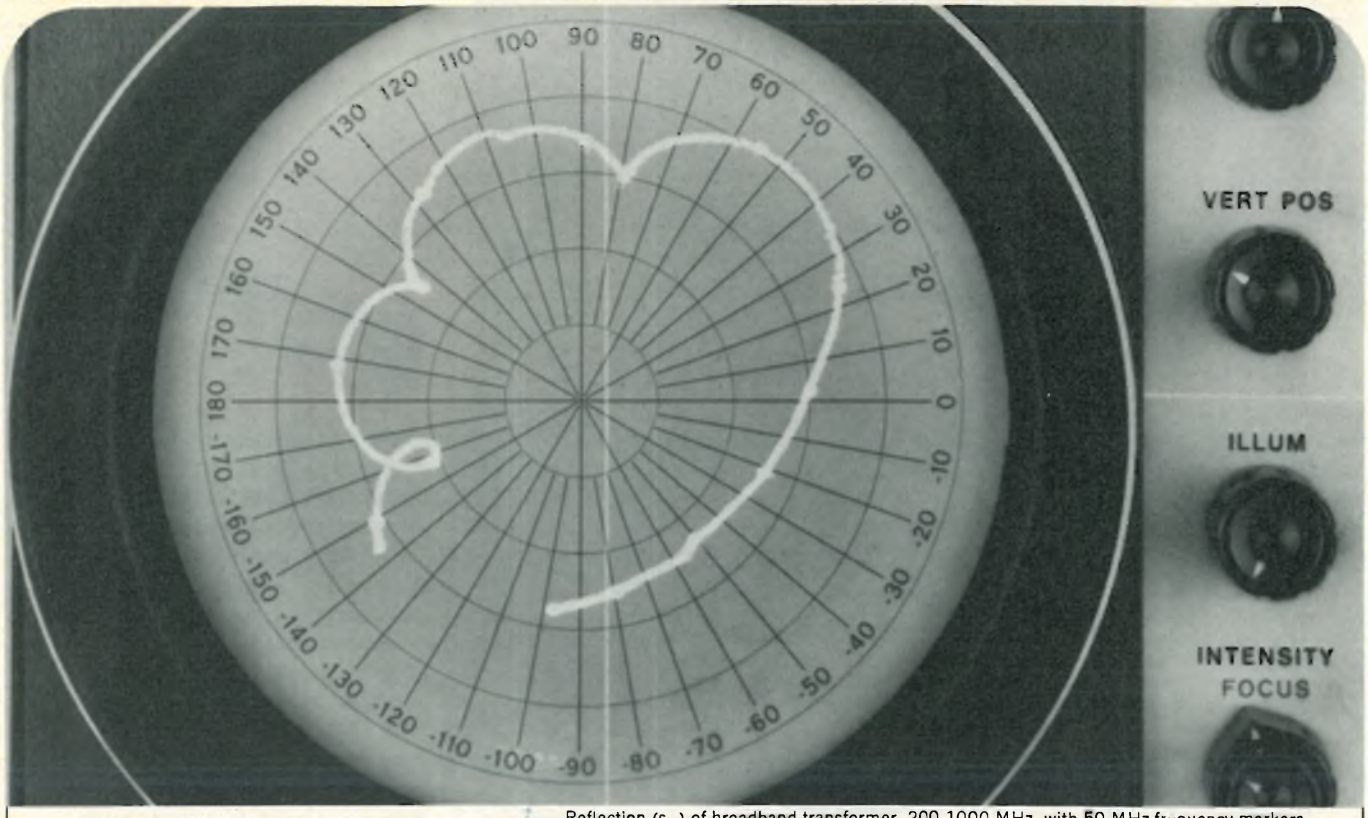


In an effort to prevent data loss caused by power failures, many manufacturers are providing battery back-up for their semiconductor memory systems. For this application, memories with low standby currents become very attractive since they minimize the size, weight, and cost of the required batteries. Such a memory is the SIL-1902A—a fully static complementary-MOS random-access memory which has a worst-case standby current of only 200 nanoamperes per bit at 125°C with V_{DD} = 5.5 volts. The 1,024-bit RAM is offered in two temperature ranges: -40 to 85°C and -55 to 125°C. Prices, for at least 90 pieces, range from $28.60 for the limited-range unit in a plastic dual in-line package to $79.70 for the military device in a ceramic flatpack. Deliveries are from stock.

Siltek International Ltd., Airport Industrial Park, Bromont, Que. Canada J0E 1L0 [415]

Tiny LED lamp puts out 1,000 foot-lamberts

Measuring only 0.020 inch high by 0.018 in. wide, the Micro Led series of discrete light-emitting diodes



Reflection (s_{11}) of broadband transformer, 200-1000 MHz, with 50 MHz frequency markers.

Here's the way to make multi-octave RF and microwave vector measurements.

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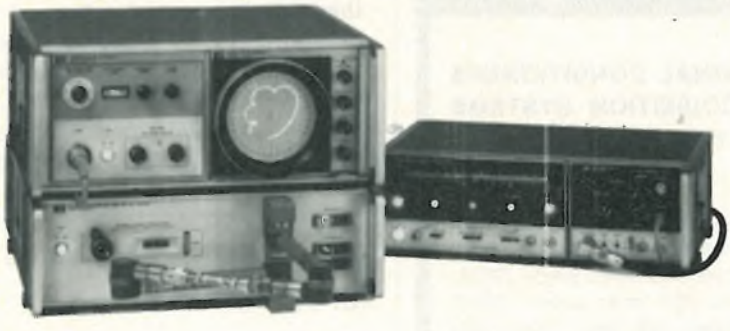

The familiar HP 8410 Network Analyzer now has automatic tuning to track the wide sweeps of the HP 8620A sweeper with its new broadband plug-ins.

Sweep 2-18 GHz with the HP 86290A plug-in and 100-2400 MHz with the new HP 86222A/B. The HP 86222B adds unique digitally-processed birdie markers for precise frequency identification.

Why not find out more about this complete high-frequency vector system? All the details are yours by calling your nearby HP field engineer, or writing.

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New products

have a brightness of 1,000 foot-lamberts at a drive current of 10 milliamperes. The Micro Leds have a viewing angle to half brightness of ±90°. They are offered in red, green, and yellow versions. Potential applications of the lamps include the illumination of small dials and liquid-crystal displays, lamp arrays, and cockpit and battery-status indicators. The LEDs are priced below 50 cents each in large quantities.

Digital Components Corp., 1111 East Elizabeth Ave., Linden, N. J. 07030 [416]

Uhf transistors have high peak-power ratings

Two high-performance power transistors are designed to deliver extremely high peak-powers across the 200 to 500-megahertz frequency range. Intended for use in uhf radars, the CD 2246 and CD 2196 have peak power ratings of 300 watts and 250 W respectively. Designed to be used in a common-base configuration, the transistors are housed in low-inductance stripline packages which offer a low ratio of thermal resistance to thermal time constant. The CD 2246 sells for $295 each in small quantities while the CD 2196 is priced at $195.

Communications Transistor Corp., 301 Industrial Way, San Carlos, Calif. 94070 [418]

National is second source for Intel EROM

A pin-for-pin replacement for Intel's 1702A programable and erasable 2,048-bit read-only memory (EROM) is organized into 256 eight-bit words. The MM1702A

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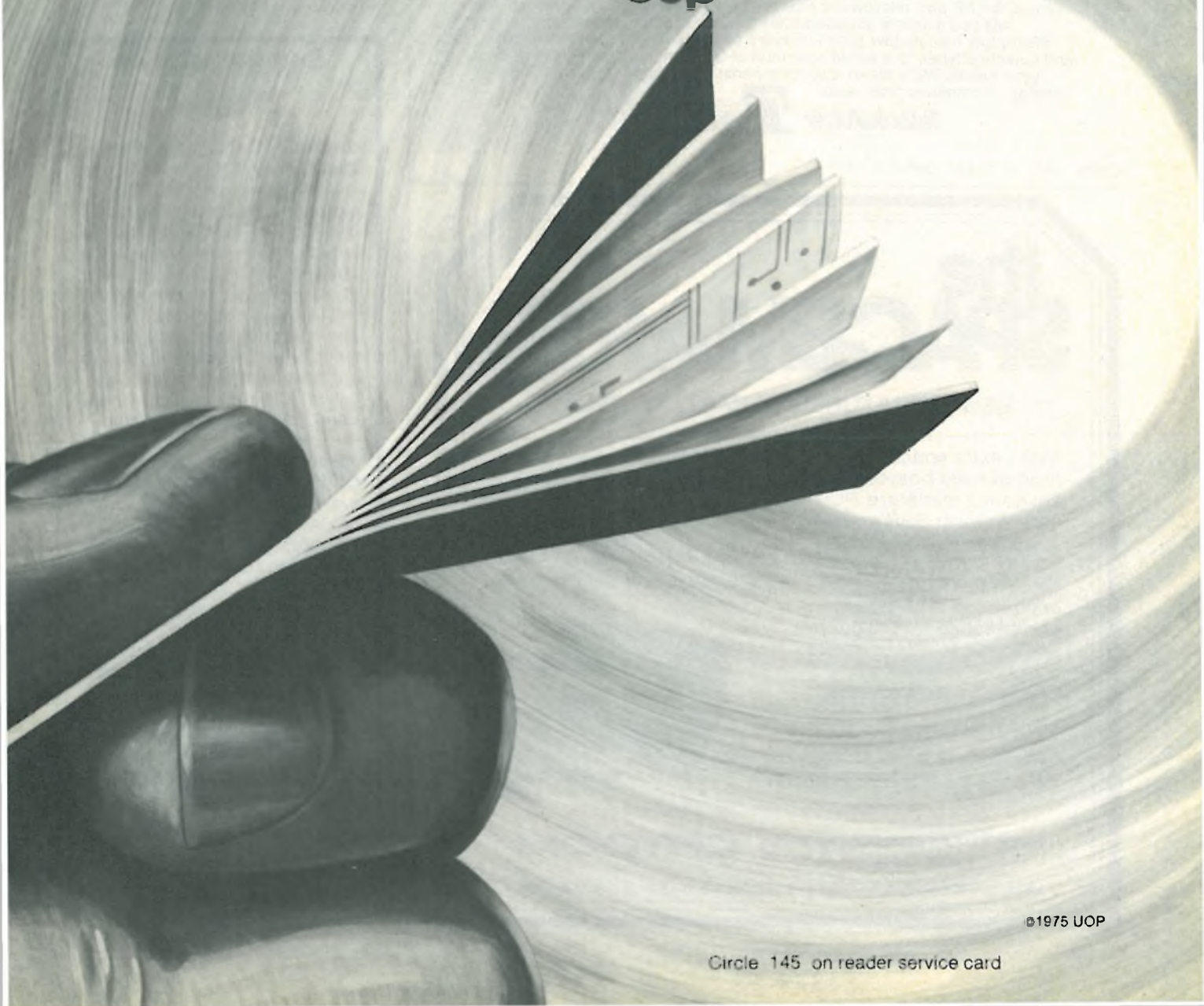


Circle 145 on reader service card

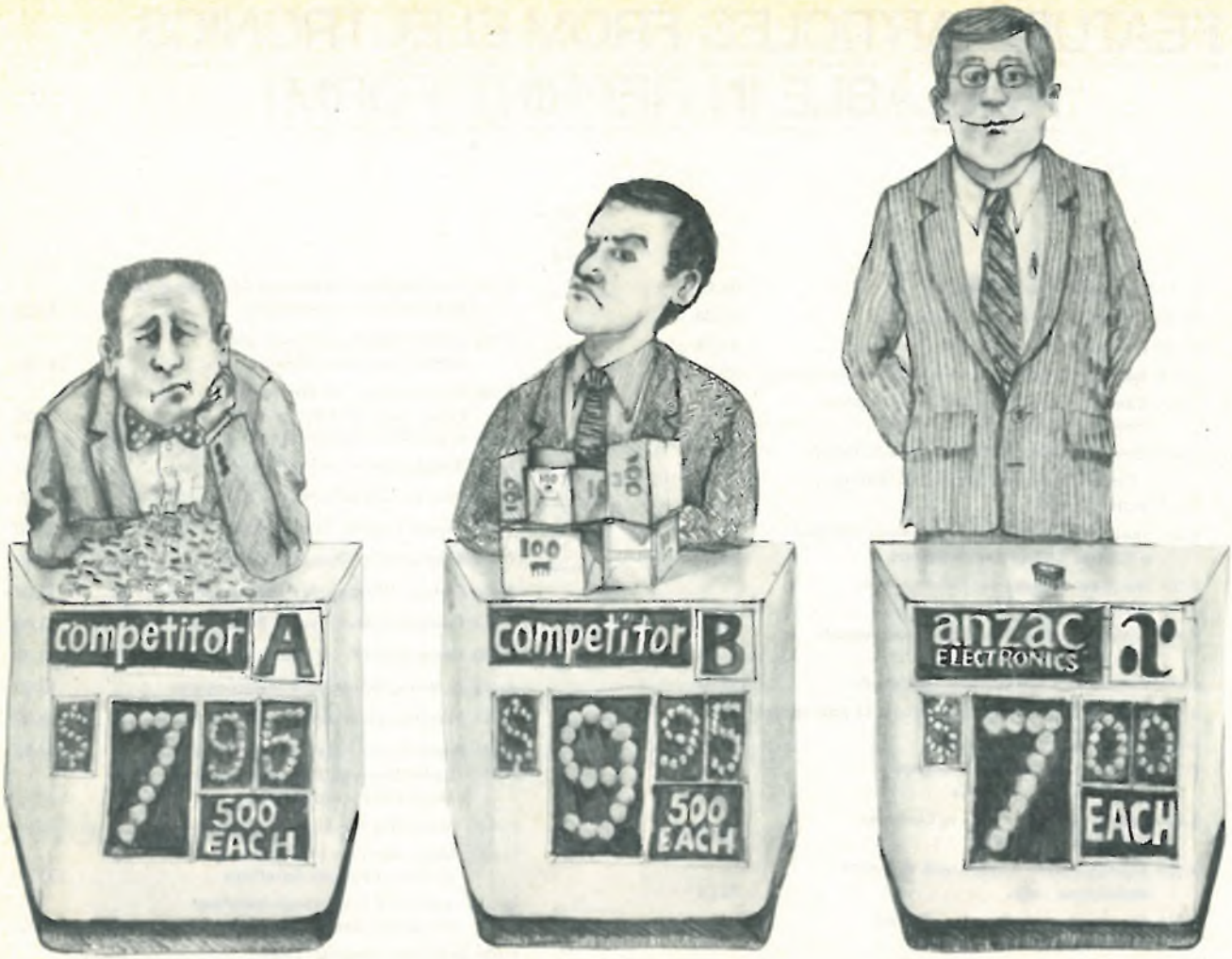
New products

from National Semiconductor is a fully decoded, static, non-volatile memory which is manufactured by means of a p-channel silicon-gate process that uses floating-gate avalanche MOS technology. The EROMs are shipped with a logic 0 stored in each memory cell. Applying a 48-volt pulse to a given cell stores a charge there and changes the 0 to a logic 1. The stored data in all cells is erased by exposing the chip to short-wave ultraviolet radiation (253.7 nanometers) through the quartz lid on the package. This returns all cells to the logic 0 state. The MM1702A sells for $27 in hundreds; large quantities are available from stock.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. [417]

Semiconductor Topics

Unitrode Corp., Watertown, Mass., makers of a broad line of discrete power devices, is offering practically its entire product line for sale in chip and wafer form as well as in packages. The chips are all of planar or hard-glass-passivated mesa construction with aluminum metalization and gold backing suitable for eutectic or epoxy mounting. Details are presented in Unitrode publication CH-101 entitled "Hard Bond Power Chips and Wafers." . . . The line of high-reliability memories made by **Intersil Inc., Cupertino, Calif.,** previously available only by special order, can now be bought from stock. The products, which are manufactured in accordance with MIL-M-38510A and are tested to MIL-STD-883, include TTL programable ROMs, TTL static RAMs, a C-MOS static RAM, an asynchronous C-MOS static RAM, and a synchronous C-MOS static RAM. . . . A green readout has been added to the 730 series of large (0.625-inch) light-emitting-diode displays made by **Dialight, Brooklyn, N. Y.** The display, which sells for $4.95 in thousands, is offered both with and without a decoder/driver.



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New products/materials

Bright copper cleaner for printed-circuit boards is a tarnish-removing agent. It leaves behind a thin, corrosion-resistant, protective film that is stable to 280°C. The cleaner re-

moves oxides and enhances soldering, fluxing, and coating operations. Price is $4.50 a gallon.

Transene Co. Inc., Route One, Rowley, Mass. 01969 [480]

Multilayer flexible laminates are fabricated from layers of Teflon film, silicone rubber, and glass fabric. The resultant material, called Tefcone, is resistant to high and low temperatures, has a very low coefficient of friction, has good dielectric properties, and will not stick to most materials. Available in a number of standard sizes or custom die-cut shapes, Tefcone is also offered with adhesive-backed silicone rubber and peel-off release paper.

Visilox Systems, P. O. Box 372, Newark, Calif. 94560 [343]

Solvent-free solder resist 184-25-A is an epoxy-based, single-component, odorless material which yields a coverage of 1,200 square feet per gallon when applied through a 175-mesh polyester screen. The hardener in the formulation is activated only at curing temperatures, so no material is lost because of pot life limitations and none of it will harden in the screens. When cured, the resist will withstand acid and activated rosin fluxes and various flux removers. Further details are contained in bulletin SR-25-A.

Hysol Division, The Dexter Corp., Wornow Products Dept., 15051 East Don Julian Rd., Industry, Calif. 91749 [344]

New products/materials

Contact cleaner Tuner 600 is a nonflammable, nonconducting material that comes packaged in 6-ounce aerosol cans. Intended for the in-place cleaning of sensitive tuner contacts and channel switches, the cleaner dries very quickly and leaves no residue. The manufacturer (Kontakt-Chemie of West Germany) claims that Tuner 600 is a 99.8% pure material that is perfectly harmless to components.
Regmo Data Corp., 6992 Oxford St., Minneapolis, Minn. 55426 [476]

Machinable magnet material CKS-500 can be rolled, drawn, swaged, or stamped. Magnetically, CKS-500 is similar to Alnico-V with a coercivity of 600 to 730 oersteds and a saturation magnetization of 12 to 13 kilogauss. It is particularly well suited for applications in which only a small magnet is needed, as in speedometers, timing motors, watches, pickups, relays, transducers, and switches.
NIM Corp., 11150 Tennessee Ave., Los Angeles, Calif. 90064 [477]

A multipurpose epoxy resin can be used for potting, casting, sealing, coating, and bonding applications by being mixed with one of several different hardeners. Metacast 5230 uses a low-viscosity resin base mixed with a nonsettling filler system. It sells for 68 cents a pound in drums. An evaluation kit is available for $7.50.
Mereco Products division of Metachem Resins Corp., 530 Wellington Ave., Cranston, R. I. 02910 [478]

A line of silicone fluids, dielectrics, and greases is available from stock for a variety of applications. The fluids come in a broad range of viscosities and offer water shielding, resistance to oxidation, and a high flash-point. The dielectric coatings do not melt, dry out, or harden with age; they can withstand temperatures from −75°C to 220°C. The greases are long-life lubricants that resist high speeds, high temperatures, and aging. They can be used from −75°C to 250°C.
Isochem, Cook St., Lincoln, R. I. 02865 [479]

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New literature

Fm telemetry. A 12-page application note entitled "Amplitude Adjustment of FM Subcarriers" discusses the factors that determine the optimum setup of subcarrier amplitudes in a multiplexed fm system. The note can be obtained from EMR-Telemetry, P. O. Box 3041, Sarasota, Fla. 33578. Circle 421 on reader service card.

Plated-through holes. A reference guide shows flow charts for three processes for the manufacture of printed-circuit boards with plated-through holes. The processes are: multilayer, conventional, and semi-additive. The guide is offered by The Sel-Rex Co., 75 River Rd., Nutley, N. J. 07110 [422]

Industrial adhesives. A selector chart of industrial adhesives provides a guide to the use of newer epoxy formulations in critical applications. It also includes a brief section on surface-preparation techniques. The chart is available from The Dexter Corp., Hysol Div., 15051 E. Don Julian Rd., Industry, Calif. 91749 [423]

Power transistors. A 112-page manual on the design and application of power transistors is intended to provide a basic understanding of high-speed, high-voltage, and high-current power transistors. Entitled "RCA Power Transistors for Amplification, Switching, and Control," the manual can be purchased for $2 from RCA Solid State Div., Box 3200, Somerville, N. J. 08876 [424]

Thick-film materials. The company's line of thick-film materials, which includes inks for conductors, resistors, and dielectrics, plus solder pastes, sensor pastes, and conductive epoxies, is described in a catalog from Plessey EMD, 320 Long Island Expressway South, Melville, N. Y. 11746 [425]

Photoresists. Four new AZ-1300 positive photoresists are described in a four-page brochure that includes photomicrographs showing edge acuity, step coverage, and adhesion to etched aluminum. Intended for semiconductor fabrication, the photoresists come in four viscosities, each of which has been optimized for a different application. The brochure can be obtained from the Shipley Co. Inc., 2300 Washington St., Newton, Mass. 02162 [427]

Semiconductor fuses. A semiconductor fuse cross-reference lists more than 300 devices made by other manufacturers along with their IR equivalents. The cross-reference is available from Semiconductor Div., International Rectifier Corp., 233 Kansas St., El Segundo, Calif. 90245 [428]

Resistors and capacitors. A revised components catalog from Corning incorporates color-coded pages and indexing to make it easier to locate product groups. Catalog EPD-ECC describes Corning's line of glass, glass-ceramic, ceramic, and solid-tantalum capacitors, as well as glass tube heater resistors and temperature-sensitive resistors. The catalog is offered by the Marketing Communications Dept., Electronic Products Division, Corning Glass Works, Corning, N. Y. 14830 [429]

Power supplies. A 12-page catalog from Calex describes the company's line of modular, encapsulated power supplies. Single, dual, and triple supplies with voltages from 5 to ±15 volts dc are included. The catalog is obtainable from Calex Mfg. Co. Inc., 3305 Vincent Rd., Pleasant Hill, Calif. 94523 [430]

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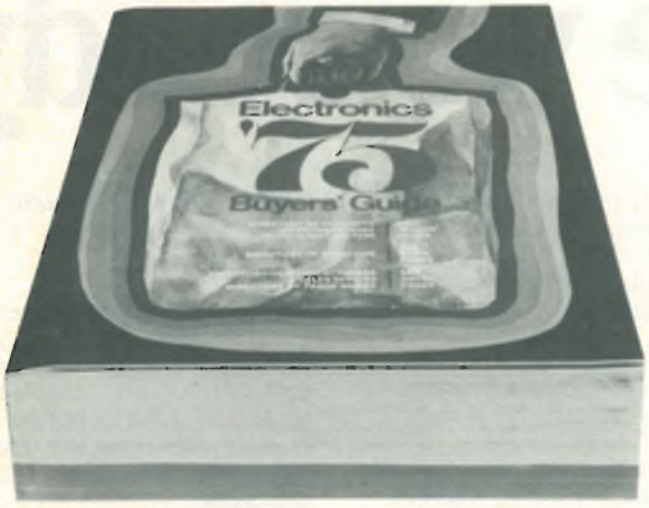

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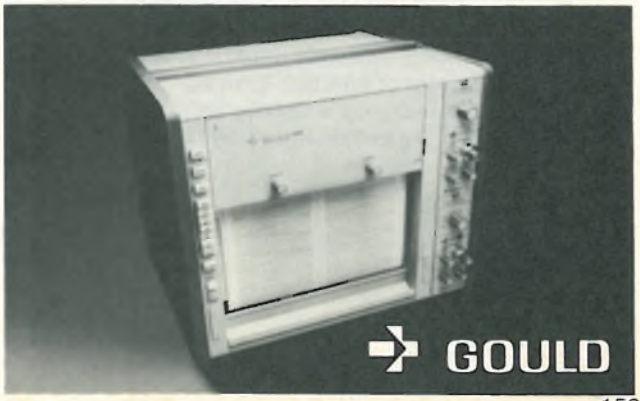


Circle 153 on reader service card

"A boom is on the Are we ready

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

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

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

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

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

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

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

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

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

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

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

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

way. for prosperity?"

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

5. *Unload some old ideas.*

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

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

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

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

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

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

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

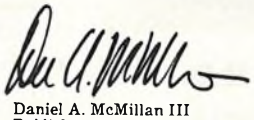
Do electronics companies cut advertising in a recession? Do they ever. In the first 5 months of 1975, the advertising page pool for which Electronics competes is down a whopping 26% from last year. Our market share is substantially up, but that's small comfort.

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

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

And now, a word from the sponsor—

When you decide to broaden your markets by turning on your advertising, the most effective place you can put that advertising is in Electronics.



Daniel A. McMillan III
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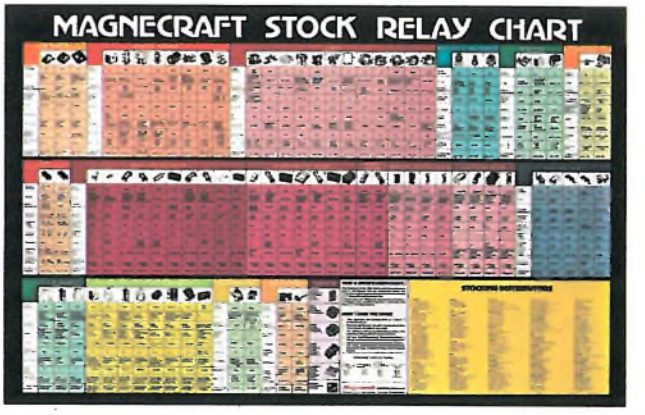

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