SEPTEMBER 18, 1975

**IEEE PRESIDENCY: THE CANDIDATES DISCUSS THE ISSUES/76**

Why logic testers are growing in popularity/88

Technology update: optically coupled isolators/98

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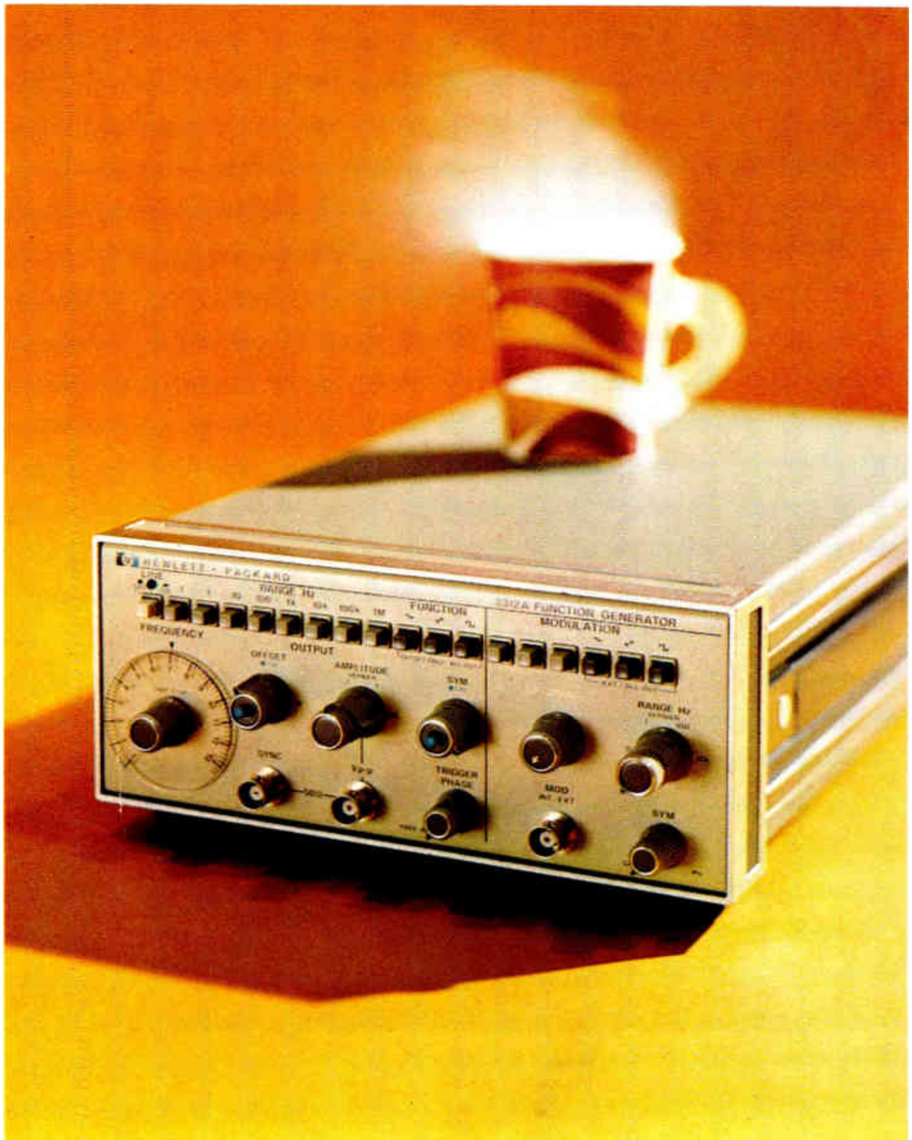


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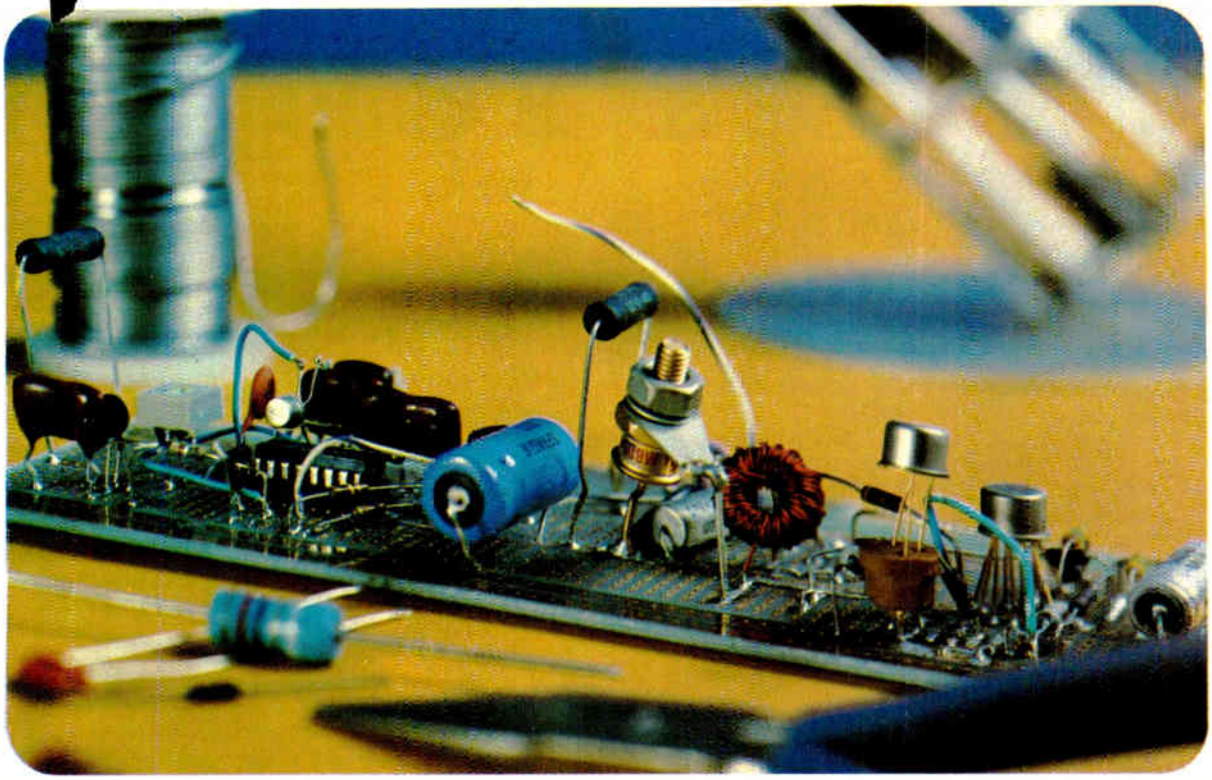

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Electronics
The International Magazine of Electronics Technology
Vol. 48, No. 19 • September 18, 1975



**Highlights**

**Cover: Saying goodbye to mechanical logic, 81**
In its bid to undercut nonelectronic controls in consumer and commercial applications, the Scamp microprocessor's biggest assets—given its low price—are reliability and a wholly novel flexibility.

Cover arrangement and photograph are by Associate Art Director Charles D. Ciatto.

**The IEEE election, 72 & 76**
To cover the contest for the presidency of the Institute of Electrical and Electronic Engineers from as many angles as possible, *Electronics* polled the voters for their opinions of the candidates (p. 72) and the candidates for their opinions of the issues (p. 76).

**Update on optically coupled isolators, 98**
Applications are multiplying, performance is improving—and specifications are becoming harder to evaluate in the absence of standardized parameters.

**Electronics can boost cement production, 103**
Computer control maximizes the efficiency with which the 80 or so large-scale operations required to produce cement can be monitored and regulated, says the last article in the series on electronics and industry.

**And in the next issue . . .**
Questioning the reliability of modern components, part 1 of a two-part analysis . . . bipolar LSI, part 2: where the technology is going next . . . designing active filters.

## Publisher's letter

**Decision time for the IEEE** is fast approaching. In a campaign that is more spirited than most members can remember, two candidates are vying for the presidency of the Institute of Electrical and Electronic Engineers.

As an important service to our readers, we have asked both candidates, Joseph K. Dillard and Irwin Feerst, to state their views on some of the major issues facing the IEEE today.

The six questions that we posed were:

- What are the strengths of the IEEE today?
- What are the top priorities of the IEEE in serving the needs of its members?
- How would you implement carrying out these top-priority projects for the benefit of members?
- How would you assess the present structure and operation of the IEEE organization in dealing with technical and professional matters, and as president would you propose any changes?
- What steps, if any, would you take to implement a portable pension plan for EEs?
- Please comment on the following statements.

(a) The IEEE should be a spokesman on technology matters to the Federal government and lobby for passage of legislation to increase spending in R&D.

(b) The IEEE should arrange to negotiate for members in disputes with employers regarding salary or age discrimination.

On page 76 you'll find their answers. We hope that you will find them of value in deciding how to cast your vote in the election.

**As a companion article** to the views of the IEEE presidential candidates, we have gone out into the field to find out how the IEEE membership views the election. Predictably, there are those who "couldn't care less," and there are those who have violent feelings one way or another.

However, the majority of those interviewed echoed the statement of one chapter official who said that the election is "exceedingly healthy, the best thing that has happened to the institute." For that story, turn to page 72.

**Coming attractions,** as any theatregoer knows, often slip a little on the schedule. And, magazine articles are not immune to the same effect. Last issue, we promised that part 2 of "The bipolar LSI breakthrough" by Horst H. Berger and Siegfried K. Wiedmann would be published in this issue. Unfortunately, with the authors at IBM's laboratories in Boeblingen, West Germany, and our offices in New York, communications suffered an intercontinental hitch, and we had to delay publication until the next issue.

And speaking of coming attractions, we'd like to point out that the October 16 edition is our annual issue devoted to "Technology Update." In it, we'll detail the current trends all across the electronics technologies and take a look at what the next year or two will bring. We're sure you won't want to miss it.


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# Readers' comments

## Faster than that

**To the Editor:** It is certainly true that "smart cameras" will gain new markets for electronic components, as Ron Schneiderman [Aug. 21, p. 74] says. However, camera electronics will grow faster than photography's "average of 9% a year," 1975 to 1980, for two basic reasons, one relating to the changing mix of camera sales, and the other to the component composition of camera electronic systems.

The camera world population is about 150 million, half of that in the U. S. Two-year-old cameras are technologically obsolescent. Add household formation growth and changing life-style factors in determining photography's share of disposable income, and the result is upward trending new-and-replacement camera sales. Fully half of Kodak's and most of Polaroid's cameras currently being sold incorporate electronics, reflecting a continuing increase in the electronic share.

But ICs represent less than one third of the average $4.50 electronic parts value (my estimate) in the Kodak Instamatic electronic models. The rest is in the flexible circuit, solenoids, photoconductors, LEDs, capacitors, resistors, switches, transistor, and the piezoelectric element used to generate flash-ignition voltage (for a total component count of 23). Thus the IC leverage for decreasing electronic system cost is limited.

The article failed to mention the innovative actuation principle of the new Kodak-GE FlipFlash. In this, a piezoelectric crystal is struck to provide a short, precise 3,000-volt pulse which ignites the primer in the zirconium flash lamp.

Incandescent flash lamps still are produced in quantities of 2 billion a year, despite the inroads of electronic flash, and the technological improvement represented by the Flip-Flash will tend to extend their product life.

Harvey S. Miller
K-M Associates
Palo Alto, Calif.

# How sure are you of what stands behind your JAN, TX, & TXV hi-rel supplier?


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# News update

■ The Aerospace Corp. has decided not to develop Josephson-junction devices as parametric amplifiers for operation at 100 gigahertz and up [May 16, 1974, p. 34]. The reason, says Arnold Silver, director of the firm's Electronics Research Laboratory in El Segundo, Calif., is a matter of priorities, "not lack of potential." The fact that Aerospace has chosen not to go to shorter wavelengths with the device does not mean that the goal is not possible, he adds.

Josephson devices have previously been used as parametric amplifiers. However, the Aerospace version uses a new geometry operating in a multi-idler mode. This, said the company, greatly relaxes operational requirements.

■ The idea of taking the computer to the site of oil explorations seems to have caught on [May 30, 1974, p. 30]. Geophysical Systems Corp.'s Geocor II—a Varian V-73 plus peripherals in a van—has passed all its tests in the San Joaquin Valley of California, says Robert Fort, vice president. Not only that, but it was sent to work immediately. Among the jobs: geological mapping project at the Elk Hill Naval Petroleum Reserve, and another one at the site of Los Angeles' proposed nuclear generating plant. Two units are under long-term contracts to oil companies, and two more systems are being built.

■ Dynacron Industries Inc. of Leonia, N.J., is beginning to have some success with its Dynacron material, which is a rubbery plastic substance with electrical resistance that varies with pressure [May 30, 1974, p. 26]. Harold Charles, president, says he has completed licensing arrangements with "a large Japanese company." In addition, Charles says there have been several sales of small amounts for various applications and he says a number of potential customers are evaluating Dynacron.

**—Howard Wolff**

Hoo boy, have we got a deal for you! Ordinarily you'd expect to pay at least $965 for a good sweeper alone. But what good's a sweeper without a scope? So we're offering you both at this incredibly low price.

First there's our Model 1050A, a compact, laboratory-quality sweeper covering the frequency range of 1 to 400 MHz. It features excellent linearity, PIN diode leveling and has a built-in detector. Naturally, the 1050A is all solid state and has provisions for up to 6 plug-in marker modules.

The other half of this combo is our Model 1901B X-Y Display Oscilloscope. It has a big 12-inch diagonal CRT and incorporates a very stable, low-noise vertical amplifier with sensitivities from 1mV per division. Just hook it up to your 1050A sweeper and you have the perfect test setup for measuring frequency response in the VHF region.

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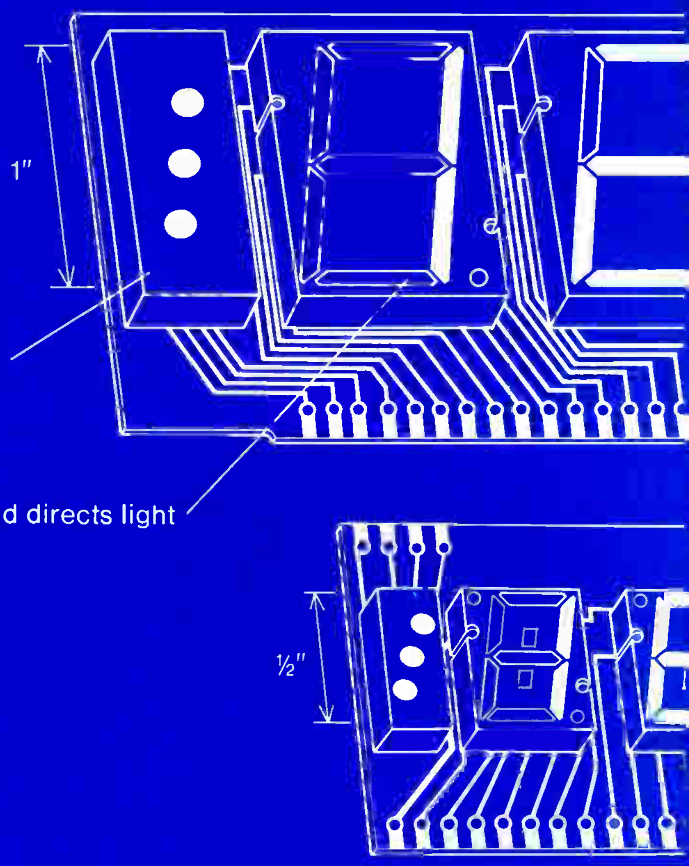


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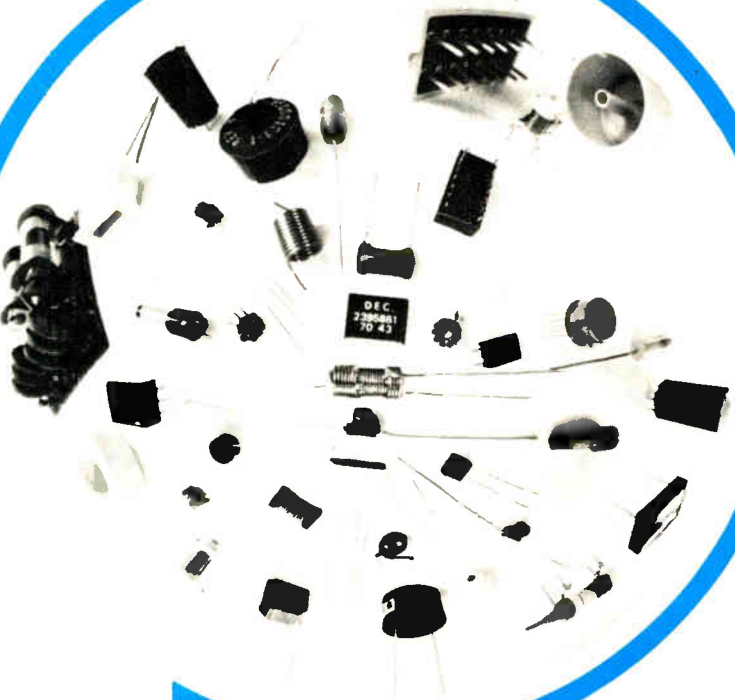



worldwide sales at the ITT Semiconductor group's Intermetall GmbH in Freiburg, West Germany.

To extend the company's activities to the U.S., Micic has set up an outlet in Chicago. From there, with the help of ITT's sales organization, his firm will offer devices and applications aid to U.S. customers.

**MOS emphasis.** Initially the emphasis will be on MOS circuits for TV receivers, says the affable, 45-year-old Yugoslav-born Micic (pronounced mit-chitch). Later on, semiconductors for tuners and automotive applications will be included. And eventually, Intermetall, now the European continent's largest supplier of ICs for autos, organs and clocks, will offer its whole range of consumer circuits in the U.S.

"It's America where the action is, and we want to be part of it," says Micic, who joined Intermetall in 1958 as a quality assurance engineer. He notes that TV receiver design in the U.S. is now undergoing big changes and will soon be incorporating on a big scale such features as electronic tuning, digital channel selection, and ultrasonic remote control [*Electronics*, Aug. 7, p. 50]. "By next year we hope to be well established in the U.S. and in a position to influence new consumer circuit applications," he says.

Micic's marketing policy is based on what he terms "selling by service." This entails "trying to understand the customer's language, the language of watch makers, TV designers, organ builders, and automotive engineers," he explains.

Micic stresses that it matters little whether the solution offered is bipolar, MOS, or C-MOS. "We are not out to push a specific technology down the customer's throat but to suggest a product that best fits his needs."

Modest to outsiders, Micic won't comment on how his selling-by-service policy has helped Intermetall. But one of his associates says, "He has succeeded in considerably boosting the company's market share in Europe within a relatively short time, especially the share of MOS devices for the entertainment sector."

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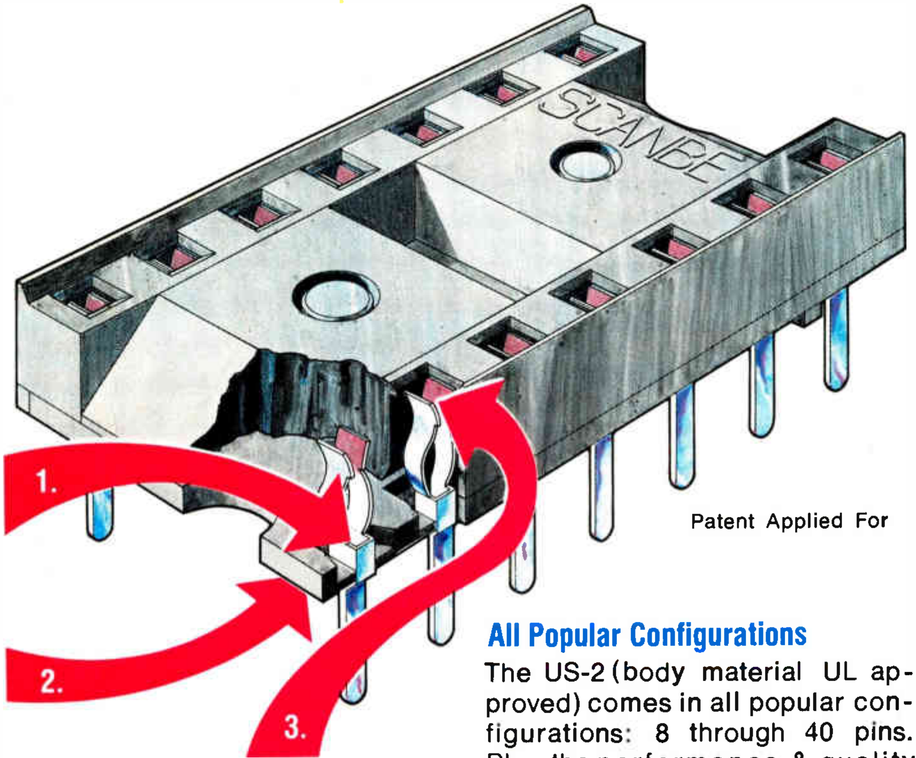


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Who says a low profile socket can't be exciting? Our US-2 is. In fact, revolutionary is a better word. Here's a socket designed for the world of LSI & microprocessors. The Ultimate Socket. For three prime reasons. And many more.

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Our patented built-in anti-wicking design makes it impossible for solder to flow into the contact.

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Our competitors have tried to lick the wicking problem with a wafer. It isn't a very good barrier. And it creates an even worse problem. Flux entrapment. Which can cause intermittent short circuits that may shift from contact to contact as the flux heats up. Think what this problem could cost in your finished product.

Our US-2 doesn't need a wafer since there's no wicking problem to begin with. Consequently, no flux entrapment. Ever.

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The US-2 also has the Ultimate Contact, which accepts the full range of IC leads without overstressing. The contacts are designed for ideal insertion and withdrawal forces, even after multiple insertions. Contact material is copper alloy CA-770 with a 100 microinch gold inlay on the contact surfaces (and no gold adder). An independent test lab has proven the US-2 edge-wipe design to meet or exceed EIA RS-415 specs by a wide margin. Example — 195 gram insertion, 28 gram withdrawal & 14 milliohm contact resistance.

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# Meetings

**Industry Applications Society Annual Meeting,** IEEE, Regency House Hotel, Atlanta, Ga., Sept. 28–Oct. 2.

**Eascon '75, Electronic and Aerospace Systems Convention,** IEEE, Stouffer's National Center Inn, Arlington, Va., Sept. 29–Oct. 1.

**TELECOM '75—World Telecommunications Forum,** IEEE, Palais des Expositions, Geneva, Switzerland, Oct. 2–8.

**NEC 75, National Electronics Conference and Exhibition,** NEC (Oak Brook, Ill.), Hyatt Regency O'Hare Hotel, Chicago, Oct. 6–8.

**ISA/75 Industry Oriented Conference and Exhibit,** Instrument Society of America (Pittsburgh, Pa.), Mecca Exhibit Hall, Milwaukee, Wis., Oct. 6–9.

**Tenth International Symposium on Remote Sensing of Environment,** Environmental Research Institute of Michigan, University of Michigan, Ann Arbor, Oct. 6–10.

**Ninth Annual Instrumentation and Computer Fair,** Instrumentation Fair Inc. (Beltsville, Md.), Sheraton Inn/Washington-Northeast, Lanham, Md., Oct. 7–8.

**Data Communications Symposium,** IEEE, Le Concorde, Quebec, Canada, Oct. 7–9.

**Electromagnetic Compatibility International Symposium,** IEEE, El Tropicano Motor Hotel, San Antonio, Texas, Oct. 7–9.

**NEPCON '75 Central,** National Electronic Packaging and Production Conference, Industrial & Scientific Conference Management Inc. (Chicago, Ill.), Arlington Park Exposition Center, Arlington Heights, Ill., Oct. 7–9

**16th Annual Symposium on the Foundations of Computer Science,** IEEE, Claremont Hotel, Berkeley, Calif. Oct. 13–15.

**35th National Fall Conference of the American Society for Nondestructive Testing,** ASNT (Evanston, Ill.), Marriott Hotel, Atlanta, Oct. 13–16.

**1975 Annual Semiconductor Test Symposium—Memory and LSI,** IEEE, Cherry Hill Inn, Cherry Hill, N.J. Oct. 14–16.

**1975 International Conference on Advanced Signal Processing Technology,** IEEE, Lausanne, Switzerland, Oct. 14–16.

**ITC/USA/'75, International Telemetering Conference,** International Foundation for Telemetering (Woodland Hills, Calif.), Sheraton Inn, Silver Spring, Md., Oct. 14–16.

**13th Annual Workshop: Government-Industry Data Exchange Program,** GIDEP (Corona, Calif), Conrad Hilton Hotel, Chicago, Oct. 15–17.

**Powercon II—Second National Conference on Solid-State Power Conversion,** Powercom Inc. (Oxnard, Calif.), New York Hilton Hotel, New York, Oct. 16–18.

**ACM '75—Association for Computing Machinery National Conference,** Radisson Hotel, Minneapolis, Minn., Oct. 20–22.

**U.S. National Meeting of International Union of Radio Science (URSI),** IEEE *et al.*, University of Colorado, Boulder, Oct. 20–23.

**50th Annual Convention of Electronic Industries Association,** EIA, Beverly Hilton Hotel, Beverly Hills, Calif., Oct. 21–24.

**Eighth Annual Connector Symposium,** Electronic Connector Study Group (P.O. Box 1428, Camden, N.J.), Cherry Hill Inn, Cherry Hill, N.J., Oct 22–23.

**IC-QC Workshop,** American Society for Quality Control, Downtowner Motor Inn, Durham, N.C., Oct. 24–25.





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# CP 1600 GENERAL INSTRUMENT'S 16-BIT MICROPROCESSOR

CP 1600 is the first single-chip 16-bit microprocessor with third generation minicomputer architecture. The only one. And, together with its powerful and continually growing support package, provides a new level of microprocessor system capability.

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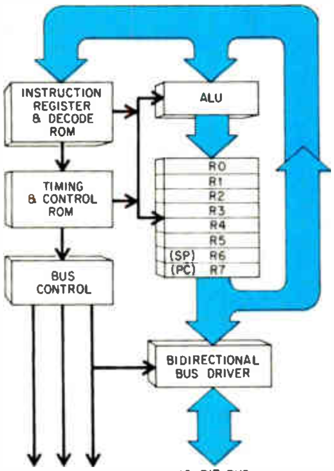
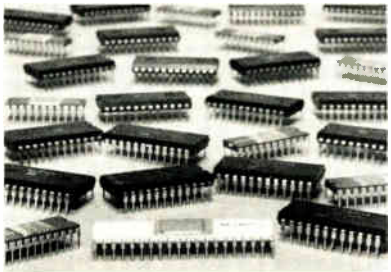



And it's twice as fast. Register to register operations take only 3.6 $\mu$s. Memory to register and Input/Output operations, only 4.8 $\mu$s. But speed is only one of the CP 1600's outstanding features. 16-bit word length and four addressing modes permit efficient access to 64K of memory—in any combination of program, data storage, or peripheral devices. So, I/O data can be manipulated just like memory. By all 87 instructions.

Regarding stack storage or program interrupts. CP 1600 has unlimited stack depth and self-identifying, nested interrupt capability with priority resolution. The competition's chip has only a 16 level stack and 4 interrupt levels.

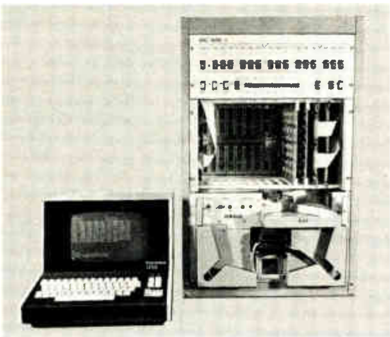
# AND ALL THE SUPPORT THAT GOES WITH IT

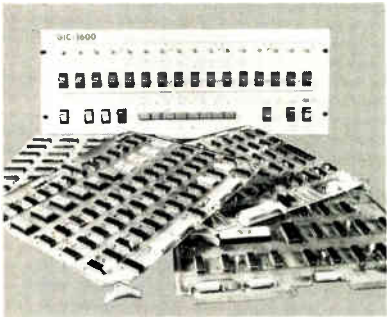
With a chip like the CP 1600, it's only right to maximize its support. So, we have a complete family of processor and memory products. ROMs from 4K to 16K . . . to optimize program storage efficiency and provide 16-bit computing power at 8-bit density. All fully static. All with a single 5 volt power supply. Plus static RAMs from 1K to 4K bits. And there's a continually growing family, including the Programmable Interface Controller chip, coming in January.



## Development Hardware

The Series 1600 MicroComputer System will simplify your design cycle. It will provide you with a test bed for interfaces and related hardware, as well as full program preparation facility with resident on-line hardware and software debug aids. Peripheral interfaces you can use include TTY, high-speed paper tape equipment, serial line printer and magnetic tape cassettes. And all card level modules of the Series 1600 system ranging from microcomputers, memory and I/O modules, to general purpose arrays, are available on an OEM basis for further system integration.





## Complete Software Support, Too

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**GENERAL INSTRUMENT CORPORATION MICROELECTRONICS**

**Bell plans test of fiber-optic phone system . . .**

Fiber-optic telephone transmission will move closer to reality at the end of the year when Bell Laboratories starts a field trial of a system near Atlanta. **Significantly, production-type equipment will be used in a real operating environment.**

The transmission medium will be cables containing a large number of fibers, from both Bell and Corning, with a single fiber per channel of information. Also significant will be the repeater spacing: five to six miles rather than the easily attainable two or three, meaning repeaters could be taken out of manholes and placed in central offices. And though Bell won't comment, it is believed to have ready for production an advanced repeater with a "quick-connect" design.

**. . . as GTE sets field trials of optical trunks**

At about the same time that Bell conducts its tests, GTE Corp., the nation's No. 2 telephone company, will start a field trial of its own "practical" fiber-optic system. The test will take place, using existing links, at an operating GTE facility, probably on the West Coast. Thus, the system, which will use an electronic/optical interface, appears to be the first big step **toward replacing T-carrier interoffice trunking with the much higher capacity fiber-optic system.**

According to E. Bryan Carne, director of electronic technology at GTE Labs, the fibers used in the trial will have a loss of 5 decibels per kilometer so that runs of 15,000 feet between repeaters are possible. By comparison, repeaters for twisted-wire pairs are spaced every 6,000 ft.

**Philips line seen heating up C-MOS market**

As if suppliers of complementary MOS haven't got enough to think about with plummeting prices and oversupply, they now have to worry about a formidable new entry in the already chaotic C-MOS marketplace. **Philips Gloeilampenfabrieken, the Netherlands giant, is readying its long-awaited 4000 C-MOS line,** using a proprietary local oxidation process to build standard parts that it says will give them the edge, even as a late starter. According to Philips officials, the LOCOS 4000-series "has twice the packing density and three to five times the performance potential of standard C-MOS." The only other American supplier using an oxide-isolated C-MOS process with identical performance is Fairchild.

Although Philips officials are keeping mum, this high-performance line could easily be transferred to the American-based Philips subsidiary Signetics, whose own C-MOS sales have flagged in recent months. In any case, with the first 20 parts planned for this month, building to 63 by the end of the year, Philips should be a major contender in the growing European C-MOS market now served mostly by U.S. suppliers.

**DEC to announce end user micro system**

Look for Digital Equipment Corp. of Maynard, Mass., to announce at Wescon **its first end-user, microcomputer-based system.** For the single-quantity price of $9,950, a user can get a PDP-11/03 (the packaged version of DEC's LSI-11 microcomputer) with 8,192 words of random-access memory, a dual floppy-disk drive holding more than 0.5 megabyte, a VT52 CRT terminal or an LA36 keyboard serial matrix printer for input and output, and DEC's RT-11 operating system. The printer operates at 30 characters per second, while the CRT terminal displays 24 lines. The PDP-11/03 and the dual floppies are in one package, measuring 15 by 17 by 19 inches, while the CRT is in a table-top configuration and the printer is a stand-alone floor model.

Volume users, according to DEC, can save as much as $3,500 per system in quantities of 100 by buying the principal subsystems separately from the DEC Components Group.

### N.Y. buildings slow to add fire safety systems

In few of the 945 high-rise buildings in New York City where landlords have been ordered to **upgrade their fire-safety systems with electronic sensing and control equipment has work actually begun,** although, by law, they must comply by January 1976 [*Electronics*, Nov. 28, 1974, p. 78]. So far, says a spokesman for the city's buildings department, work is in progress on only 126 of the buildings covered by Local Law No. 5.

Meanwhile, U.S. District Judge Kevin Thomas in New York has rejected an attempt to prevent the enforcement of the new regulations. A real-estate operator contended that they exceed the city's powers and impose an unfair burden on building owners, but the judge ruled that he must take his suit to the state courts first.

### Codex adding 'smart' processors to modem line

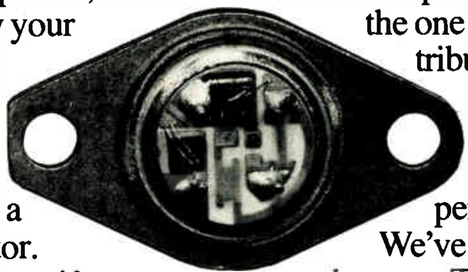
Codex Corp., the Newton, Mass., modem maker, will enter a new market when it begins delivery in January of a new family of intelligent network processors, using LSI microprocessors. The 6000 series, capable of a variety of network configurations, **operates at speeds ranging from 2,400 bits per second to 56 kilobits per second in multinode networks.** A typical 6000 system with 28 terminal ports would be priced at about $12,500 or leased at $420 per month.

### Addenda

RCA Corp.'s Solid State division in Somerville, N.J., will announce next month the availability of complementary-MOS devices using the "hermetic-in-plastic" tri-metal process introduced earlier this year in linear ICs [*Electronics*, May 1, p. 29]. **RCA claims that the silicon-nitride passivation and subsequent titanium-platinum-gold system ensures non-corrosive metalization and less electro-migration than conventional metalization interconnect systems.** . . . The lawsuit filed in August 1972 against Rockwell International Corp. by Allen Organ Co. of Macungie, Pa., goes to trial Jan. 5 in U.S. District Court in Reading, Pa. **Allen Organ charges violation of antitrust and securities laws, Securities and Exchange Commission rules, and breaches of contract.** The original suit charged several members of management in what was then North American Rockwell Microelectronics Co. with making false representations on a number of agreements involving development and licensing of an MOS device used in organs and other musical instruments. . . . A floppy-disk controller incorporating eight LSI chips, to be introduced by Rockwell International's Microelectronic Device division, **cuts the price of such units from about $1,000 to about $200 each** in lots of 1,000. Rockwell says that replacing the 200 or so ICs required in conventional controllers with a PPS-8 microprocessor chip plus RAM, ROM, parallel-data controller, direct-memory-access controller, and floppy-disk controller chips makes possible the saving.

# Build a switching regulator in half the time.

You know that a switching regulator can quadruple the efficiency of your power supply. It'll save power, cut heat loss, simplify your design, save board space, weigh less, and maybe cost less than a linear regulator.



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To make your life even easier, we've got a 24-page booklet that'll tell you everything you need to know about designing a switching regulator. It's the only booklet of its kind available, and it's free. To get yours, along with detailed specs for our power switching circuits, circle our number on the reader service card.

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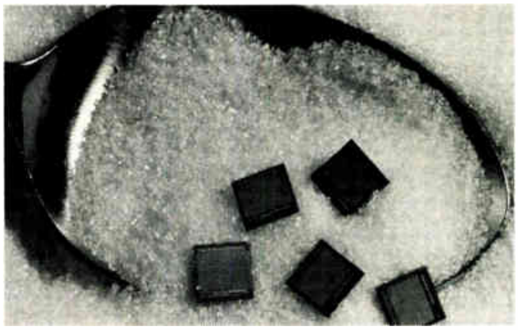
# IBM enters market for low-end applications with portable computer

Unit, with 48k ROMs and cathode-ray tube, to compete with programable desk-top calculators and special minis

IBM's General Systems division, which shook the computer world in January when it established a new lower boundary for IBM computers with the stand-alone System 32, is pushing the boundary still lower. Its portable desktop computer, the 5100, sells for $8,975 in its simplest version—no leasing—and puts IBM in competition with makers of some of the high-end programable desk-top calculators or specialized mini-computers.

The 5100 is being aimed at such users as financial analysts, statisticians, and engineers, and its keyboard is therefore coded for commands in Basic, the widely used general-purpose language, or APL, the complex mathematical language, or both. In addition, apart from the processing electronics, the 50-pound computer contains a 4-inch cathode-ray-tube display holding 16 lines of 64 characters each, plus a new tape cartridge developed jointly by IBM and 3M Co.



**Desk set.** Special tape cartridge with 300 feet of ¼-inch tape was developed for the new IBM portable computer. Characters are read at 2,850 per second, written and checked at 950 per second. Each 0.23-inch-square chip, right, used to interpret commands in the computer contains 48 kilobits of read-only memory fabricated using metal-oxide-semiconductor field-effect-transistor technology.

**Read-only memory.** Characterizing the 5100 as a significant reduction in the entry size and cost of the company's data-processing products, General Systems division president C. B. Rogers Jr. says that the machine uses the newest IBM technology. One of its key new components is the 48-kilobit n-channel MOS read-only-memory chip, which is used to interpret the high-level-language inputs from the keyboard. The computer uses up to 25 such chips. The previous high for IBM was the 24-k chip used in the 3740 Data Entry System, while the densest ROM now available from semiconductor manufacturers contains only 16 kilobits.

For read/write memory, the computer uses 2-k MOS chips to form a 16,384-word memory, which can be expanded in 16-kiloword increments up to 65,536 words. For mass storage, the new tape cartridge holds up to 204,000 characters on 300 feet of ¼-inch tape. Operating at 40 inches per second, the unit can read at 2,850 characters per second and write at 950 c/s. A second tape unit, available in a separate package for $2,300, can double the storage capacity.

The 16-bit (plus two parity bits) central processing unit is built on one card using 13 bipolar circuits. Microinstruction execution time of the unit is 1.75 microseconds.

At the same time, IBM announced a new matrix printer to go along with the computer. The printer, type 5103, sells for $3,675 and operates at 80 characters per second from right to left and from left to right. Lines contain 132 print positions, with 10 characters to the horizontal inch and six lines to the vertical inch. The unit measures 12¼ by 13¼ by 23 in. and weighs 60 lb.

Rogers says that the Atlanta-based division, whose other products—the Systems 3, 7, and 32—are handled by all salesmen, has established a special sales force for the 5100 because of the broader base of potential customers.

The company will provide users with three problem-solving libraries on prerecorded tape cartridges. The mathematical library contains 44 interactive routines, such as solutions of linear equations, eigenvalue problems for complex matrices, and evaluations of integrals by the trapezoidal rule. The statistics library, with 41 routines, handles histograms, moments, correlations, and multivariate analyses. Thirty business analysis routines are available, too. Each library comes on two tape cartridges and leases for $500. □

**Reliability**

# Funds cut at Rome Air Development Center threatens work on reliability standards

Congressional efforts to shave the Pentagon's $106.3 billion record budget request for fiscal 1976 threaten to terminate outside reliability study contracts sponsored by the Rome Air Development Center, Griffis Air Force Base, N. Y. In fact, funds assigned to RADC's Reliability Branch ran out in July, and the branch has received only small contracts from the Defense Electronics Supply Center and the Federal Aviation Administration.

**Small.** As Pentagon programs go, the $2.16 million cut by the Senate Armed Services Committee is quite small, but both RADC's Reliability Branch and USAF Headquarters consider the sum important to developing future electronics reliability standards. The Air Force has asked the Senate-House Armed Services conference committee to restore RADC's funds for establishing reliability procedures for testing, qualifying, and screening of solid-state devices. The RADC's Reliability Branch recently, for example, sponsored studies for developing reliability standards for random-access and read-only semiconductor memories and programable ROMs [*Electronics*, April 17, p. 38].

Air Force officials see the RADC funding problems stemming from two sources. First, there was a Navy budget request for a single new systems-oriented reliability office to certify program performance. Second, there seemed to be some confusion in Congress between reliability operations dealing with systems and those at RADC dealing with technologies and components. Thus when the Senate committee cut the Navy request, recommending instead that systems reliability funds be budgeted in the requests for each program, it cut RADC reliability funds, too, apparently believing that its work was systems-oriented as well.

The Office of Secretary of Defense went along with the Navy cut, according to one Air Force official, "because the shoe fit. The Navy proposed to set up a reliability steering group and all that other embroidery, but while OSD agreed that systems reliability should all be in one bundle, it also agreed that costs should be distributed among the appropriate systems."

"We're quite hopeful," says David F. Barber, who heads the RADC Reliability Branch, "that the people at the Pentagon who are aware of this misunderstanding will be able to get back to the Senate-House conference committee and say, 'Here's the way it really is, and we feel this is a very appropriate way for the Air Force to spend its money.'" Barber indicated that the Air Force would face expensive duplication of effort if it had to decentralize its reliability programs.

**Merger?** However, Joe Flood, who directs reliability for Motorola's Semiconductor Products division, believes that if RADC loses its reliability function, the Defense Electronics Supply Center in Dayton, Ohio, could supervise microelectronics products, as it now does transistors. As a tri-service agency, DESC could build a microelectronic capability, which it lacks, he says.

Gene Selven, marketing vice president at Raytheon Semiconductor, says that "It would make a great deal of sense to merge the two functions—[RADC's] specification and [DESC's] qualification—at DESC" if RADC's funds are not restored. But National Semiconductor Corp.'s director of military/aerospace marketing, James Feldt, disagrees. "The military marketplace is already fragmented enough without doing this," says Feldt.

Meanwhile, the Air Force says it has been "scratching around for money it could reprogram". Already, three contracts have been paid off from such funds, leaving five outstanding. Those contracts for which RADC is seeking money include: $146,000 to Syracuse University for advanced reliability and maintainability studies; $24,857 to Bowmar/Arizona Inc., for a microcircuit process control handbook; $42,500 to General Electric Co. for digital microcircuit characteristics and specifications; $64,600 to Hughes Aircraft Co. for reliability evaluation of programable read-only memories, and $19,355 to RCA Corp. for a reliability study on complementary-metal-oxide semiconductors on sapphire.

"Our next milestone, if you will," says RADC's Barber, "is about Oct. 1. It's important that we have a favorable decision by then if we are going to continue our current effort." RADC's Reliability Branch employs about 75 engineers and scientists, including about 10 military personnel.

What's the outlook? "I wish I knew," says Barber. "I can predict reliability better than I can predict this," meaning the contract funds. □

**Solid state**

## STL improves MOS clocking methods

A synchronous MOS logic that couples metal-oxide-semiconductor packing density with the design flexibility of transistor-transistor-logic has been designed by Standard Telecommunication Laboratories Ltd. The ITT subsidiary's researchers have simplified and improved conventional MOS-clocking methods by combining the dynamic storage of MOS with a simple direct-current flip-flop. As a result, logic operation down to zero frequency can be handled by a single-phase clock, as in TTL, instead of the two-phase nonoverlapping clock pulse needed by slower MOS logic.

**Flexibility.** This arrangement has improved maximum operating efficiency and makes the generation and distribution of the clock pulses quite flexible, the researchers claim. Essentially, designers can now "operate MOS LSI with the same sort of logic interconnection rules and delay rules as in conventional TTL," says A.D. "Jimmy" Odell, a research engineer. The technique can be used for economical shift registers, counters, and flip-flops that can interface directly with conventional MOS NOR and NAND gates, he points out. In a typical J-K flip flop, for example, the number of transistors can be halved. Under a classified Ministry of Defense contract, STL is in the mask-manufacturing stage for a circuit it expects to produce within two months.

STL foresees neither added processing nor higher chip costs because the logic uses exactly the same processes and masks as conventional MOS LSI designs. Moreover, the use of simpler clock-pulse-generation circuits on the chip means some savings in chip area, Odell says, since any increase in complexity is more than offset by savings in distributing the clock pulse. Details of the new logic were first presented at the First European Solid State Circuits Conference early this month at the University of Kent,

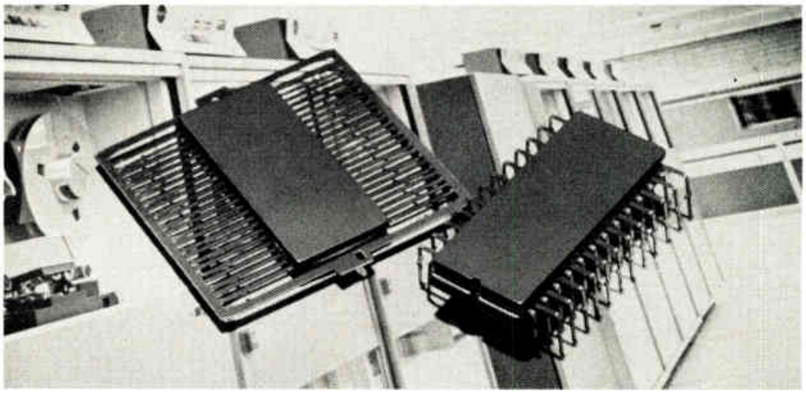
## Two rows of staggered pins trim over-all size of LSI package

Package designers, as well as circuit designers, are being challenged by the dense circuitry and large number of input/output ports characteristic of the new breed of microprocessors. So to accommodate the 48-pin input/output requirements of one of their microprocessor chips, packagers at Motorola Semiconductor Products division have introduced an unconventional dual in-line package. Called quad in-line, or QUIL, the new package has two rows of staggered pins on each side (see photo) with half the spacing of the conventional single-row-per-side arrangement.

The result is striking. The new Motorola package is about half the size of more conventional 48-pin packages—1.250 by 0.52 inches as compared with 2.5 by 0.7 in., says Joe Lee, a production engineer at the Motorola division in Phoenix. Moreover, the new package allows for much shorter internal interconnections, he points out, adding that the larger package's longer interconnections were found to reduce circuit speed. Lee also implies that the quad in-line package, originally developed for Motorola's MC 10800 4-bit emitter-coupled-logic bipolar processor slice, could be the first of a new family of packages for extremely dense (48 pins and up) large-scale integrated circuits.

**Staggering.** The special QUIL lead frame has 24 leads on a side on 0.050-inch centers, exactly half the spacing of conventional DIP pins. The denser QUIL leads are bent into two staggered rows. For now, a QUIL-packaged IC must be inserted directly into a printed-circuit board because no socket is yet available. However, a "large connector manufacturer" is designing a mating socket for it, Lee reports. The ceramic-alumina-oxide package can dissipate 1.3 watts over a temperature range extending from 0°C to 75°C.

Motorola, now seeking a patent for the quad in-line, intends to license its use. And Ed Tynan, emitter-coupled-logic-product manager for Motorola, says, "we are planning to apply this package to in-house MOS and bipolar LSI. There is also a lot of outside interest in the new small LSI package. Work is now in progress to make a slightly larger 64-pin version and also higher-temperature versions using beryllium oxide as the ceramic case."



located in Canterbury, England.

Normally, integrated-circuit logic operates in a step-by-step serial fashion under control of a master synchronizing waveform. MOS LSI circuits have generally needed some combination of dynamic storage and two-phase nonoverlapping clock pulses to trigger the logic steps. Although the logic doesn't need much space, it requires two storage capacitors to handle each step. A minimum clock frequency is also necessary, because the capacitors tend to discharge unless they're continually refreshed.

**Adaptation.** TTL, on the other hand, uses two dc flip-flops with one single-phase clock pulse to control the logic steps in a classic master-slave relationship. TTL is simpler to operate, but "it requires a lot of components and consequently a lot of chip area for LSI," explains Odell.

By combining one TTL flip-flop with MOS dynamic storage, the STL researchers were able to run the MOS logic so that the upper and lower pulses of a single waveform would replace the two individual pulses needed by conventional MOS logic. Essentially, the logic circuit consists of three transistors. The first is a conventional transfer device, which, when the clock is high, passes information from the input to the gate of the second transistor.

The data remains as a stored signal when the clock is low. In parallel with the second transistor, the third transistor is driven directly from the clock waveform so that the condition of the signal at the gate of the second transistor has no influence on the output when the clock is high, but determines the output impedance when the clock is low. □

## Business

# German exports seen softening

The Federal Republic of Germany is learning that, in telecommunications trade, the bottom line is not all that matters. Despite the latest 1974 totals that show that Germany logged a 16.5% gain over 1973 in telecommunications exports, a breakdown of the figures by U.S. Government analysts indicates problems in store for this year.

**WEST GERMANY'S TELECOMMUNICATIONS EQUIPMENT TRADE**

*(in millions of marks)*

| | 1974 | 1973 |
|---|---|---|
| **IMPORTS** | | |
| Total | 494.6 | 415.2 |
| From U.S. | 74.4 | 51.0 |
| From European Community | 317.0 | 283.0 |
| From Japan | 33.8 | 31.7 |
| **EXPORTS** | | |
| Total | 1,612.8 | 1,384.3 |
| To U.S. | 37.4 | 47.4 |
| To European Community | 479.0 | 395.4 |
| To South America | 131.4 | 134.8 |
| To South Africa | 87.4 | 62.3 |
| To Greece | 62.2 | 63.9 |
| To Iran | 73.0 | 79.4 |
| To Australia | 44.5 | 15.2 |

Overall, the 1974 totals netted Germany a telecommunications trade surplus of 1.1 billion Deutschemarks from exports of 1.6 billion DM (see table above). But Germany's problem, according to an unreleased analysis by the U.S. State Department, is reflected in the heavy reliance for its telecommunications trade on its partners in the European Economic Community—all of whom are now cramped by economic recession—and the slippage of exports to the Third World.

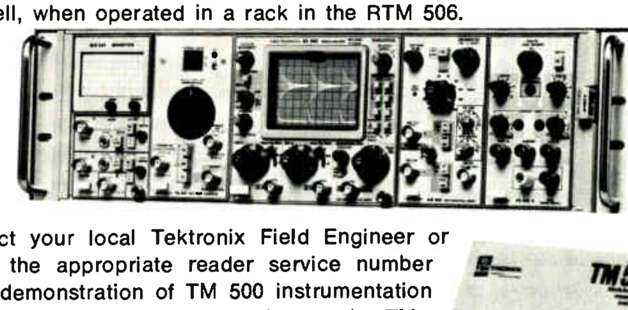
**Trends.** While Germany's EEC telecommunications exports rose 21% last year to 479 million DM, its South American shipments dipped 2% to 131.4 million DM. And exports to the expanding Iranian market dropped 8% to 73 million DM. Moreover, says one U.S. specialist in European electronics trade, "I doubt that Germany expects its European community business this year to match the 1974 level."

One U.S. analyst in Washington suggests that the chief of Siemens AG's Telecommunications Technology division may have shown considerable foresight earlier this year by worrying about the possible entry of Western Electric Co. into overseas markets. At the end of August, American Telephone & Telegraph Co. disclosed formation of a new subsidiary, American Bell International Inc., "to handle initially telecommunications systems planning and engineering" under a new contract with Iran. Some U.S. Government and industry analysts see this as but the first in a series of moves by AT&T to compete abroad.

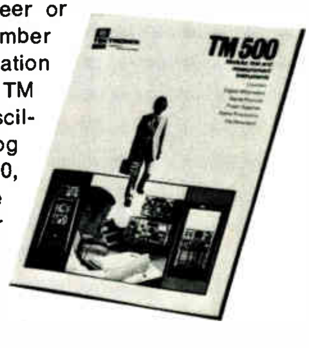
**Third.** The Siemens executive had noted that his company ranks about third after Western Electric and ITT Corp. in the world telecommunications market, which he put at 110–115 billion DM annually, or $46–48 billion at current exchange rates. By far the largest share of this is in the U.S. domestic market, but the U.S. analyst notes that Siemens is concerned that "if Western Electric moved into overseas markets, it would be able to underprice German producers" substantially.

The report says that the Bundespost, the Federal Ministry of









TM 500

Posts which operates the nation's telephone network, cut back its equipment buys about 5% last year and expects comparable cuts this year. "The big companies like Siemens and AEG-Telefunken are less affected, since they are able to offset losses in some lines by gains in other sectors," the U.S. assessment notes, although other, smaller producers are being hurt. The report cites as typical the cutbacks at companies like Telefonbau and Normalzeit and closing of Texas Instruments' semiconductor plant at Ingolstadt.

On the import side of Germany's telecommunications trade ledger, the 19% increase last year to 494.6 million DM included some 317 DM from the European community, while U.S. shipments jumped 45% to 74.4 million DM. Imports from Japan in 1974 rose only 6% to 33.8 million DM. □

## AT&T, Plantronics introduce new phone computer terminal

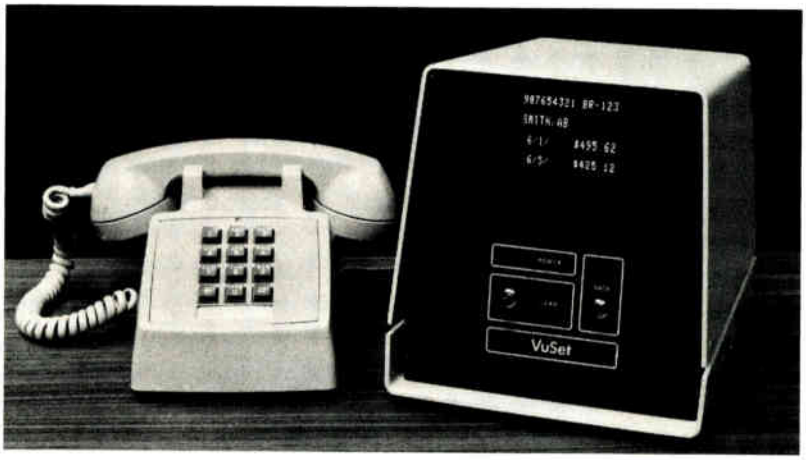
A new type of telephone computer terminal, with a cathode-ray-tube visual display, was unveiled by American Telephone & Telegraph Co. last week at its exhibit at the Info '75 show at the New York Coliseum. Called VuSet, the device uses the Bell System's Touch-Tone dialer instead of a more expensive typewriter-like terminal, making it possible to link it with a computer and obtain a visual display of data, even in the home.

The terminal is being produced by Plantronics Inc. of Santa Clara, Calif. for AT&T, independent telephone companies, and a few telephone interconnect firms. About five Bell System companies have already filed tariffs and expect the terminal to be available to their customers within the next few months for about $30 monthly.

AT&T officials foresee initial applications ranging from account states and inventory availability to management information systems, sales statistics, and maintenance reports.

In operation, a recognition tone heard in the handset tells the user when the computer is connected. The user enters data using the push-button phone. Each entry may be displayed on the screen for verification and editing by echoplexing the message back from the computer end of the system. Once the computer response data has been received by the display unit, the user can disconnect, freeing both the computer and the telephone line for other use. The received message remains on the screen until the user erases it.

The terminal uses a 300-baud Bell 103-equivalent modem and has data and power indicators. It weighs 10 pounds.




### Microprocessors

## HP adds new calculator, printer

Few system builders are in a position to design and fabricate their own microprocessors. But instrument-maker Hewlett-Packard Co. is one that can. And when it came to developing two new products—a programable calculator and a page printer [*Electronics,* Sept. 4, p. 26]—HP took the flexible approach: it applied one microprocessor that was already on the market, but it designed the other one itself.

The two products are from the firm's Calculator Products division, Loveland, Colo., which also developed the microprocessor. The other microprocessor is a commercial device—the M6800—from Motorola Semiconductor Products division, Phoenix.

**A first.** For the Motorola M6800 [*Electronics,* March 7, 1974, p. 29], which the semiconductor firm disclosed more than a year and a half ago, the HP model 9815A programable desktop calculator is the first commercial application. The Motorola part was selected for the calculator because of its fairly fast operation, compatible chip set, and minimal requirement for external circuitry, says Doug Clifford, HP's project manager on the 9815A. "It's in complete control of the machine," including operation of a built-in tape transport, display, and thermal printer, he observes.

The microprocessor also controls the timing and handshaking routines for optional input/output interfaces, which includes the IEEE standard interface, binary-coded decimal, and general interface options along with circuitry designed to talk to specific HP instruments.

The calculator itself can store up to 472 program steps and has 10 data registers. Memory is expandable to 2,008 program steps and can be allocated to any combination of program steps and data registers.

The tape transport uses a car-

# Our 3½ digit DMM passes the "sweat box test." (Can yours?)

**The 8000A is the most rugged DMM in the world.**

Phew. The temperature's pushing 90° and the humidity's close to 100. What a day for a service call.

Well, just throw the multimeter in the wagon . . . or even the trunk! All accuracy specs of the 8000A are guaranteed between 17° and 125° F (−10° to +55°C).

No other DMM we know of does as well.

**It's made to take abuse and keep operating.**

The 8000A is designed to be the good right arm of any field service man or utility maintenance man.

The high impact plastic case allows the 8000A to survive many bumps, jostles, and falls. You practically have to hit it with a sledge hammer to keep it from working. LSI technology means fewer parts to cause trouble and a field proven MTBF of better than 10,000 hours.

It's truly a rough and tumble instrument.

**It also has the best all-around specs.**

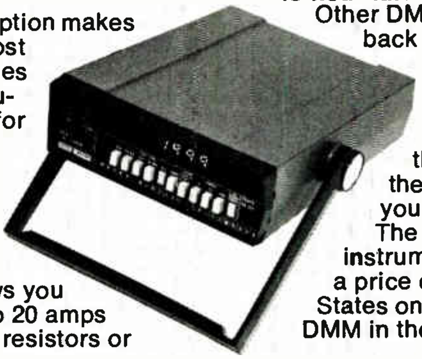
We only have room to highlight them.

Overload protection specified for **all** ranges. 26 ranges of volts, amps, and ohms. Normal mode rejection of 60 dB at 50 and 60 Hz. Common mode rejection of 120 dB with an unbalance resistance of one kilohm. Auto zero automatically sets zero reference, eliminating the need for front panel manual adjustment. And the best accuracy statement of any 3½ digit DMM.

**A unique set of low cost options and accessories.**

Compare the 8000A's versatility to your own DMM, and watch your eyebrows rise.

Its low ohms option makes it the only low cost DMM that provides 0.001 ohm resolution (invaluable for checking pcb lands, motor windings, heating elements, shunts, etc.).



The high current option allows you to measure up to 20 amps with no external resistors or shunts—a must for power supplies where 5 amps is the common measurement.

It offers 100 and 500 MHz rf probes, a high voltage 40 KV probe, and a 600 amp clamp-on AC current probe.

And the built-in rechargeable battery gives you complete line isolation capability.

There's new high voltage protection on all ac/dc voltage ranges. The instrument will take transients up to 6 KV, 10 μ seconds wide over a duty cycle of 60 per second.

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Other DMM's have to be sent back to the factory if they go out. That takes a month. But because Fluke has service centers throughout the world, we can get the instrument back to you in 48 hours.

The 8000A is a tough instrument, all right. And with a price of just $299 (United States only), it's the best selling DMM in the world.

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**Micro control.** Desktop calculator in foreground uses M6800 microprocessor from Motorola. But for its new page printer, Hewlett-Packard designed its own microprocessor.

tridge designed by HP in conjunction with 3M Co., Saint Paul, Minn. Each cartridge can store 96,384 bytes of data on a 140-foot-long tape.

Clifford notes that the microprocessor allowed a reduction in size for the calculator's control circuitry from four boards to one. This, added to the lower-cost thermal printer and tape transport, resulted in a calculator priced at $2,900, less than half the cost of a similarly equipped model 9810 programable unit.

**Printer micro.** A microprocessor also helped cut the cost of HP's model 9871A page-width printer, says Rick Spangler, 9871A project manager. But in this case, HP decided to make the microprocessor itself.

A major objective in the printer's design was that it be self-contained, with no external power supplies or control electronics, says Spangler, but "without a microprocessor, we would have had to build some sort of discrete processor or go to some other drive system." The HP division decided to build its own because "none of the processors commercially available at the time could do our job."

The microprocessor, a parallel 16-bit n-channel, metal-oxide-semiconductor device, has a typical execution time of 1 microsecond for a 16-bit instruction. In the printer, it receives and accepts 7-bit codes from a calculator or other controller, then determines whether the code must be stored or if the printer is ready. Next it locates the printer's character wheel and carrier, calculates the movements necessary to position the paper, controls the positioning stepper motors, and commands the hammer to fire.

The printer, priced at $3,400 with an interface to HP's earlier calculators and $3,600 with an interface designed for the 9815A, can print 30 characters per second and has variable spacing and plotting capabilities. □

## Consumer

# RCA receiver adjusts own color

RCA's new ColorTrak television receiver relies so heavily on electronics that most minor adjustments are taken out of the hands of the viewer [*Electronics*, Sept. 4, p. 25]. The company is so sure of the most ambitious digital tuning system thus far introduced that it's removed all primary controls from top-of-the-line sets and boxed them in a calculator-type remote-control package. The direct address system, as it's called, gives viewers an 82-channel pushbutton capability, plus on-screen channel and time display, for 25-inch console receivers priced at $1,095. The premium tuner, estimated at $200 more than a conventional remote unit, will be extended down to 19-inch sets later this year.

ColorTrak is the culmination of an effort that RCA began two years ago to completely revamp its large-screen color chassis. "No one change we made looks impressive by itself; it's the aggregate of all of them that gives us a better picture," comments Jay J. Brandinger, engineering vice president for RCA's Consumer Electronics division, Indianapolis. Electronic components in manual versions of the all-solid-state chassis have been redesigned to fit on six plug-in modules, four fewer than in earlier RCA sets. The remote-control 19-inch sets require three additional modules, and the direct-address tuners on 25-inch sets need five more.

**Advances.** Improvements include color-correction circuitry that continuously adjusts flesh tones without affecting greens and blues, a color-overload detector that eliminates abnormally high colors, a voltage-regulated transformer that compensates for variations in line voltages, and a light-dependent resistor that senses room lighting and adjusts contrast to match it.

In addition, the color control has been tied to the contrast control so that color saturation "tracks" changes in contrast. Background video has been clamped to black at the video-output stage, and phase-equalized filters get the symmetrical peaking that adds apparent sharpness to the picture. A new filtered-phosphor picture tube gives 25% more contrast than previous ones at a 4% sacrifice in brightness.

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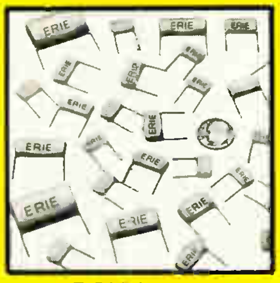

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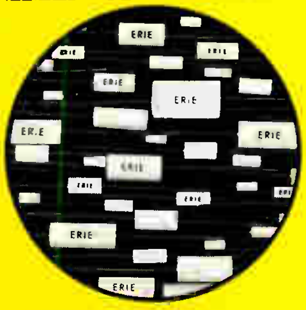

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Circle 37 on reader service card

the RCA line is the direct-address tuning system slated for high-ticket models. The system uses 10 custom complementary-MOS integrated circuits built by RCA's Solid State division, Somerville, N.J., to translate commands from a 14-function remote control keyboard into the voltages required by varactor very-high- and ultra-high-frequency tuners, as well as stepping color, tint, and volume adjustment up and down.

**Ultrasonic.** The hand-held remote control transmitter is built around an IC that contains a crystal-controlled oscillator and dividers to supply ultrasonic energy to the transducer at one of 14 frequencies. The transmitter package is the only "key" to the TV set, and RCA has built in a circuit with a light-emitting diode to indicate when the battery is low.

The amplified ultrasonic commands are read by an LSI chip, consisting of a frequency counter and decoder, that converts input frequencies to binary code. Other chips are used for control, display, time-of-day clock, crystal-controlled reference clock, and digital-to-analog conversion for driving color, tint, and volume.

The three remaining custom chips select appropriate tuner-control voltage and apply it to the varactor tuners. Vhf-tuner voltages are supplied from a reference voltage through a matrix of 12 potentiometers. Although preset at the factory, the vhf potentiometers can be adjusted to adapt the tuner to cable and master antenna systems. Uhf tuning is similar, but because of the large number of uhf channels, two ICs are used to select them. □


**Numbers.** Colortrak receiver is able to display the channel and time of day on screen.

## Companies

# National, Rockwell enter MPU pact

A "supported alternate source" agreement between National Semiconductor Corp. and Rockwell International's Microelectronic Device division is the latest in maneuvers by microprocessor manufacturers to find second sources.

The National-Rockwell agreement allows each to market any of the other's microprocessor products already announced—all of which are p-channel parts—and can be extended to cover new products as they're introduced. The agreement isn't exclusive—either may enter a similar deal with a third party.

In fact, Daniel Del Frate, the Rockwell division's vice president for marketing, says his firm will be announcing other second-sourcing arrangements on microprocessors. The first of these will probably be with an overseas company and could come within 60 days.

The contract further provides for National and Rockwell to exchange masks and process information—whatever is required to get each into production with the other's products encompassed by the pact. It covers memory and logic devices associated with National and Rockwell microprocessor systems. But it excludes the 4,096-bit n-MOS memories each is marketing or developing.

**Taking things in stride.** The National-Rockwell agreement hasn't dismayed their two chief competitors, Motorola and Intel Corp. Motorola's Semiconductor Products division had previously arranged for American Microsystems Inc. to second-source the M6800 n-channel MOS microprocessor. And William Davidow, Intel Corp.'s manager of microcomputer systems, says versions of his n-MOS 8080 are being produced by Texas Instruments, Advanced Micro Devices Inc., Nippon Electric Co., and at least two

# Twelve new reasons to use the Intel 8080 microcomputer system.

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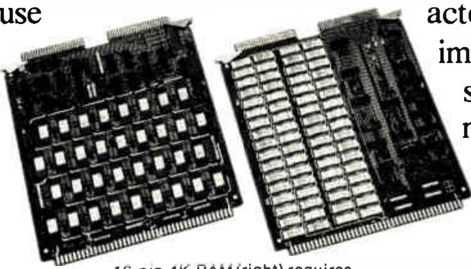
# Still designing without 16-pin 4K RAMS?

## You may be kicking yourself tomorrow.

Let's not beat around the bush. Fairchild has put a lot of money into developing its ion-implanted Isoplanar 16-pin 4K RAM. Why? Because we'd be nuts to ignore 16-pin. It's a better design, hands down, than either 18 or 22-pin RAMS. It's the design of the future. Here's why.



16-pin 4K RAM (right) requires significantly less board space than 22-pin design (left)

### Easier, less costly

The 16-pin 4K RAM uses only six address lines. That means you only need *half the number* of address drivers that you do with 18 or 22-pin designs! Result? Fewer parts, less cost.

Support functions are included on-chip. (TTL-to-MOS conversion, address, chip-select and output latches.) Results?

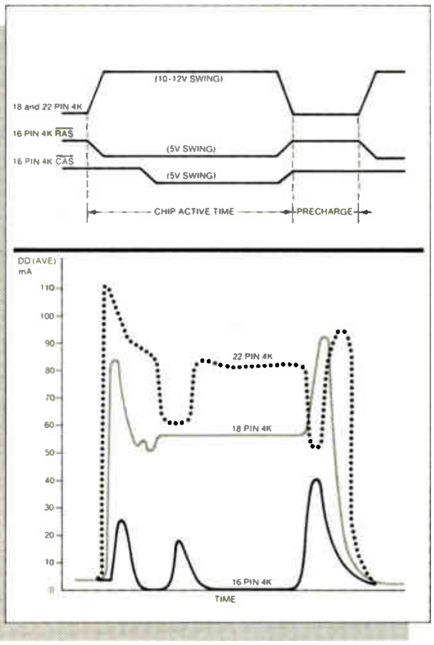
Your system noise characteristics are improved. Your system is more reliable. And your system design and component costs are lower.

Fairchild's 16-pin 4096 is designed with low-voltage, low-capacitance clocks—rather than 12-volt clocks—throughout the system. Results? System noise reduced to a minimum. And again, a simpler and less costly system.

| Part Number | Random Access Time (ns) | Cycle Time (ns) | Average $I_{DD}$ (mA) |
|---|---|---|---|
| 4096-2 | 200 | 300 | 35 |
| 4096-3 | 250 | 365 | 30 |
| 4096-4 | 300 | 425 | 27 |
| 4096-5 | 350 | 500 | 25 |

### Lower power requirements

Our 16-pin 4K is a power-miser compared to 18 or 22-pin RAMS. (See diagram.) It also requires smaller voltage swings, producing smaller transient spikes.




16-pin 4K RAM consumes far less average power and generates much lower noise spikes than 18- or 22-pin design .

### Higher board density

With the Fairchild 16-pin 4096, you get the most RAM bits per unit area of PC board. Significantly more than any other design on the market. (See photo.) And you get *exactly the same* speeds as 18 or 22-pin designs.

### True alternate sourcing

The 16-pin package is the only 4K RAM with true, identical-spec alternate sources.

### Easier future expansion

When 16K RAMS are developed, they will be made other semiconductor companies.

Davidow of Intel, the industry leader, points out that the best second-source arrangement is the informal kind that spurs the second-sourcer to improve the device. And Motorola vice president and general manager, John Welty, is confident that "our microprocessor family is still the best price-performance package available." □

## Commercial

# Ad display system uses microprocessor

A small California firm armed with a microprocessor-based floppy disk operating system is offering adver-

## News briefs

**Liquid-crystal displays from IBM show alphanumerics**

IBM Corp.'s System Products division, Hopewell Junction, N.Y., has developed liquid-crystal panels that display alphanumeric characters. The displays, for which IBM discusses no specific applications, may be 20 or more characters long. However, the best length is closer to 10 characters because of the many interconnections required for a longer display, says Walter E. Mutter, a senior engineer. Each character is defined by a five-by-seven matrix, and as many as three complete displays can be multiplexed at the same time. The units operate in a reflective dynamic-scattering mode, which tends to offer a longer life than the field-effect mode popular for watches, although threshold voltage is higher, and contrast lower.

**IEEE takes stand on older engineers**

The Institute of Electrical and Electronics Engineers' executive committee has adopted a position on age discrimination that will be offered for approval to its board of directors at their meeting this week in San Francisco. A key element of the proposal is that industry, government, and educational institutions employing EEs be encouraged to adopt affirmative action programs to "insure the efficient, proper, and humane utilization of experienced, middle-aged, and older engineers." When adopted by the IEEE board, the position will be incorporated into an ongoing industry relations program of the institute.

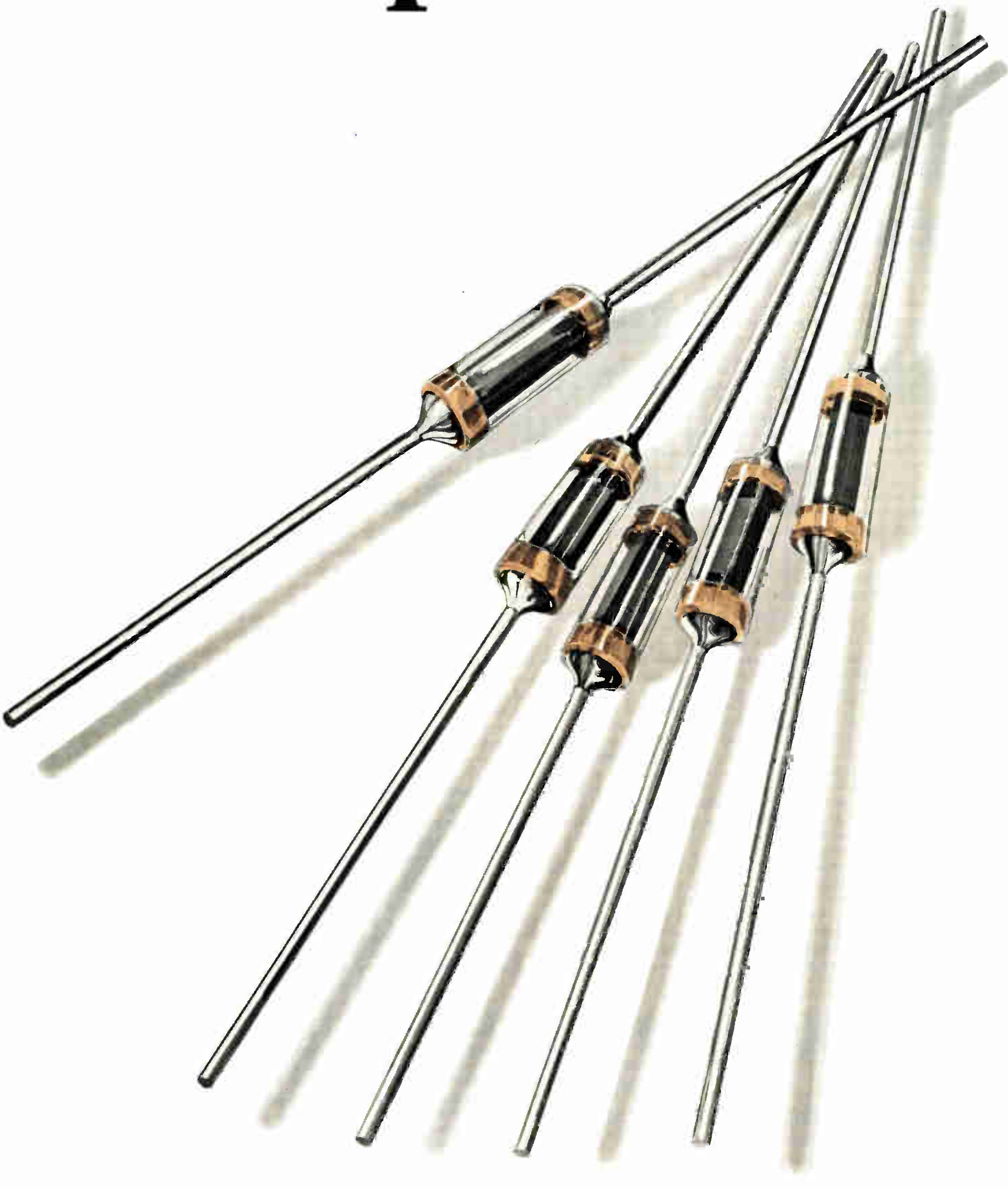
**AT&T subsidiary to handle Iran communications**

American Telephone & Telegraph Co. has formed a new subsidiary, American Bell International Inc., to assist the government of Iran in planning and engineering a nationwide communications system. The contract for AT&T's services is with the Electronics Systems division, Hanscom Air Force Base, Mass., the contracting agency under the military sales agreement between the U.S. and Iran. This is the first move by AT&T to handle projects abroad since it formed American Bell Inc. several years ago to administer a contract for the Commonwealth of Puerto Rico's telephone system.

**Analytic instruments to rely heavily on microprocessors**

After a start in 1975, penetration of microprocessors into analytical instruments should have a full head of steam up by the early 1980s, predicts a partially completed study by Darling & Alsobrook, a Los Angeles consulting firm. By then, it will "completely revolutionize" that industry, very likely causing fundamental structural changes. In 1982, about 65% of the total market ($1.32 billion), or about $858 million, will incorporate microprocessors. Only the very small instrument will be left out. The first microprocessor-based instruments, introduced early this year, targeted the atomic absorption analysis field with new spectrophotometers. Next will come emission spectrometers and infrared spectrophotometers. For the immediate future, redesigns will center on special-purpose, highly automated instruments to achieve up-times in excess of 90%, a significant hike over conventional units, according to the study.

# AVX puts class



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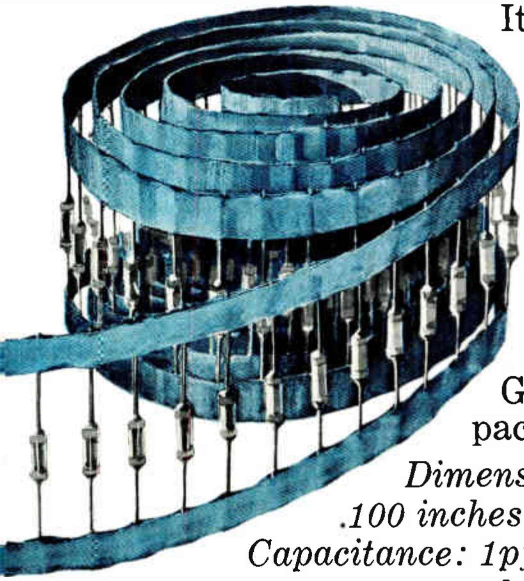

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# Washington newsletter

**Procurement bill may get boost from F-18 protest**

Watch for a Senate Government Operations subcommittee to seize on the General Accounting Office's upcoming judgment on the Navy's selection of the F-18 Air Combat Fighter as strong support for its pending Federal procurement reform bill. The legality of the choice of McDonnell Douglas-Northrop's F-18 was protested to GAO by loser LTV Aerospace, which had been teamed with General Dynamics Corp. [*Electronics*, May 29, p. 42]. GAO officials refuse to comment, but congressional sources say it will blast the Navy's choice for reasons that include the plane's heavy weight and reduced range when loaded with the specified fuel and missiles. **"It will be almost a different plane," one congressional staffer argues, "and far too heavy for the job. Navy has misled everybody on that."**

Whether the GAO report, expected soon, can be used to overturn the Navy's selection is questionable, sources believe.

**Aeronutronic Ford set for P.O. order**

Top U.S. Postal Service (USPS) management has given preliminary approval for the purchase of five advanced optical character-reader mail sorters from Aeronutronic Ford's Communications Systems division, Willow Grove, Pa. The price tag is estimated at more than $10 million. **And sources predict that if the five production units perform as expected, the USPS will seek as many as 55 additional sorters, a potential buy of $100 million.** A final decision is expected in October.

**Proposals sought to convert a-m radio to stereo**

Proposals to give a-m radio the capability for stereophonic broadcasting are being sought by an industry-organized committee that will hold its first meeting on Sept. 24 in Washington. Representing a revival of interest in an old idea, the National AM Stereophonic Radio Committee is being created at the urging of the Federal Communications Commission. Membership is being drawn from the Electronic Industries Association, the IEEE Group on Broadcasting, and the National Association of Broadcasters, which will host the first meeting. With Harold Kassens, recently retired head of the FCC broadcast equipment unit, as chairman, **the committee will determine the technical criteria necessary for a-m stereo broadcasts and forward the results to the FCC.**

**NASA's standard satellite plan may be changed**

NASA may soon move toward more complete standardization of its Earth Observatory Spacecraft (EOS) program by releasing just one request for proposals and signing just one contract for procurement of the basic frames for all of the 41 planned EOS spacecraft [*Electronics,* March 20, p. 66]. The EOS satellites will conduct a variety of atmospheric, land, earth, and water surveying missions. The original procurement concept calls for comparatively limited standardization, with RFPs and contracts being issued for batches of four or five EOS craft. **If NASA Administrator James C. Fletcher gives the go-ahead for the new procurement plan, which he may do within weeks, an RFP for one prototype EOS frame, five production units, and options for 36 more could be out "in a year,"** according to a top-level NASA source.

# Washington commentary

## Why U.S. telecommunications policy needs changing

Federal policy on telecommunications for its own use is in trouble—indeed, there are some who question whether a national policy exists at all. That's because more than 70 different departments, agencies, offices, boards, and other Federal bodies use telecommunications, says the White House Office of Telecommunications Policy. "Each of these users has its own 'unique' requirements," OTP adds, "and has the authority to validate its own requirements."

This cannot be shrugged off as merely the way of a competitive capitalist republic when the Federal telecommunications outlay exceeds $10 billion annually and the total existing investment of $50 billion continues to grow at a 10% annual rate. That may produce a substantial variety of business for U. S. telecommunications equipment makers, but it produces insufficient business for significant growth by any one of them, except for AT&T. Although there is much Federal money for telecommunications systems R&D, production runs on many Government communications buys are smaller and far more expensive than they would be if overlapping and redundant systems could be somehow consolidated. However, the fact that new markets developed by Americans initially for their own use are slipping away to foreign competition is becoming increasingly clear in the pattern of worldwide sales of satellite earth stations, digital microwave and PABX hardware, plus land mobile 900-megahertz equipment now being developed.

### Radionav's problems

Consider the case of radio navigation systems, a category that OTP estimates takes one third of total Federal telecommunications expenditures and uses 16% of the available spectrum—far more than the 1% used by the entire broadcast industry. A newly completed, two-year study of U. S. radio navigation systems for OTP by Computer Sciences Corp. identified some 80 ground and satellite systems or variants thereof now in Government use. CSC's computer told OTP that by advance planning, management, and coordination, these could be cut "to about 13 without a degradation in service." A reduction in systems coupled with greater equipment standardization could have saved the Government "a minimum of $3.5 billion," as well as cutting radio navigation spectrum space requirements, contends John Eger, OTP's acting director.

The Federal Communications Commission, which is generally limited to managing the non-Government portion of the spectrum, can do nothing. What can OTP do? The answer is again nothing, even though OTP is ostensibly responsible for managing Federal spectrum usage for the executive branch.

Beyond the fact that the CSC study estimated that it would take about 20 years to achieve a meaningful reduction in radio navigation systems to protect the investment of existing users, there is another, larger reason for OTP's inability to act. Simply stated, the office has no clout, legally or otherwise. Despite its White House connection, it cannot order anyone around other than its own small, inadequate staff.

### Need for action

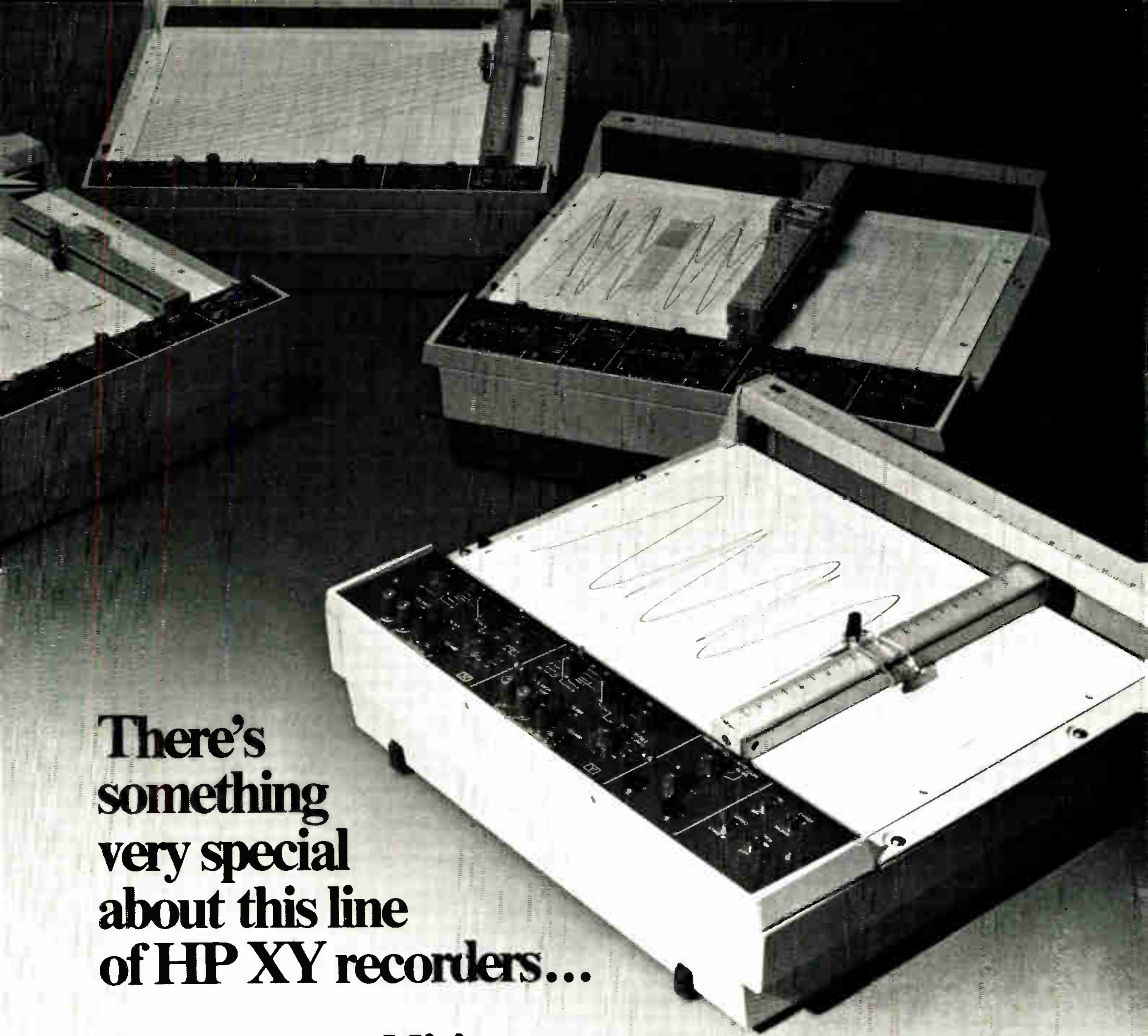
Consequently, OTP's analysis of U. S. radio navigation systems is likely to get little more than one reading before being shelved by its recipients. Indeed, all OTP's Eger has been able to do is to ask the agencies affected "to review the study and to furnish OTP their views. . . ."

While that may be the unfortunate status of OTP and Federal telecommunications policy generally at this moment, there is nothing to say it cannot be changed by President Ford if he is so moved. And he could be so moved if the matter were brought to his attention with sufficient force by the communications manufacturing and engineering community.

Indeed, industry must speak out because there is more at stake for the U. S. than the need to conserve spectrum space and Federal dollar outlays. While Federal telecommunications expenditures have great short-term appeal for industry, they tend to limit the nation's capability in other telecommunications markets—areas that are increasingly dominated by competitors from other nations operating in the U.S. as well as other world markets.

It is a problem recognized by the Commerce Department's own Office of Telecommunications, as well as by some in the Congress, among them West Virginia's Harley O. Staggers, senior Democrat on the House Interstate and Foreign Commerce Committee. Among other things, Staggers wants to develop better coordination between and among Federal users of telecommunications and their suppliers.

Whether the place for that authority is with OTP or somewhere else cannot be decided until both the White House and Congress agree that such authority is needed in the first place. And that decision is unlikely to come unless the telecommunications industry and its members speak out strongly and soon. **—Ray Connolly**



# There's something very special about this line of HP XY recorders...

# the newest addition is the fastest most sensitive machine we've ever built.

HP's line of XY recorders is designed to let you choose the right machine with the right options to do the right kind of job for your lab. First: a basic one-pen workhorse. Then, a fast high-performance version. And a two-pen model that doesn't sacrifice speed.

Now, HP introduces a very special combination of acceleration and sensitivity: The Model 7047A.

This is an outstanding XY recorder, the top of the line. Sensitivity of 50 $\mu$V/in. Acceleration in the Y axis of 3000 in/sec$^2$ and 2000 in/sec$^2$ in the X axis. With fully guarded input and 130db common mode rejection.

To meet the demands of the most exacting lab work, the 7047A gives you a switchable input filter, 11 scales of calibrated offset, internal time base and TTL remote control. All as standard equipment.

And like all recorders in the line, the 7047A is built on a strong die-cast aluminum mainframe. Inside, there are no complicated slip clutches, just tough, continuous duty servo motors that can be driven offscale independently without damage.

This is the best of the best XY recorders ever offered by Hewlett-Packard. Prices start at $2,850 (domestic USA price only). For complete details on the new 7047A and the other recorders in the HP line, see your HP field representative or write Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304. 11408

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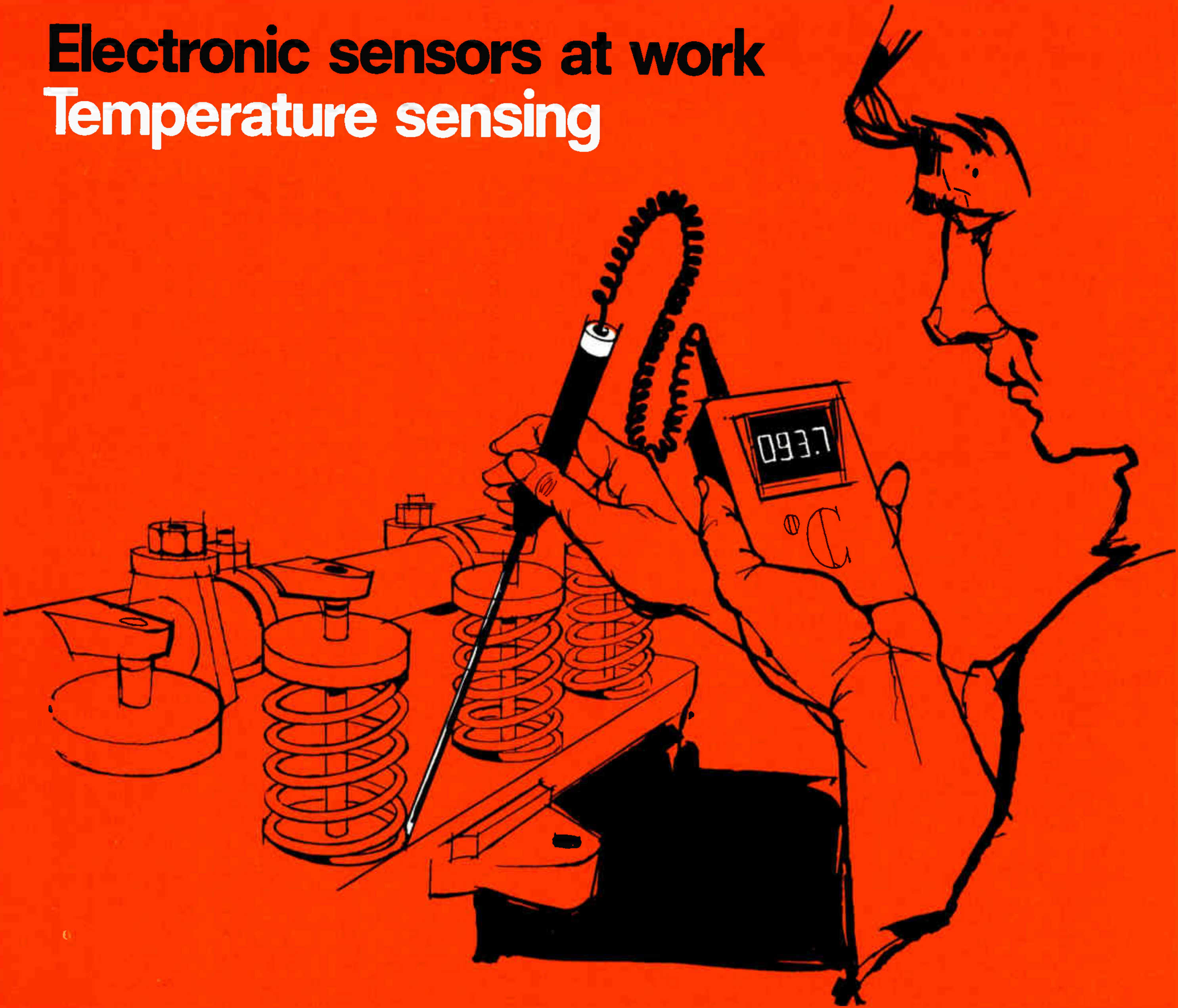
# Electronic sensors at work
# Temperature sensing




Temperatures at selected points can be measured in seconds by electronic instruments using movable probes. Their sensor elements – NTC thermistors with a highly temperature-dependent resistance characteristic – react several times faster than thermocouples or resistance thermometers. They are equally suitable for temperature measurements in laboratories and experimental stations and in clinics and medical practices.

NTC thermistors installed in systems and equipment have proved reliable in millions of applications over a period of many years. They monitor, measure and control temperatures in heating and air-conditioning systems, hothouses and cold-storage houses, ovens and drying kilns, incubators and refrigerators, washing machines and dishwashers . . . .

They are used to measure vacuum, flow and thermal radiation and to control the level of liquids, to protect motors against overload and to compensate temperature variations in all types of electronic circuits.

Wherever NTC thermistor devices are needed – you will find the right type in Siemens' comprehensive line of products.

# NTC thermistor sensors from Siemens

B 0/7509.101

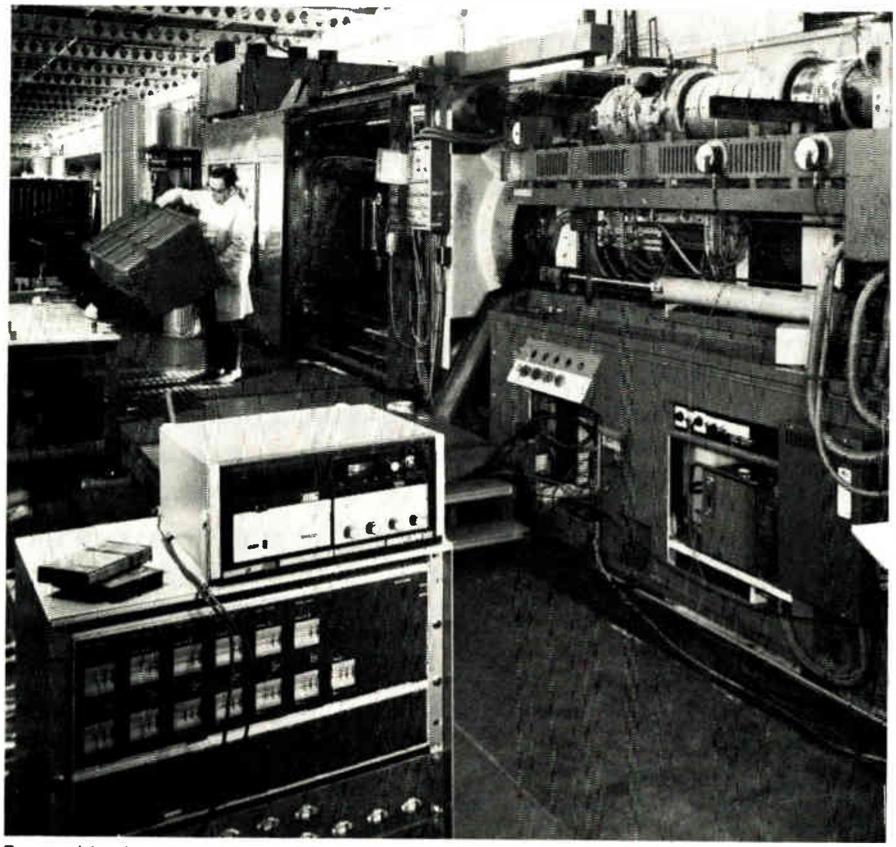
# Electronics International

Sept. 18, 1975

## Single antenna spins for MLS computers: page 7E

Hamburg communications-relay tower contains systems from AEG-Telefunken: page 9E

# We've taken the expense out of data recording

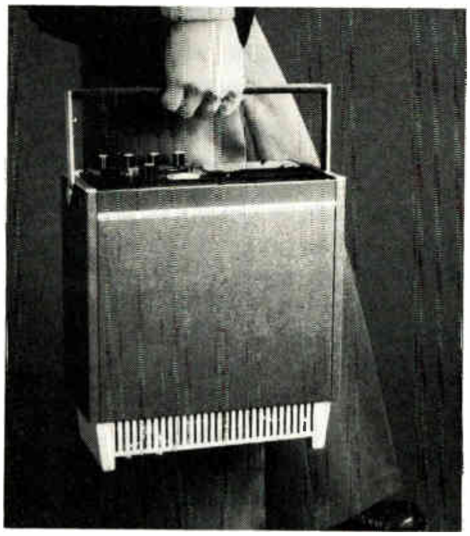


For trouble-shooting or process control two speeds allow rapid survey or slow motion analyses.

Low operating costs and simple operation combined with high-performance and reliability makes the new Mini-Log 4 analogue cassette-recorder a really practical proposition for industry. Mini-Log 4 uses standard compact-cassettes. Equally important, its purchase price is considerably lower than any competitive system.

Outputs from the four FM-channels on the Mini-Log 4 can be used to drive an oscilloscope or chart recorder.

Simply 'post' a compact-cassette into a slot in the front panel and Mini-Log 4 is ready to use.



Mini-Log 4 is extremely compact and lightweight and operates from mains or battery supplies.

I am interested in *full information/demonstration of the new Mini-Log 4.

Name: ____________________

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*Delete which does not apply 4-1

Write for demonstration or full information to:
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# International newsletter

**Siemens succeeds Unidata as IBM's European rival**

Siemens is likely to inherit Unidata's position as the only large European computer manufacturer with a range of IBM-compatible machines designed and built with all-European technology. The long-expected demise of the Unidata venture, launched in July 1973 by Siemens, Philips, and France's struggling Compagnie Internationale pour l'Informatique, was triggered by the French government's decision last May to merge CII with Honeywell Information Systems' subsidiary, Honeywell-Bull. Although Unidata has yet to be formally dismantled, Philips early this month announced its withdrawal and revealed that the three Unidata partners had agreed back in August "to end the basic Unidata agreement in its present form." **But neither Siemens nor Philips is hiding its view that the French are to blame for the collapse of Unidata.**

The Philips departure ends the Dutch giant's expensive excursion into large computers. As many as 2,500 persons will be relocated to other jobs within the group, and the company will return to its small business machines and minicomputers. **While Philips is reputed to have lost as much as $80 million a year on its computer operations, its small-machine sales have grown fast and have been profitable.** Philips has been careful to keep all its business in this market—including a manufacturing plant in France—outside the Unidata agreement.

Until mid-August, the loosely knit Unidata marketing association had won a total of 375 orders for the four machines in its line, fitting roughly between IBM's 370/115 and the 370/158. **Siemens is now planning to build all four models in its own factories, thus taking over responsibility for the small 7720 model developed by Philips and the 7740 built in France by CII.**

**French show stars calculators and minicomputers**

European sales of large computers may not move ahead by much more than 10% this year, but minicomputers and calculators are doing much better. At Europe's leading data-processing show, the Sicob exhibition that opens in Paris Sept. 20, **minicomputer makers are reporting an upturn in sales growth rates from 15% to 25% since this summer.**

Calculator producers say that the European market is still growing as fast as ever, despite the flattening of business in the U.S. Riding this wave, Commodore, of Santa Clara, Calif., claims to have taken over the leadership in European sales volume this year, jumping ahead of Rockwell, Hewlett-Packard, and Texas Instruments. **Altogether, European sales are expected to reach 15 million units out of a worldwide total of about 50 million.** European sales have been so strong this year that Commodore executives say that half their global sales are now in this market. Sales executives estimate that the German market will take at least 5 million units this year, the British market 3 million, and the French at least 2 million.

**Berlin show augurs profits for TV and components makers**

By any measure, the mammoth international radio and television exhibition that closed Sept. 7 in West Berlin proved to be every bit the success that the electronics industries had hoped. Attracting 386 exhibitors from 23 countries and more than 600,000 visitors to the city's sprawling fairgrounds, the show triggered what one TV manufacturer terms **"exceptional ordering activity by wholesalers, and thus the turnaround."**

However, manufacturers of components, and especially semiconductors, are also expected to prosper because consumer-electronics equipment traditionally provides the largest market for solid-state devices. Now that consumers are finally beginning to loosen their purse strings, the stockpiles that had built up to between 300,000 and 400,000 TV sets this summer are expected to go down fast, and **production lines are predicted to operate at their normal capacity through this year.**

## Japanese team with Americans to make solar-power cells

A $1 million company, Japan Solar Energy, has been formed by three Japanese and two American companies to grow single-crystal silicon ribbons for fabricating solar batteries. **The plant is to be completed next spring in Shiga Prefecture near Kyoto Ceramic Co., which is the majority partner with 51% of the approximately $1 million capitalization.** Other Japanese partners are Sharp Corp., which owns 24%, and Matsushita Electric Industrial Co., with 10%. The American companies, which own 7.5% each, are Mobil Oil Corp., New York City, and Tyco Laboratories, Waltham, Mass. The American partners are to contribute U.S. technology developments.

**The three Japanese partners are to cooperate in developing processes to produce materials from which Sharp and Matsushita will fabricate solar batteries.** The owners claim that their agreement is not directly connected with the Japanese government's Sunshine project for the utilization of solar energy.

## Ferranti bipolar IC improves operation of Racal series 99

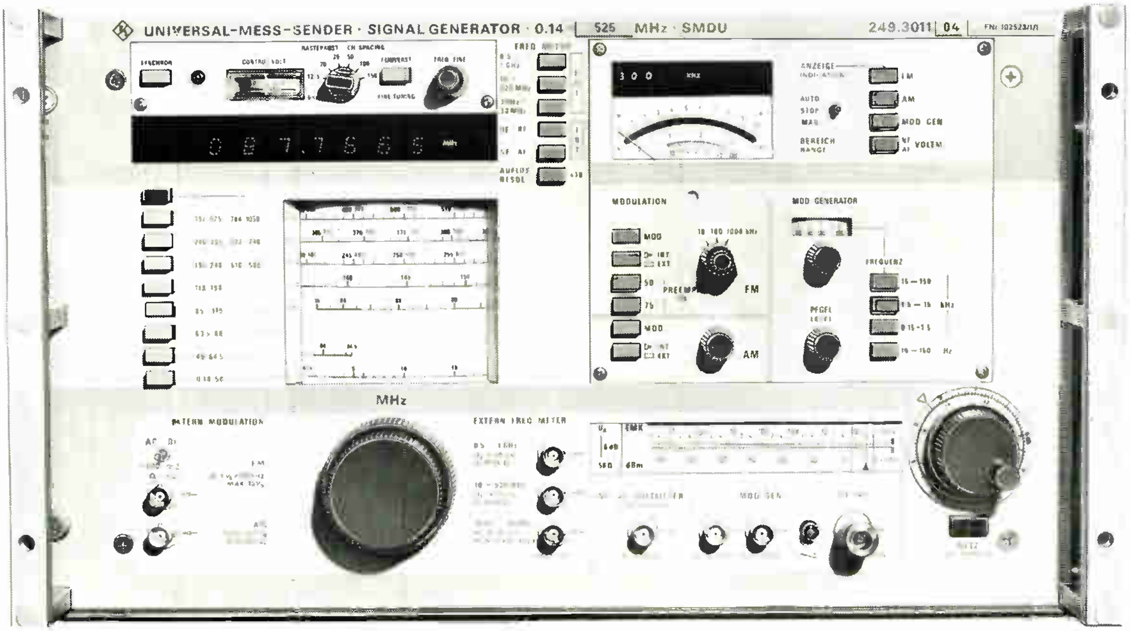
Three universal counters and four frequency meters that their manufacturer, Racal Instruments Ltd. in the UK, calls the most advanced of their types are backed by a two-year guarantee. The superior capabilities and reliability of the digital 99 series are credited to custom large-scale-integrated bipolar circuits from Ferranti Ltd. **The bipolar chips are made by collector-diffusion isolation techniques, which combine bipolar speed with the circuit complexity achieved through simple masking steps of MOS to produce the equivalent of more than 5,000 discrete components per chip.** The chip, which replaces about 140 transistor-transistor-logic devices, provides more standard features for the digital 99 family than previous devices. Yet, the price remains the same as the predecessors and comparable with that of competing instruments.

## NEC 2,048-bit ROM is electrically programed, erased

A new 2,048-bit electrically alterable read-only memory from Nippon Electric Co. can be erased as well as programed electrically at high speeds. **What's more, the memory, to become available in October, can retain a program for more than 10 years if not erased.** NEC says reliability should be better than it is for devices erased by ultraviolet techniques because the package need not include a window and because the device is apparently damaged less by high-speed electrical programing and erasure. Writing time is 60 milliseconds for an 8-bit word and 15 seconds for the entire device. The memory can either be erased completely in one minute, or word by word.

**The stacked-gate configuration of the memory transistor facilitates high-speed programing by injection of hot electrons into the floating gate and high-efficiency erasure by injection of hot holes into the floating gate.** The floating gate is buried in oxide, much like Intel's Famos, and an aluminum control gate on top of the oxide has an external connection. However, the Famos is erased by ultraviolet light.

# Allround signal generator 15 Hz to 1.05 GHz




## Enonomical – precise – versatile – easy to operate

Rohde & Schwarz offers the better alternative with the new Signal Generator SMDU. It comes in several versions, for you to choose the one best suited to your requirements.

**Standard version**
145 dB signal-to-noise ratio, 7-digit frequency meter, AM and FM, operation with synchronizer, and – an attractive price.

**Universal version**
Stereo modulation also, built-in AF voltmeter with autoranging, low-distortion AF generator 15 Hz to 100 kHz.

**Air-navigation version**
Same as universal version plus measuring capabilities for aeronautical receivers.

Several options are available for all three versions: Synchronizer, Overload Protector, 1.05-GHz Frequency Range Extension, 1-GHz Frequency Meter.

Application areas: laboratory measurements, international standard measurements on commercial receivers (radiotelephony, aeronautical radio, directional radio, telemetry), on mono and stereo broadcast receivers as well as on active and passive components.

Single-range attenuator and channel selection at locked frequency intervals cut down on measurement time.

**Ask Rohde & Schwarz**
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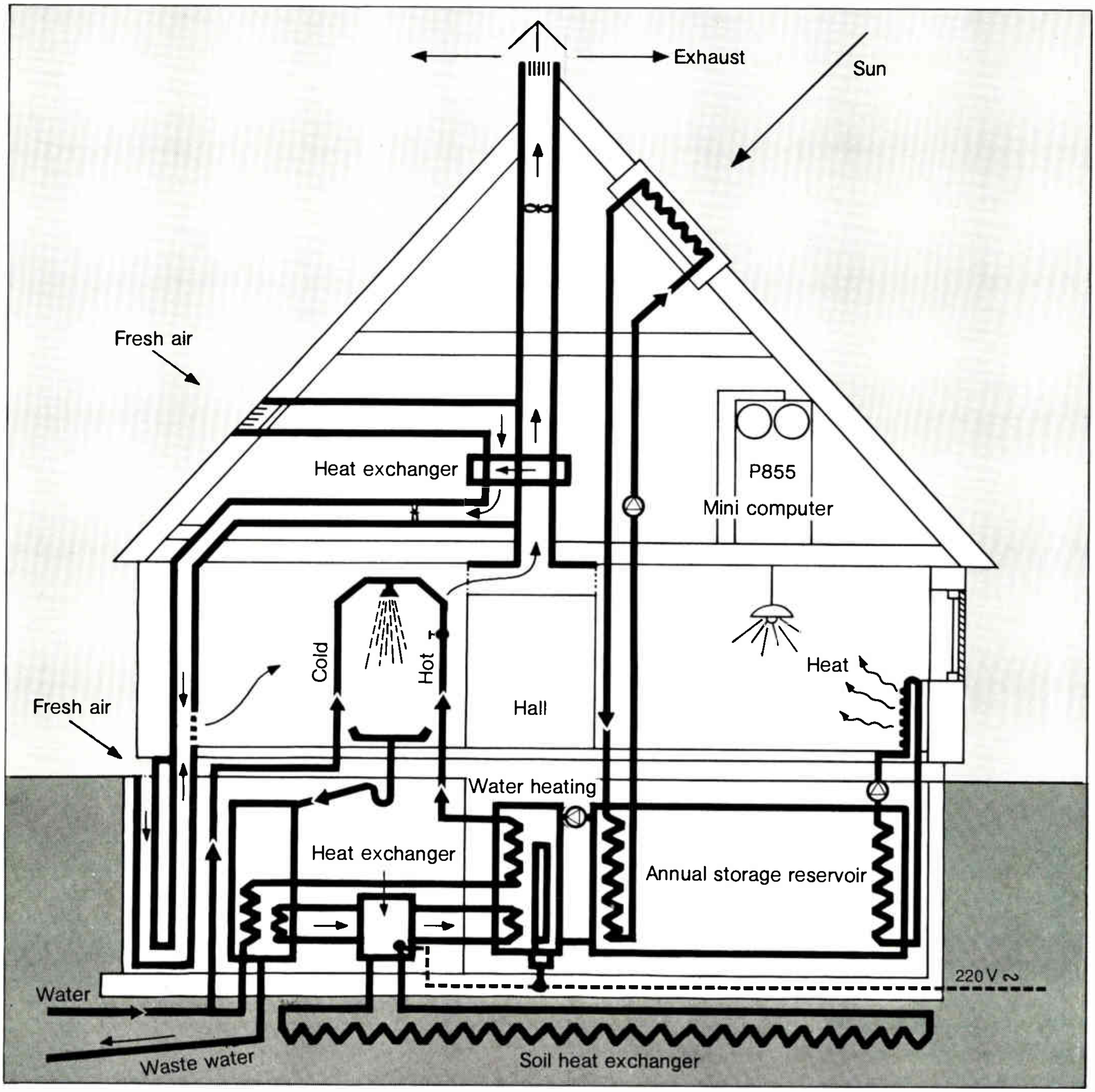
# Energy conservation in practice

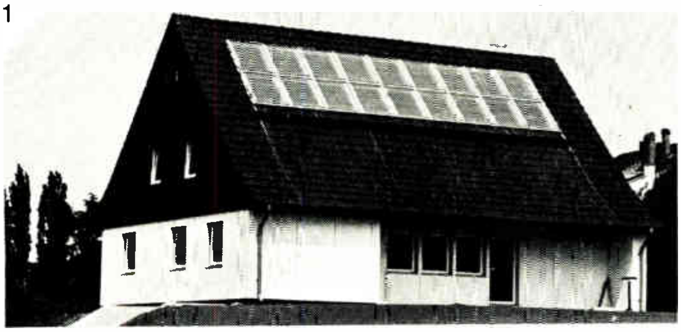
Discovering new energy sources is not the complete answer to our future energy needs. We must also discover ways to conserve energy and to use it more efficiently.
To study methods of energy conservation under practical conditions, Philips, in cooperation with RWE, Essen, and the German Federal Ministry for Research and technology, have built an experimental house in the grounds of the Philips Research Laboratories in Aachen.
The energy consumption requirements of an average family of four are simulated by two Philips computers, which also control the heating system and process the data measured. A normal electricity supply is used for lighting, cooking and the usual appliances, however, energy for all



household heating - totalling some 8300 kWh per year - is supplied by the sun. For example, incident solar energy striking a solar collector battery in the roof is converted into low-temperature heat (up to 95°C) and stored in an annual storage reservoir in the cellar. Solar energy absorbed at the earth's surface (soil heat) is also used for heating as well as for cooling during the summer months.

Heating energy requirements have been reduced to a minimum by the use of improved building insulation techniques and a unique type of double-glazing developed by Philips. Brief details on some of the technology used is given below.

1



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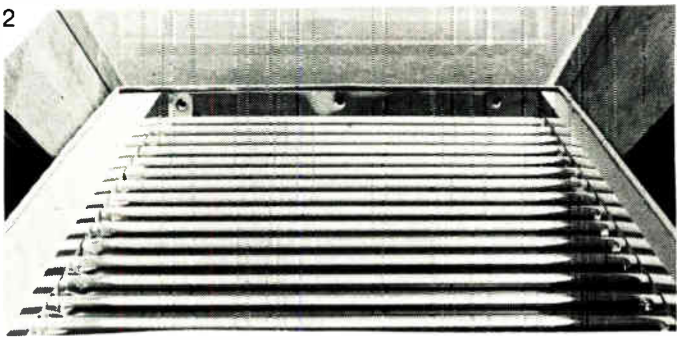

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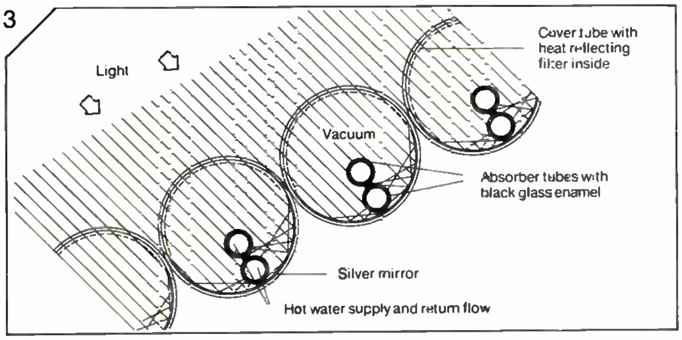


1 **The living area** of the experimental house is completely equipped with all the furniture and technical appliances for a family of four. Apart from the solar circuit, systems being tested include heat pumps, used for example, to extract heat from the ground under the house, the heat exchangers which recycle the warmth from outgoing waste water and stale air, and an air intake heating/cooling system. The annual heating energy requirement for heat conduction losses is 6300 kWh and 2000 kWh for ventilation losses.

2 **The solar collector battery** of 20 m² has been installed in the south-side of the attic roof and inclined at an angle of 48°. The battery consists of 18 solar collector boxes, each box housing 18 evacuated glass tubes containing the actual collector elements. In developing the solar collector Philips applied their extensive knowledge of heat reflecting layers in low pressure sodium lamps; the layers also being used in the collector to obtain a high degree of efficiency even with low solar radiation intensities. On average, the solar battery will collect about 10,000 to 12,000 kW hours of energy a year.

3 **Each solar collector** possesses a heat reflection filter made of indium oxide (in$_2$O$_3$) having a sunlight transmission $\tau$ = 85% and a reflection R = 90% for heat radiation. The absorber has an absorption factor of $\alpha$ = 95% for sunlight. Compared to a flat collector with selective absorber ($\alpha$ = 0.90%, $\varepsilon$ = 0.10) and double-glass covering, the Philips collector with additional covering is considerably more efficient and was specially developed for Central European latitudes. In the following table the values were found empirically for the application for heating water in summer (water temperature 50 °C above outside temperature).

| Conditions | Overall radiation W/m² | Flat collector = % | Philips collector = % |
|---|---|---|---|
| Cloudless sky/clear | 800 | 53 | 61 |
| Slightly cloudy/hazy | 600 | 46 | 58 |
| Light overcast | 300 | 17 | 45 |
| Heavy overcast | 150 | 0 | 20 |

If you would like to receive more information on this experiment, please mail the coupon, or write to Philips Industries, GAD-EMB-2/room 16, Eindhoven, Holland

Send me more information on the solar energy experiment

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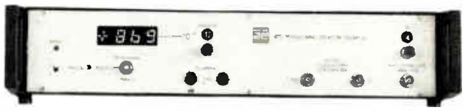
## FREQUENCY METROLOGY



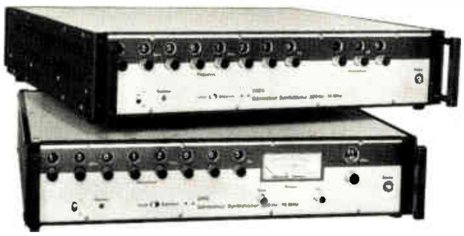
### Frequency error multiplier

Multiplication by 10,000 of a frequency error (acquisition time : 0.2 s).
$\Delta F/F$ measurement with $10^{-12}$ resolution (acquisition time : 10 s).

### Frequency standard receiver

A frequency standard controlled by atomic reference : 1, 5 or 10 MHz reference frequencies having together the long-term stability of any transmitter received within the 15 kHz/200 kHz range and the spectral purity of the high quality built-in crystal oscillator.

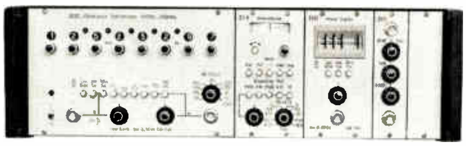
## 0.01Hz to 600MHz FREQUENCY GENERATION



### Frequency and level generator

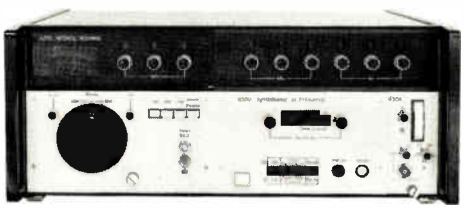
300 Hz to 14 MHz in one range, with 1 Hz resolution. Outputs : 50 Ω or 75 Ω, low impedance (less than 3 Ω), 20 MHz frequency offset. Output level regulation : ± 0.01 dB. Frequency and level programmable.

***Two models : system version and laboratory version.***



### LF/VLF modular generator

According to your requirements, the 0.01 Hz to 200 kHz synthesizer mainframe is fitted with : programmable phase standard, programmable attenuator, sweeper, carrier modulator.



### 600 MHz plug-in for the 6000 series

Extends to 600 MHz the frequency range covered by the 6000 series : AM, FM and PM facility, frequency and level programming.

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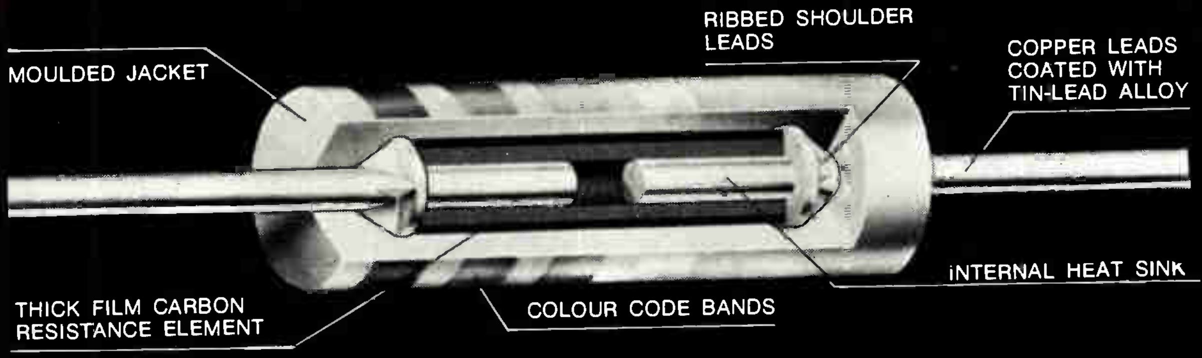
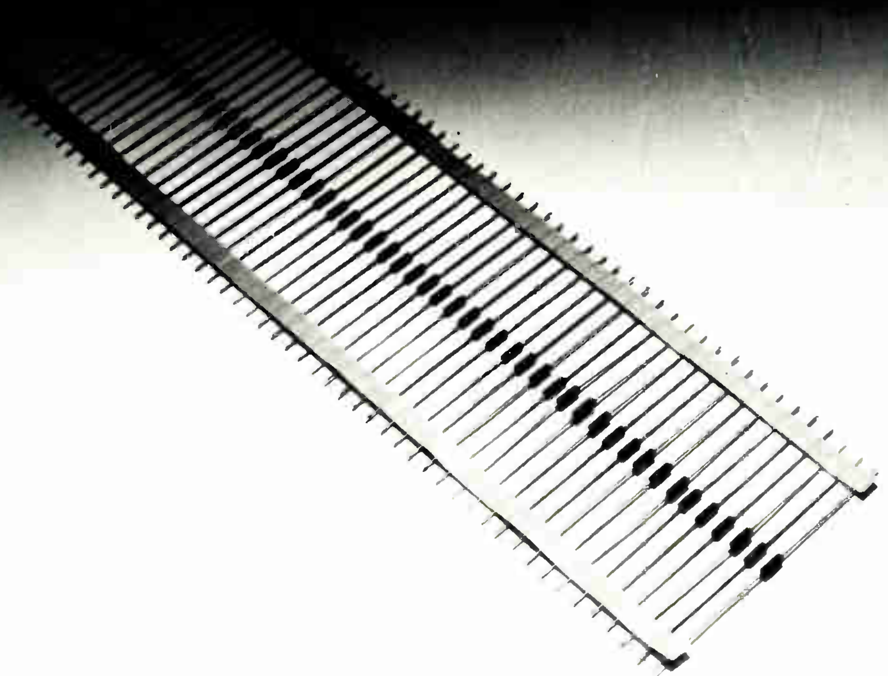
# THICK FILM CARBON moulded resistors IBT



- Moulded jacket up to 50% thicker for superior moisture and mechanical protection
- Thick film carbon resistance element for optimum high frequency characteristics
- Ribbed shoulder leads for security in jacket
- Copper leads coated with tin-lead alloy for excellent solderability
- Internal heat sink for lower operating temperatures
- Colour code bands impervious to solvents and high temperatures

IBT 1/4 - 1/4 W, **MIL-R-11 Approved RC07,** TC = 250 ppm/°C
IBT 1/2 - 1/2 W, MIL-R-11 Style RC20
IBT 1 - 1 W, MIL-R-11 Style RC30

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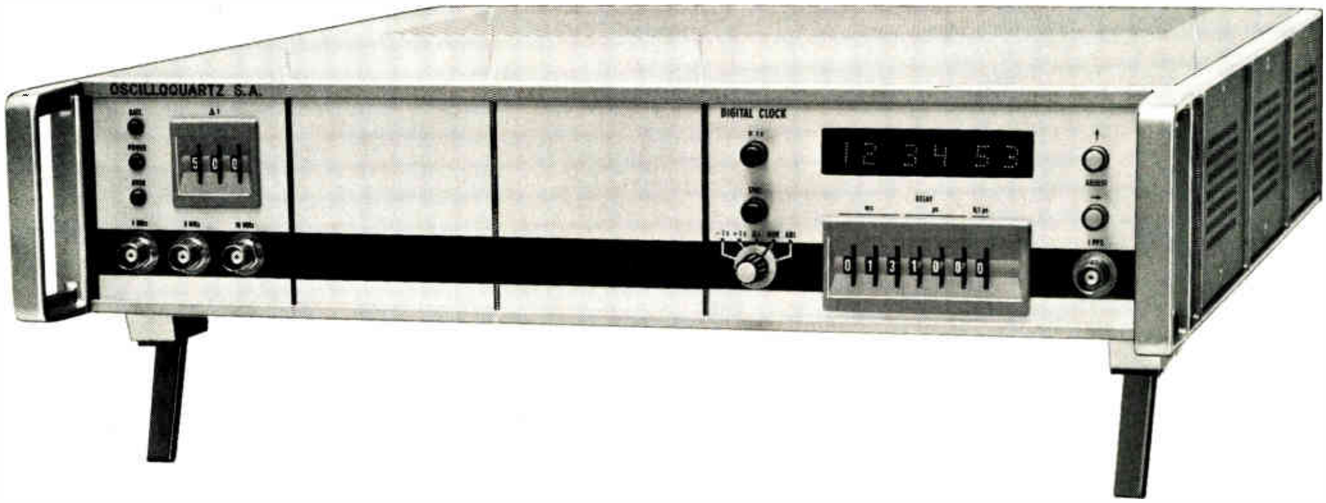


## First, it is a frequency standard with the highest short- and longterm stability.

## Second, it is a quartz clock with built-in interval meter for time comparison.

Long term stability $< 1 \cdot 10^{-10}$/day
Short term stability $< \sigma 1 \cdot 10^{-12}, \tau = 1$ s
Digital frequency adjustment
Time setting accuracy 0.1 $\mu$s
Built-in time comparator $\Delta t$
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Options: frequency divider and multiplier
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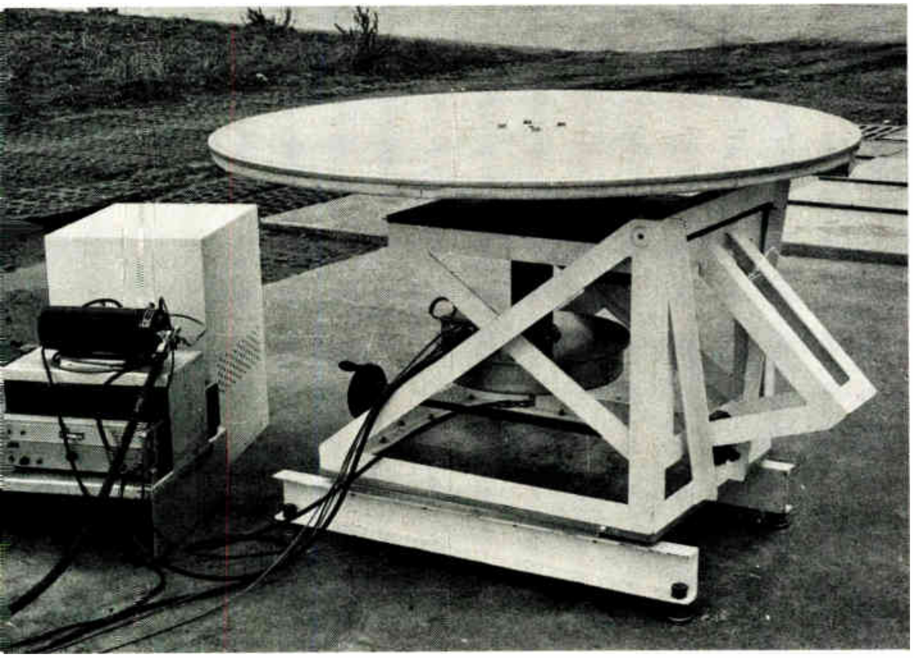


**Guidance.** Signals from spinning Astrolabe antenna are converted to heading and elevation by computer aboard aircraft.

# French develop simple microwave landing system

Aircraft computers give heading and elevation by correlating signals from a spinning antenna

**Microwave landing systems** will bring all-weather flying within reach of most airlines and most airports over the next decade. But as international civil-aviation authorities prepare to give the go ahead for a standard technique to an American-built scanning-beam design, a French research laboratory is completing flight tests of another technology that promises to make existing MLS systems obsolete before they go into service.

The system, called Astrolabe, sends out signals through a single spinning antenna. To obtain both bearing and elevation, a computer aboard each aircraft matches the incoming signals, which are keyed to a time scale, with one of every possible combination of signals that could be received in an approach to the airport. These combinations are stored in the computer's memory.

The French technology, developed by the Office National d'Etudes et de Recherches Aérospatiales, has probably come too late to compete seriously for the huge MLS-systems market that will be opening up in the next few years. Instead, Onera plans to optimize the versatility of Astrolabe by applying it to airport surveillance, head-up displays, and to independent landing monitors—all big markets in their own right.

Onera claims its Astrolabe technique has big advantages over today's instrument landing systems and even other types of MLS. First, Astrolabe can be used to build up a fully compatible navigation and surveillance system covering MLS functions in zero visibility, on-board airfield visualization for both short- and vertical-takeoff aircraft, and over-all airfield control. Other MLS techniques can only direct landings in limited visibility.

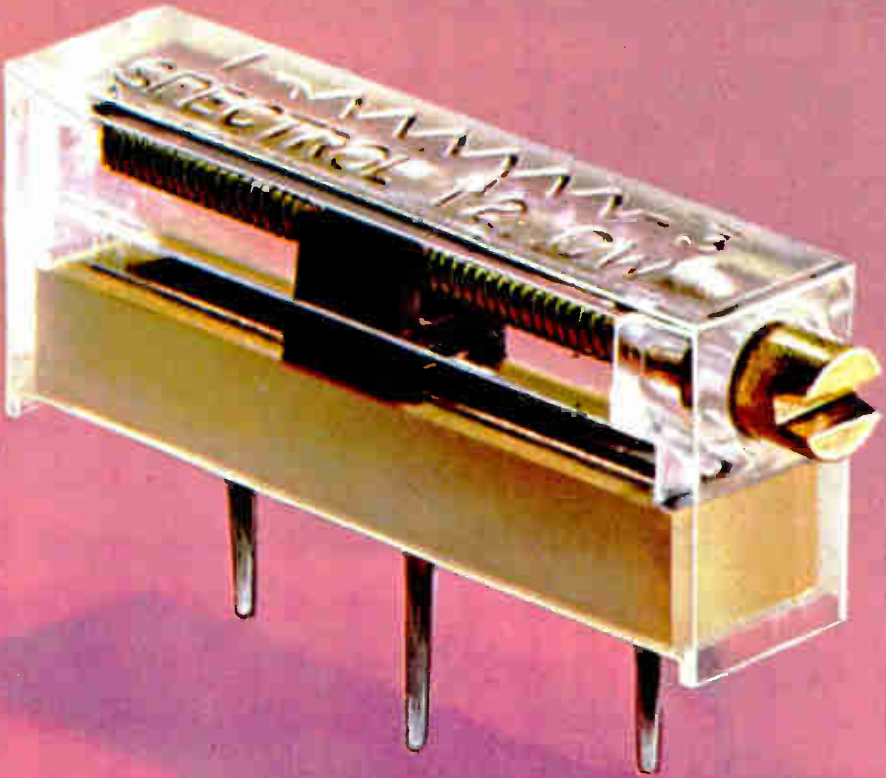
**Safety.** Onera also claims its technique eliminates accident risks caused by ground-parasite interference—a problem that MLS technology has reduced but has not avoided entirely. What's more, a single Astrolabe installation can control a large number of aircraft simultaneously, but the antenna is small and simple enough to reduce costs to a fraction of the price of rival systems requiring antennas as large as 100 feet diameter.

Onera's Astrolabe looks much like existing doppler very-high-frequency omnidirectional radio-range (doppler VOR) equipment, which finds an aircraft's bearing by measurement of the variation in frequency between transmitter and receiver. But there are big differences. Conventional systems need two antennas to pinpoint bearing and elevation. Astrolabe makes fuller use of the varying-frequency signal to calculate elevation.

Onera project leaders Jacques Dorey and Gerard Garnier found that they could calculate elevation by applying a time scale to the constantly repeated pattern of signals derived from the relationship between the aircraft's position and the signals received from the spinning antenna. Key to their analysis is that the signal is zero whenever the aircraft is directly above the antenna or at ground level. Elevation is calculated by measuring the time needed to complete the repeating frequency pattern.

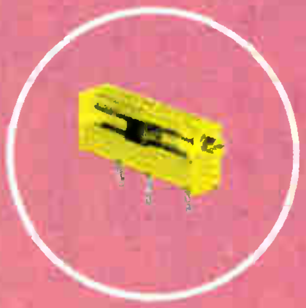
**Accuracy.** That technique gives the accuracy, within 0.2°, that MLS, ILM and similar navigation aids de-

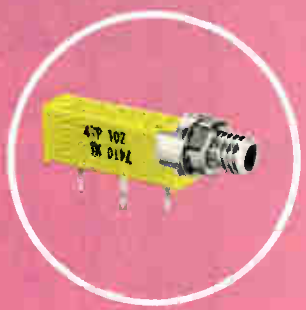
# The naked truth about our new Model 47 Trimmer




- Standard enclosure, panel mount, and clear housing versions with P and W grids available.
- Leadscrew heights and pin patterns directly interchangeable with the 3007, the 3800, and the 2600.
- Clear *housing* option, for visual observation of slider position, provides a complete housing not just a transparent lid.
- Superior Spectrol design includes unique "T" slider block, multi-finger contact, and optional full-immersion capability.
- Low cost.

For more information or a price and delivery quote, contact your nearest Spectrol factory or authorized representative.





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Circle 205 on reader service card

mand. But there is still no guarantee that the aircraft is heading down the right glide path. An airfield hangar or even a hut can deflect the radio signal to such an extent that a bearing or elevation reading may be hundreds of yards off.

Onera's team has devised what it claims is a foolproof answer. Instead of positioning an aircraft through reference to bearing and elevation readings directly from the navigation equipment, Astrolabe uses computerized correlation techniques to verify the readings. Incoming signals from the ground-located antenna are fed into an on-board computer, which then compares them with a memory packed with every possible combination of bearing and elevation signals that could be found in the approach to the airport. When the signals match a pattern in the memory, the position is pinpointed on a display, and, even if parasitic signals do by chance strike a pattern in the memory, they cannot be confused with the true position.

**Testing.** Onera's development team is now testing prototype antennas and correlating data by recording the signals on magnetic tape and then running them through ground-based computers. Full-scale prototype on-board systems still require more money than Onera has to spend, but during the next year, the laboratory plans to move ahead on two fronts.

The French engineers hope that the National Aeronautic and Space Administration in the United States will test-fly the equipment to evaluate its potential for use in navigation systems. In France, Onera itself will make an all-out attempt to produce a modified system especially adapted to helicopter and VTOL landing pads, either on offshore platforms or land.

The conversion from MLS to independent landing monitor is simple enough. The ground-based antenna is replaced by an airborne unit carried under the aircraft. The antenna then operates in the normal Astrolabe manner to zero in on a series of radio beacons placed around the landing pad. The on-board display shows an outline of the landing pad or airfield and the aircraft's position in relation to it.

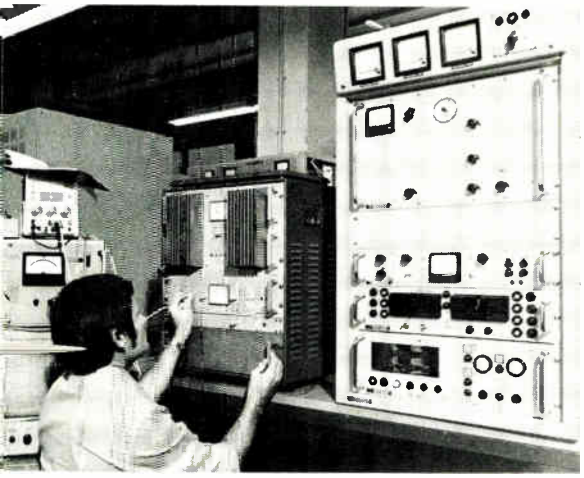
If Onera can get a foot in the door of this market—and negotiations are under way with a French navigation-aids manufacturer already—Dorey hopes that Astrolabe will be well placed in the international competition for a standard zero-visibility ILM system due to get under way in the next five years. □

## West Germany

# Despite economy lag, AEG-Telefunken sales soar for communications gear

Although many of West Germany's electronics industries are plagued by a scarcity of reorders, dwindling profits, and underutilized plant capacity, one manufacturer is reporting substantial success in at least one sector—communications. Juergen Stelter, in charge of high-frequency engineering activities at AEG-Telefunken's Communications division, claims that worldwide sales of communications equipment shot up by 24% last year to nearly $500 million in 1974.

For 1975 also, prospects are good for the manufacturer's communications business, despite a big shortfall of orders from the German Post Office, the largest single customer for such equipment. An 8% to 10% increase is predicted for this year, and with exports expected to increase by more than 30%, foreign business in communications equipment is likely to account for better than one fifth of total equipment sales, division managers say. Another indicator showing heartening strength is the backlog of orders, said to be big enough to keep the di-



**Reduction.** AEG-Telefunken's ultrashort-wave transmitter (left), is smaller, lighter, and less power-hungry than predecessor.

vision's 15,300 employees busy for about a year.

Probably the most important factor for its success in communications is that AEG-Telefunken is West Germany's only firm offering a wide range of equipment—from simple radiotelephone sets to high-power short-wave transmitters. Because of this product diversity, strengthening orders for some systems have balanced out declining orders for others. What's more, the division participates extensively in markets where national demand is covered primarily by domestic industries. By exporting knowhow and direct engagement in such markets, rather than products, the company has gained several strong footholds abroad, notably in Brazil, Canada, and Spain.

**Reputation.** Still another reason for AEG-Telefunken's good performance in communications is said to be its reputation in domestic projects, which has led to orders from abroad. One successful product is its 500-kilowatt short-wave transmitter. After installing nine of them for the Deutsche Welle, an organization roughly equivalent to the Voice of America, the firm recently received orders for similar transmitters from Radio Vaticana and the South African Broadcasting Co.

AEG-Telefunken is also a heavy contender in world markets for receiver/direction finder systems for radio-monitoring purposes. For instance, the Nigerian Ministry of Communications has ordered a radio-monitoring network of up to four fixed and three mobile stations. With understandable pride, Stelter also cites the installation of direction-finder systems on ships from Great Britain, itself "a country with considerable expertise in the radio-navigation field."

Another big export item is a digital radio system developed jointly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with the German Bundesbahn and introduced about two years ago to enhance safety in rail operations. The system has meanwhile been adopted for use by railways in Austria, Indonesia, and Yugoslavia.

**Intelsat.** The company has been successful in space communications, as well. As with the Intelsat communications satellites, AEG-Telefunken is once again the only German company participating in Intelsat IV-A follow-up satellite projects. Under contract to the Hughes Aircraft Co. in Los Angeles, the German firm has produced and delivered the command receivers and radio-beacon transmitters in the two Intelsat IV-A satellites, as well as a number of associated circular-waveguide input and output filters. The contract has recently been extended to include delivery of components for three additional IV-A satellites and is now worth a total of $1.63 million.

One of AEG-Telefunken's latest developments in space communications is a 1-kilowatt amplifier for use in satellite ground stations. Developed under contract from Germany's space-research organization, the water-cooled system operates in the 11.7-to-12.5-gigahertz range. It consists of a 60-watt helix-delay-line traveling-wave tube that serves as a preamplifier and another TWT serving as the output stage. The latter TWT's delay line is made up of coupled-cavity resonators with about 13 decibels of amplification and 1 kW of saturation output power.

The momentary bandwidth is 800 MHz, and the tuning bandwidth covers more than one 1.1 GHz. This new twin-TWT combination from AEG-Telefunken is priced lower than single-tube high-power TWTs and also has considerable less than one half the fluctuation in its gain characteristic curve at an amplification of 55 dB. □

## Productronica offers production tips and ways to improve component quality

Launching an electronics show when companies are as budget-conscious as now does not seem to make economic sense. But the production technology Productronica is offering may well help them save some money.

The show, in Munich Sept. 16 to 20, aims to demonstrate how productivity and component quality can be improved and to show what companies can do to offset rising costs for labor and material. Economy is increasing in importance since the trend to set up production facilities offshore began to reverse.

Productronica owes its birth to the success of Electronica, the exhibition held in Munich every two years. So big has this event become since it was started in 1964 that its organizers decided to limit Electronica to components and have a separate fair—Productronica—for production and test equipment in odd years. Electronica will be staged in even years as before.

**Potential.** Productronica caters to an equipment market that's expected to reach $3 billion in Western Europe this year. In West Germany alone, industry officials predict the hardware market to top the $1 billion level in 1975. On top of that, about $2.7 billion worth of materials, semifinished products, and components are consumed in production of electronic equipment in West Germany.

How successful Productronica will be, its organizers of course cannot say now. However, judging from the number of firms on hand, the show is getting a good start and "promises to be a well-attended one," says Heinrich Hofer, a fair official. More than 120 firms from 12 countries in East and West are showing their wares at the Bavarian capital, and four giant buildings at the city's sprawling fair grounds are being used.

Productronica is based on a new concept. "It's different from other exhibitions in that, not only is stand-alone equipment displayed, but also complete manufacturing lines are operating under actual conditions," Hofer points out. And some such lines use machinery supplied by several firms.

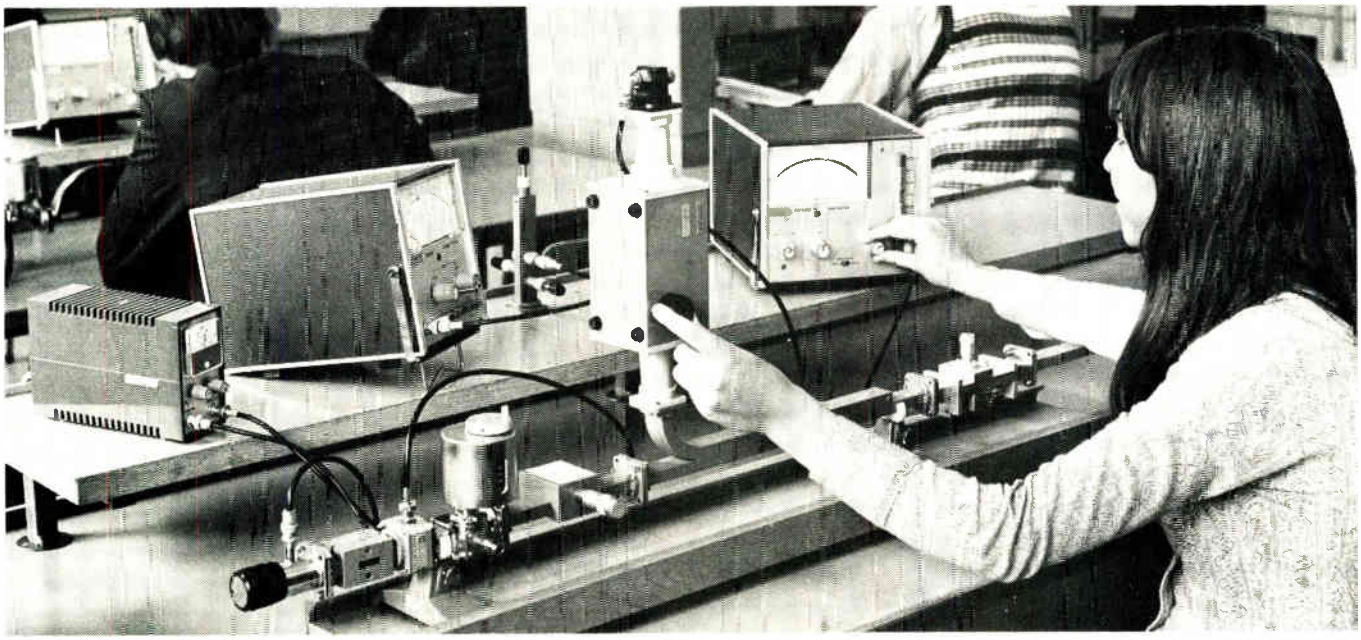
**Production.** One manufacturing setup that demonstrates production of thin-film hybrid circuits from beginning to end starts with a new vacuum-coating system from Balzers AG, the big production-equipment maker in the tiny principality of Lichtenstein. In that system, designated BAK 551, ceramic substrates are coated by flash evaporation with a nickel/chromium alloy to form the resistor film and with gold from which the conductors are made.

With equipment from other firms, the coated substrates are treated in photolithographic and selective etching processes to get the desired resistance values and the required dimensions for the conductors. Finally, using machinery from still other companies, diodes, transistors, and capacitors are bonded onto the hybrid circuits.

West Germany's Rohde & Schwarz has shifted complete test facilities from its factory into a fair hall to demonstrate testing of circuit modules. One facility shows batch testing of analog integrated circuits and complex analog printed-circuit boards and modules by the company's new automatic linear tester, ICL.

**Testing.** A punched tape carries the test program for the ICL, and results are shown in a visual go/no-go display or processed into a test report produced by a printer connected to the tester. Together with accessories like sine generators and instruments for extremely small currents, the ICL can test nearly all analog circuits on the market today, R&S says. The ICL can also be combined with the firm's automatic logic tester, ICF, to form a setup that can check digital circuitry as well.

A precision mask aligner from the Munich firm Karl Süss KG is used in high-grade thin-film technology. The



# Microwave training facts & visions

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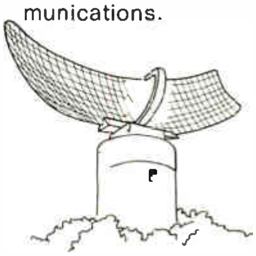
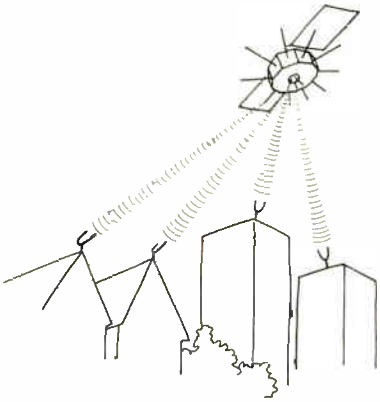
Traditionally microwaves have been associated with radar and communications.



For instance a weather radar station, which is capable of "seeing" weather conditions some 200 km away.
Today microwave systems are being designed for totally new application areas and will be used by a wider public. One example is the microwave oven, which within a short period of time has reached large number of people.
Another, more visionary idea, which is already under evaluation, is direct-distributed TV programs from satellites. With this system, many TV programs can be broadcast from an earth satellite direct to the receivers without the need for costly relay stations. Each house is then equipped with a microwave antenna and a microwave circuitry.



Another common application is velocity measurements for vechicle safety systems.
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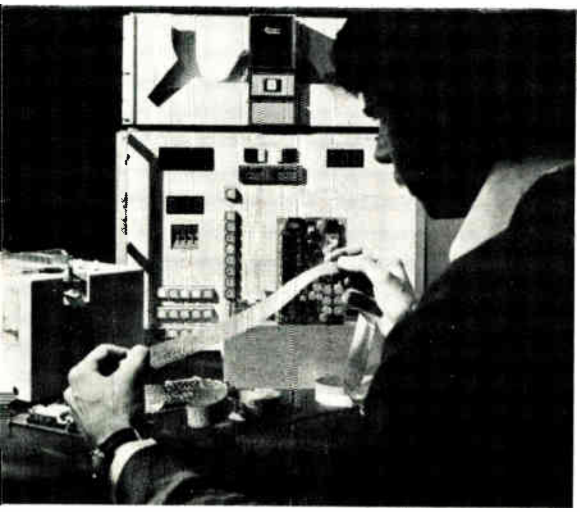
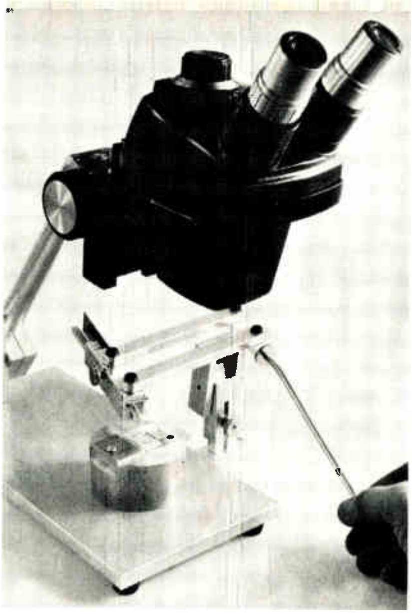




**Exhibits.** Shown at Productronica are micro-manipulator (above) from ts-electronic GmbH and Rohde & Schwarz's ICL for batch-testing analog ICs and pc boards.

accuracy of the MJB45-S, which aligns masks on substrates up to 5 by 5 inches in size, is within ±15 micrometers. The equipment succeeds the company's MJB4, an aligner designed for 4-by-4-in. substrates.

With the new MJB45-S, Süss says, proximity conditions between 50 and 200 μm are achieved by a novel optical system consisting of an elliptical reflector, high-precision deflection mirrors, a multilens condensor setup, and facette optics. The equipment also has a new split-field microscope with dark-field illumination for optimum viewing of the substrate surface. The dark-field optics can be replaced by bright-field optics. Magnification is from 40× to 150×, depending on objectives.

**Manipulation.** The manipulator's movement range is 120 by 120 millimeters, and X and Y movements are indexed separately. The uniformity of the ultraviolet illumination is within ±3%. By simply changing the transport plates, different substrate sizes can be accommodated, Süss says.

Also at Productronica is equipment for laboratory work and small production runs. One such system is a three-dimensional micro-manipulator from Munich-based ts-electronic GmbH. Intended for hybrid-circuit work, the machine consists of a ground plate with microscope support and a lever arrangement that can hold a number of quick-changeable tools that follow the operator's hand with a reduction ratio of one to five. Without a microscope, the precision manipulator sells for less than $250, ts-electronic says. The instruments are priced from $50 to $400 each. □

## Great Britain

# British Post Office to field-test fiber-optic telephone transmission

Field trials begin soon for two types of fiber-optic telephone links the British Post Office has developed and successfully tested in the laboratory. However, much development and engineering work is still needed to ensure the links' reliability and maintainability before they become part of the telephone network. The fiber-optics must also prove to be more economical than conventional coaxial cable.

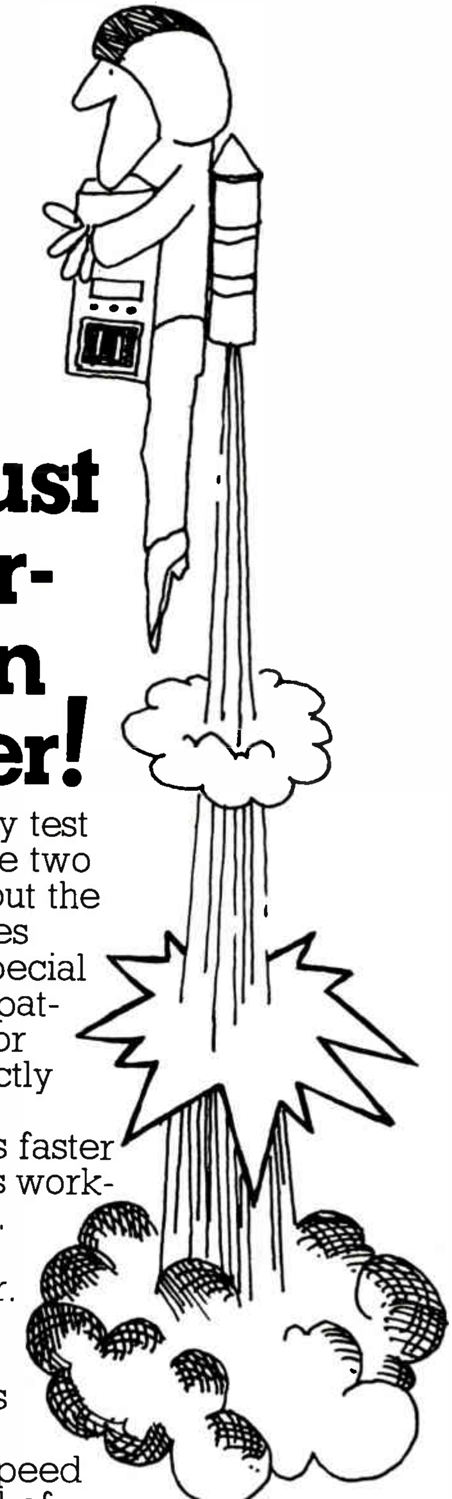
Nevertheless, BPO researchers say they are well on the way to designing fiber-optic systems that can be installed and maintained by typical telephone-line crews. "Some systems look pretty good in the laboratory, but we're engineering ours for the wet, dirty conditions in the manholes," says R.W. Berry, group head in the Optical Communications division, Post Office Research department in Martlesham Heath, Suffolk. Part of the effort is designing the fiber-optic components to fit into existing enclosures for coaxial cables, and developing splicers and joiners to install the fiber-optic cable in the field.

A system intended for medium-length hops operates at 8.48 megabits per second, and a system for long-distance trunks operates at 139.264 Mb/s, which, for convenience, is rounded off to 140 Mb/s. Both systems are composed of the light source, coupler, optical fiber, another coupler, the photodiode to convert the light to electrical signals, and the associated amplifier and processing circuitry. In repeaters spaced at intervals along the underground links, lasers must be pulsed to regenerate the signals and keep them going to the next repeaters or terminal points.

**Disclosure.** Details of the systems are being made public for the first time this month at the International Conference on Optical Fibre Communication at the Institution of Electrical Engineers in London. And if the BPO should ask for bids, some UK companies may be ready to produce most of the hardware. For instance, at the same IEE conference, researchers from Plessey Telecommunications Research Ltd. are describing an 8.48-Mb/s system they also have built in the laboratory.

The BPO's 8.48-Mb/s system contains several off-the-shelf components, including a Plessey high-radiance light-emitting diode, and a silicon avalanche photodiode from EMI Ltd. The 140-Mb/s system contains an experimental continuous-wave infrared laser made by ITT's Standard Telecommunication Laboratories Ltd. The gallium-aluminum-arsenide double-heterojunction laser has peak power of 10 milliwatts.

**Problems.** Choosing an optical-fiber supplier remains a problem, Berry says. The BPO would like to patronize a British manufacturer, but none is yet making commercial







fibers with low enough attenuation. As a possible remedy, the BPO plans to seek bids in 1976 to try to induce a British company to make the fibers. In the meantime, the researchers are using a fiber from Corning Glass Works in the U.S. that provides attenuation of 5 dB per kilometer on the 8.48-Mb/s system and a BPO-produced fiber with 16 dB of attenuation per kilometer for the 140-Mb/s system. But likely manufacturers in the UK include British Insulated Callender's Cables Ltd., Pilkington Brothers, Southampton University, and STL.

To minimize transmission losses at the critical connecting points the BPO researchers have designed a screwable coupler using aspheric optical plastic lenses to cut down distortion. The coupler actually is two half-couplers, each with lenses 5 and 7 millimeters in diameter that screw together for a precise fit. The 5-mm lens is built so that it's easy to adjust the LED, which is positioned at the focal point of the lens, explains Berry.

R.C. Hooper, BPO executive engineer, says repeater modules, terminal equipment, power units, and synchronization drives will be added to both systems for further laboratory tests. For field trials, the BPO will add normal supervisory circuitry, too. The researchers have had to replace the conventional silicon field-effect-transistor amplifier in the regenerator used in the 8.48-Mb/s system with a bipolar transistor to get the desired performance, he explains.

The 8.48-Mb/s system has been operated in the laboratory over a 4-kilometer link through multimode fiber that has attenuation of approximately 5 dB/km. The length of a field trial would be increased to 6 km, which would give an acceptable 30-dB loss for the hop at a bandwidth of 6 to 7 MHz, Berry says.

The 140-Mb/s system would need a combination of laser power and optical-fiber characteristics to provide a bandwidth of about 3 to 500 MHz per kilometer. This combination would give the required 100-MHz bandwidth needed for an 8-km

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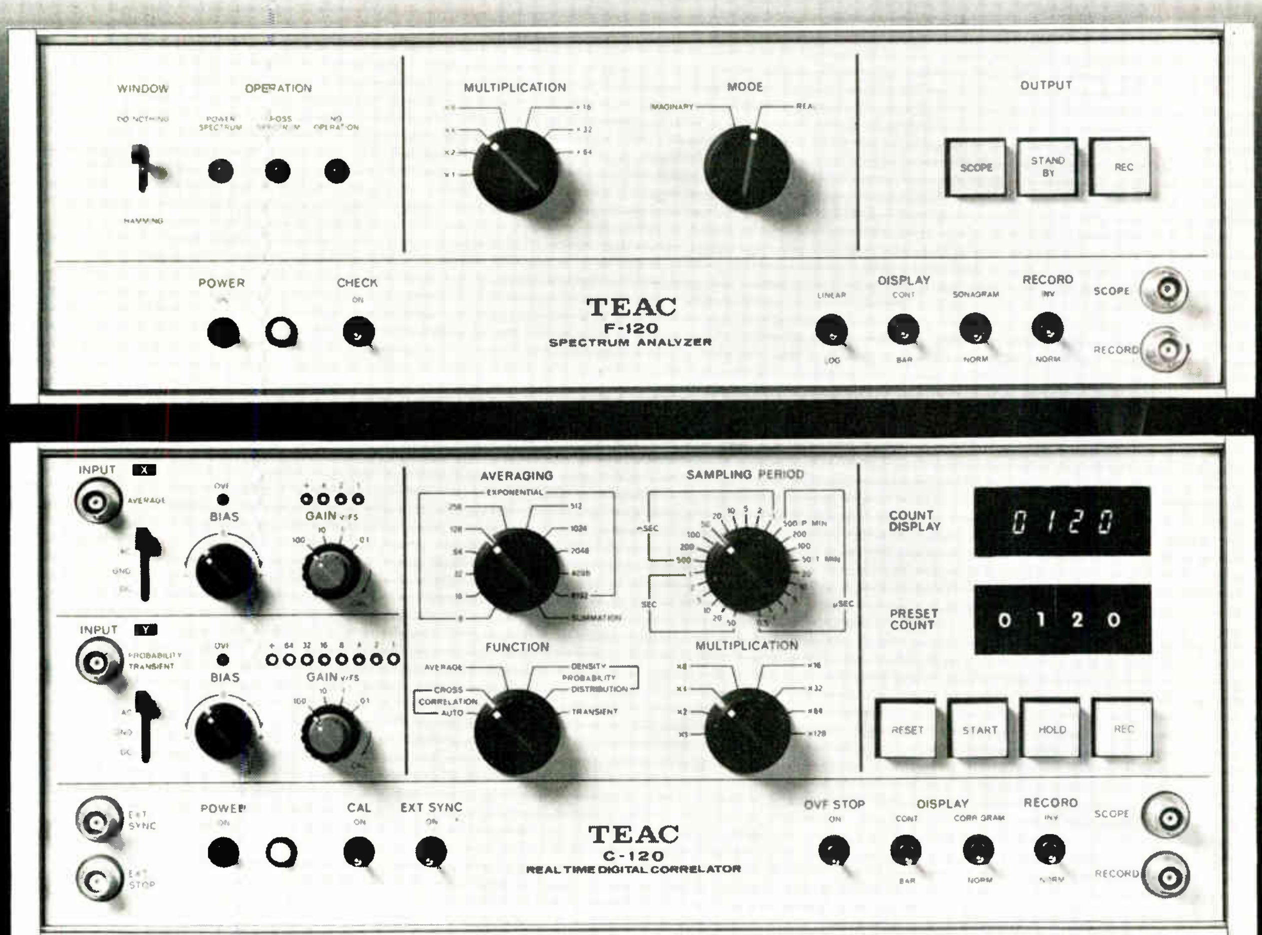


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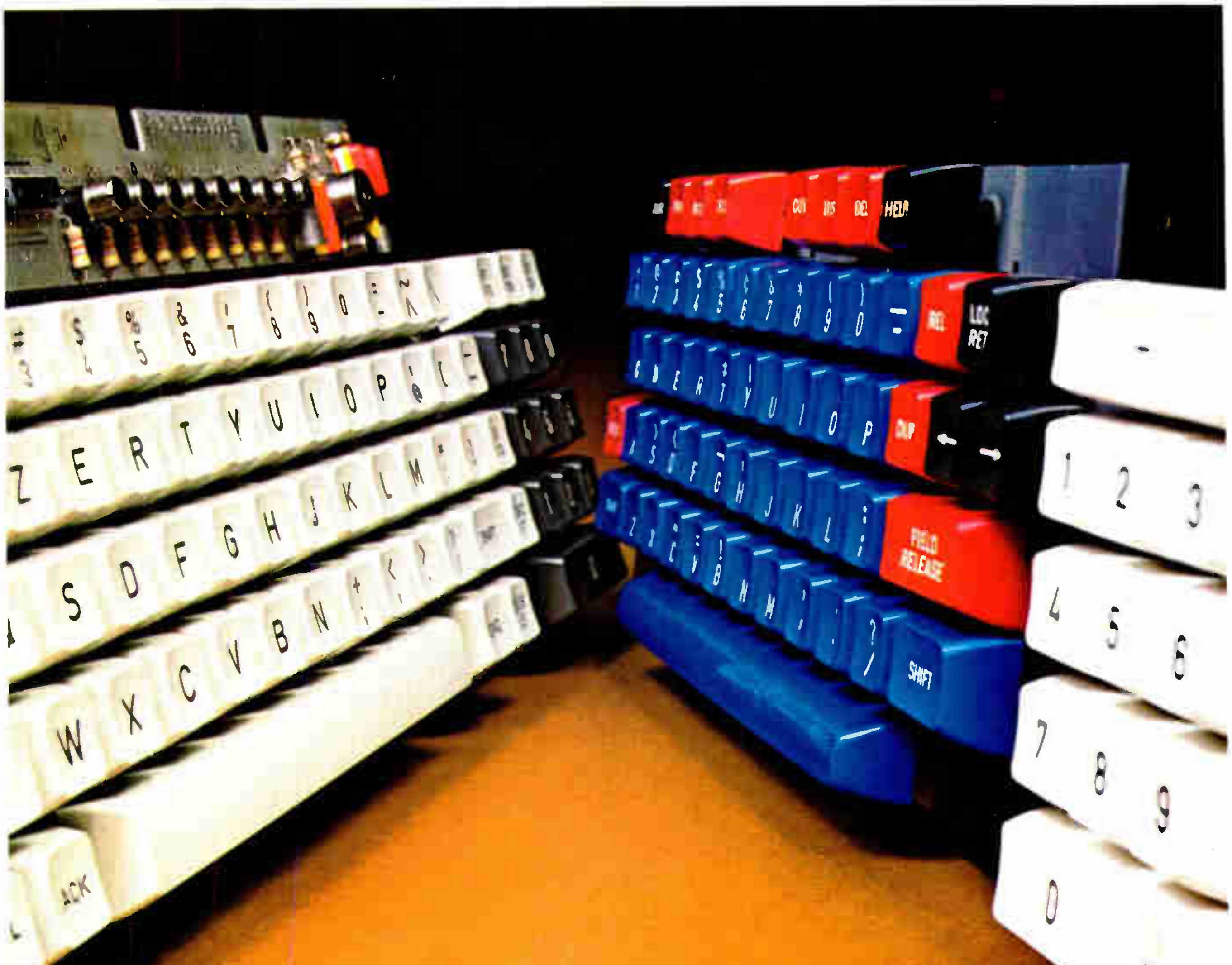
gating and clock logic. The NL 740 analog delay module, which can delay signals from 125 μs to 1 second, contains an alpha-to-delta converter, an MOS shift-register memory, clock logic, and a digital-to-analog converter at the output.

As its name implies, the Digitimer averager separates the signal from the noise by sampling as many as 256 repetitions of the signal and dividing each repetition into 256 points. An analog-to-digital converter converts each point of a signal waveform into an 8-digit number and stores those waveform points serially in the memory. When a corresponding point of the next waveform comes in, the averager adds the value for that point to the value of the preceding waveform and stores the sum into memory for averaging.

**Operation.** To operate, the averager needs two input signals—the signal to be averaged ±1 volt and a triggering signal, which can come from any of several sources. An input could be a stimulus, such as a neurological test or an electrical spark in engine combustion that originates the waveform to be averaged. Another source could be a threshold detector that picks up signals at specified amplitudes.

The operator may either use the averager's internal clock to average signals between 2.5 ms and 10 seconds in duration or plug in his own external oscillator and record signals within that period. Moreover, he can average a signal within the effective duration and play it back in the 10-second maximum interval on a chart recorder.

The alternative to using a signal averager "where there is a lot of random information," says Newman, is to "record the whole lot and do the sums on it or use a computer. But averaging is the low-cost way to do it." The delay modules aid flexibility because "sometimes, you only know you have useful information after it has happened. You may be halfway through it," he explains. The delay modules enable the operator to decide whether or not he wants a signal before it is lost. □

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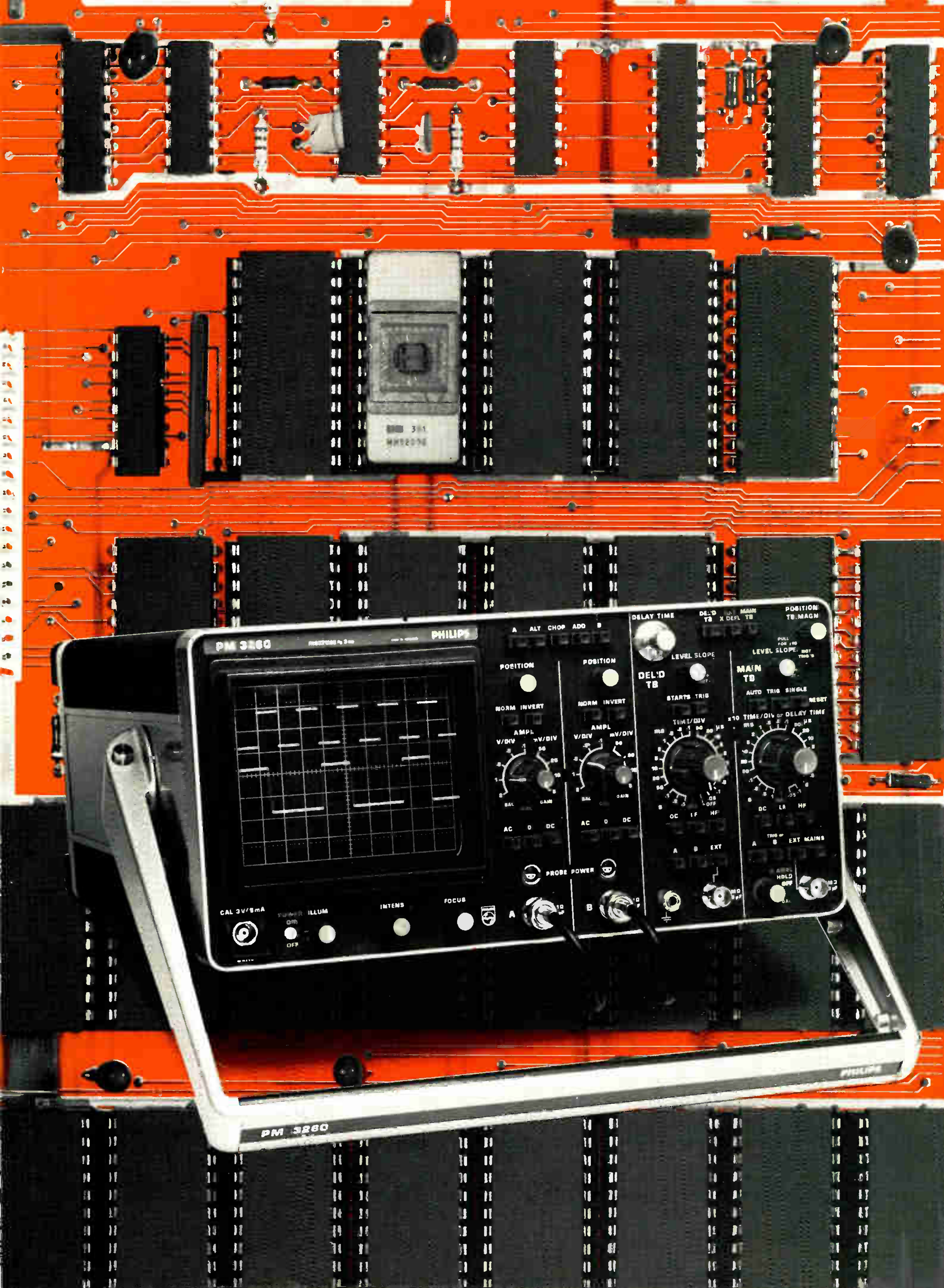
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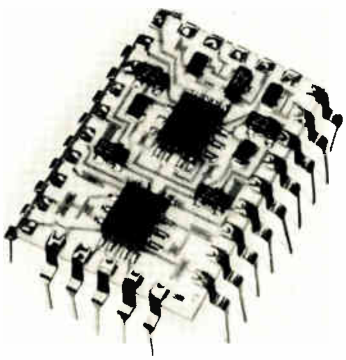

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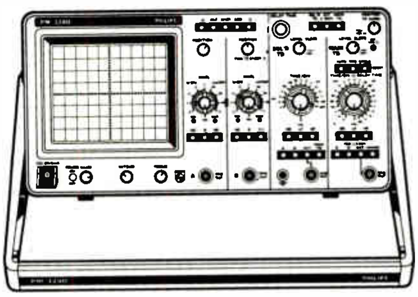
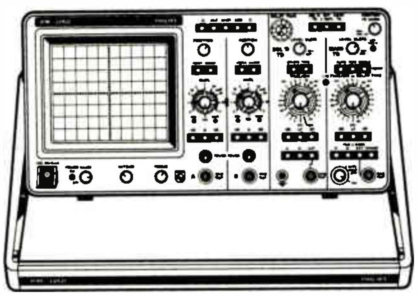


*PM 3240 : 50 MHz/5 mV; 8.4 kg; bright 8 x 10 cm display.*



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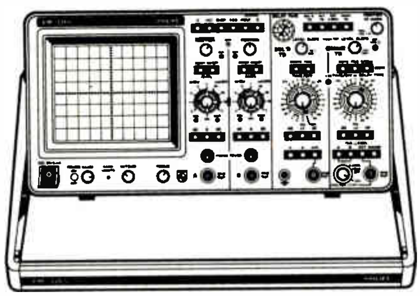

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Rifa of Sweden has introduced a new driver, type PBD 3511, expressly designed to interface 5 V DTL/TTL logic into high current, noisy or inductive loads,

e.g. relays, electromagnetic valves and solenoids.

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The 3511 will filter transient signals between the load and the logic. It also has an exceptionally short switch-off time – typically 200 – 500 microseconds.
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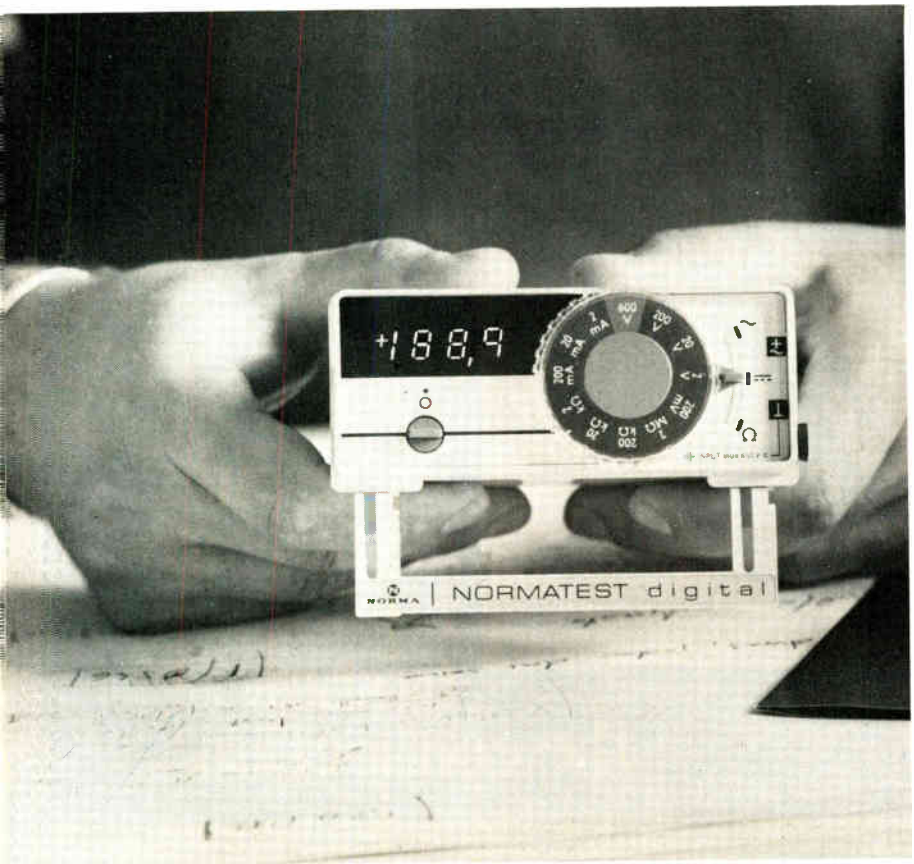
Circle 216 on reader service card




**Easy to use.** Oversize rotary range switch and sliding-arc function selector make for convenient "quasi single-control" instrument operation.

# Digital multimeter covers range from 40 Hz to 40 kHz

*by John Gosch, Frankfurt bureau manager*

Rugged 3½-digit instrument from Austrian firm built for jobs in field service, laboratories and workshops

**It's next to impossible** to design a digital multimeter that will be all things to all users. But Norma Messtechnik GmbH of Vienna approaches that ideal with its Normatest Digital.

Described as "Europe's smallest DMM of its kind," the 3½-digit instrument has features that are expected to appeal to users in the field, in laboratories, and in workshops. Among these are a multitude of ranges, high resolution, high accuracy coupled with long-term stability, and a wide frequency range. Other features are high overload capacity, an overrange indication of 50% in all ranges, and up to ±3,000 counts.

The instrument, with a seven-segment light-emitting-diode display, has 21 ranges—10 for ac and dc voltages from 200 millivolts to 600 volts, seven for ac and dc currents from 20 nanoamperes to 200 milliamperes, and four for resistance measurements from 2 kilohms to 2 megohms. Resolution in the most sensitive voltage range is 100 microvolts.

The multimeter's wide nominal frequency range of 40 hertz to 40 kilohertz more than covers the audio frequencies. Within this range, ac voltage measurements up to 300 V can be made with an accuracy to within ±0.5% of reading, ±0.5% full scale. This accuracy is guaranteed for one year, during which calibrations are not required. The extended range goes up to 100 kHz.

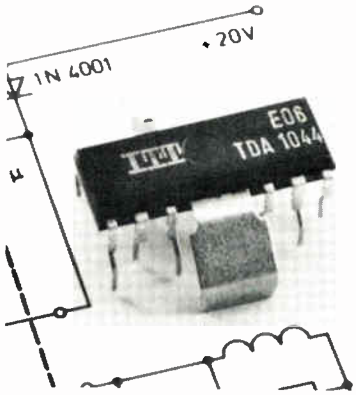
All voltage ranges are protected for up to 600 V rms or 900 V peak, and the resistance ranges can withstand a continuously applied 250 V rms, which makes the Normatest Digital a foolproof instrument, says its designer, Adolf Schendl. An overrange up to 2,999 is indicated by blinking of all digits on the display. Under such a condition, the figure 2,000 must be added numerically (that is, without regard to decimal point) to the indicated value to obtain the correct result. For example, a blinking 20.0 corresponds to 220.0 V.

The instrument's analog-to-digital converter is based on integrating charge-balancing principles, which intrinsically suppresses 50-Hz voltages superimposed on the measured signal.

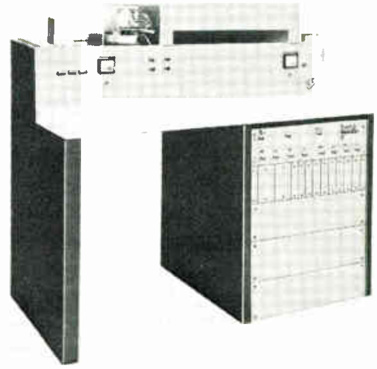
"In designing the instrument," Schendl says, "we aimed for an optimum synthesis of a pocket-size portable model suitable for field jobs and a table-top instrument for stationary use." The result is a piece of equipment that fits into a coat pocket, yet is big enough so as not to get lost among test cables on the workbench.

The Normatest Digital comes in

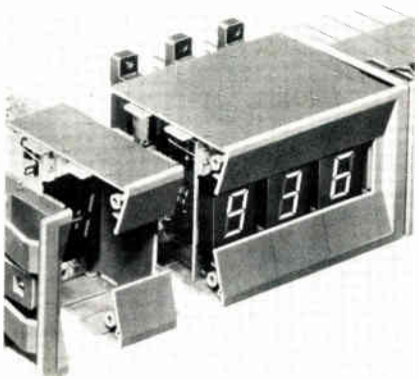
## New products international




The TDA1044 is a bipolar integrated circuit for vertical deflection in TV receivers. S-shaping of sawtooth wave is handled internally so that no external RC components are needed for that purpose. ITT International GmbH, 78 Freiburg, P.O. Box 840, West Germany [456]

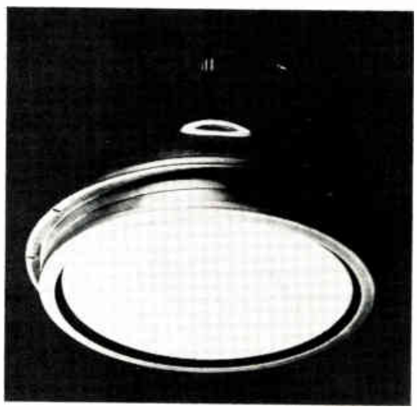


Automatic photoresist coater 2301.1 coats photoresist film on cleaned and dried wafers from 37 to 62 millimeters in diameter and up to 0.4 mm thick. After preselecting the spinning program the coating process runs automatically. VEB Elektromat, 808 Dresden, Karl-Marx-Str., East Germany [459]

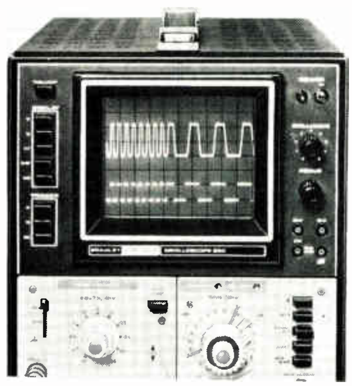



Gallium-arsenide display units, type AMG-AS, for industrial applications have red, seven-segment, 16-millimeter-high digit indicators readable from several meters away. They are driven by TTL-compatible BCD signals. Elesta AG, CH-7310 Bad Ragaz, Switzerland [457]

Electron multiplier channel B413 consists of a spiral glass tube with a slit funnel opening which is 3.5 by 15.5 millimeters in size. The unit's wall resistance is 3 × $10^9$ ohms and its amplification factor is 1.7 × $10^8$. Valvo GmbH, 2 Hamburg 1, P.O.Box 106323, West Germany [460]



Radar tube F58-100, for multi-color data representation, is about 650 millimeters in depth and has a 62° deflection angle. The usable display area on the screen is 540 mm in diameter. Colors between red and green are selectable. AEG-Telefunken, 6 Frankfurt 70, AEG-Hochhaus, West Germany [458]



A 100-megahertz oscilloscope, the Bradley 200, is a dual-channel instrument with a CRT display measuring 8 by 10 cm. For increased sensitivity, the unit has provision for cascading the vertical amplifiers. Stanley Laboratories Ltd., Luton, Beds., England [461]

# Bipolar, ready-to-go 16 bit microprocessor

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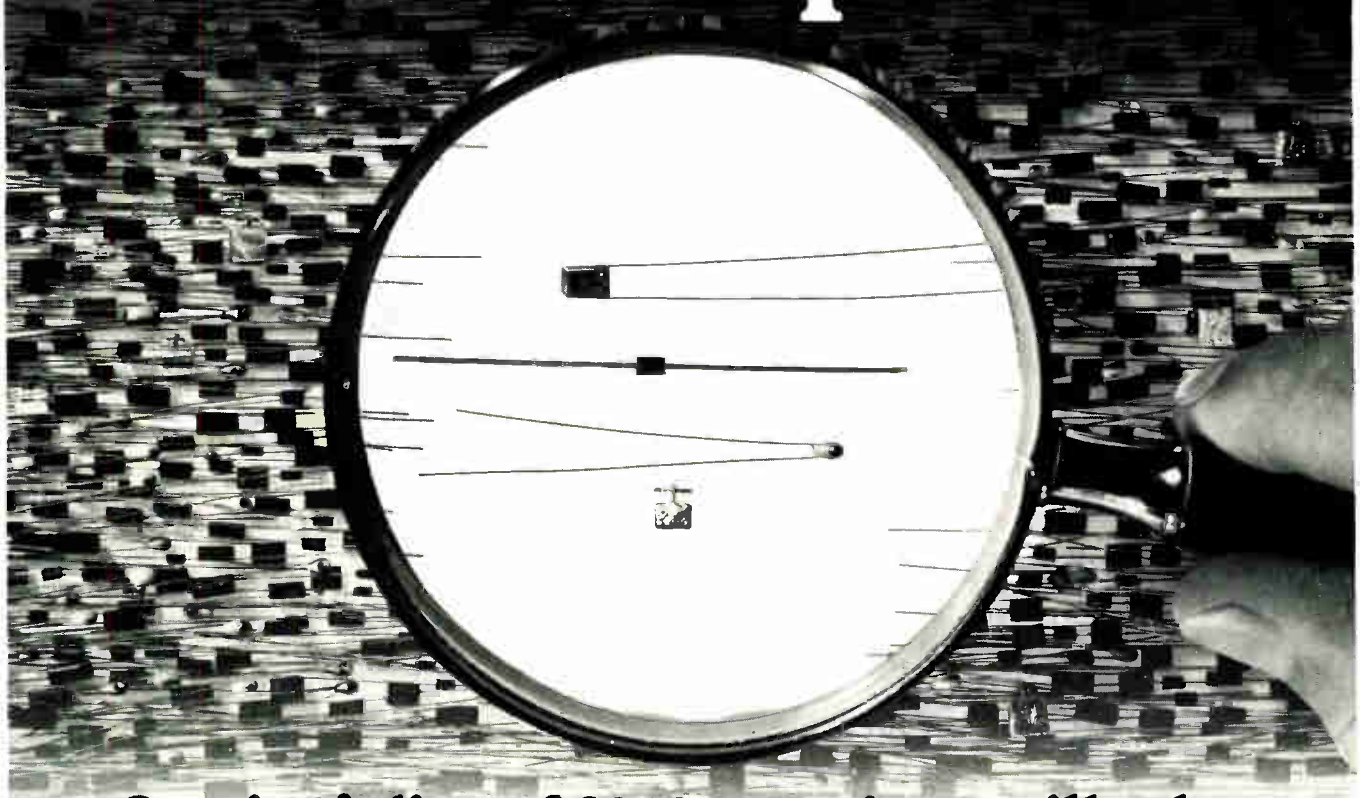
## New products international


Based on conductive elastomer technology, a combination wrist watch-calculator housing can be used with either diode or liquid-crystal displays. Up to 20 keys can be accommodated in the housing. Chomerics Europe, 66 rue de la Boetie, Paris 75008, France [462]

Variable-output laboratory power supplies are available initially in three types: GBS 30/2S (single output 0-30 V, 0-2 A), GBS 30/1D (dual output 0-30 V, 0-1 A), and GBS 30/2D (dual output 0-30 V, 0-2 A). Gresham Lion Ltd., Feltham, Middlesex, England [463]

The BG1898 silicon high-voltage cascade is designed for color TV sets with a coupled focussing control. Input pulse voltage is up to 9.1 kV peak to peak, and output dc voltage is 25 kV. Output dc current is 1.5 mA and focussing current is 300 $\mu$A. Roederstein GmbH, 83 Landshut, West Germany [464]

# Corning : test four miniature Tantalum capacitors



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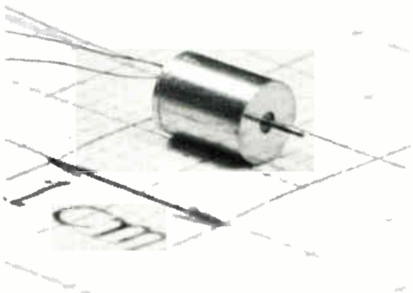
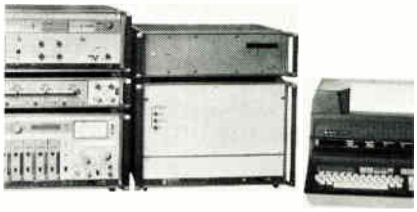
ECS


The MKS-R capacitors are noise suppression types made of metalized polyester foils. Designed mainly for TV applications, the capacitors are connected in parallel with the power supply circuitry to eliminate noise pulses. W. Westermann, 68 Mannheim 1, P.O. Box 2345, West Germany [465]



A line of five ultraminiature motors uses technology developed for analog-type electronic watches. Three are general-purpose two-pole stepping motors, one is a three-phase high-output motor, and one is a brush-type dc unit. Daini Seikosha Co. 6-31-1 Kameido, Koto-ku, Tokyo 136, Japan [466]

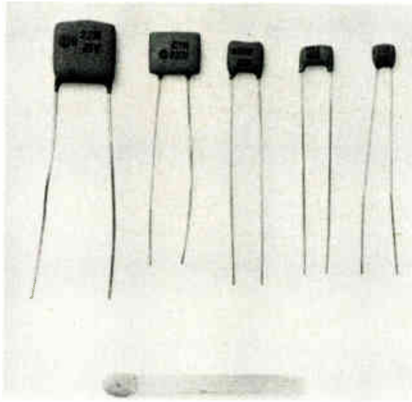


Rauschklirr-Meßautomat RA-500
Werkfoto Wandel u. Goltermann, Reutlingen

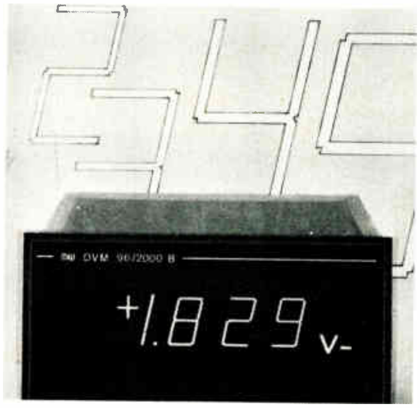
Automatic measuring setup RA-500 and accompanying filter plug-ins allow white-noise measurements on all cable, radio relay link and satellite communication systems. Upper frequency limit is 60 megahertz. Wandel & Goltermann, 7410 Reutlingen, P.O. Box 259, West Germany [467]

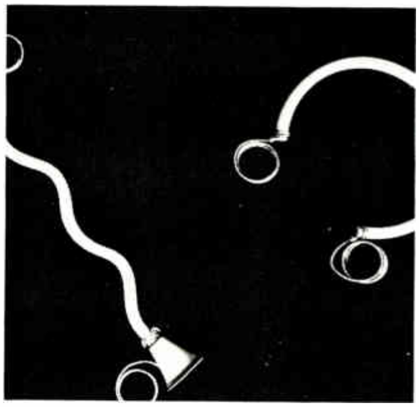
## New products international



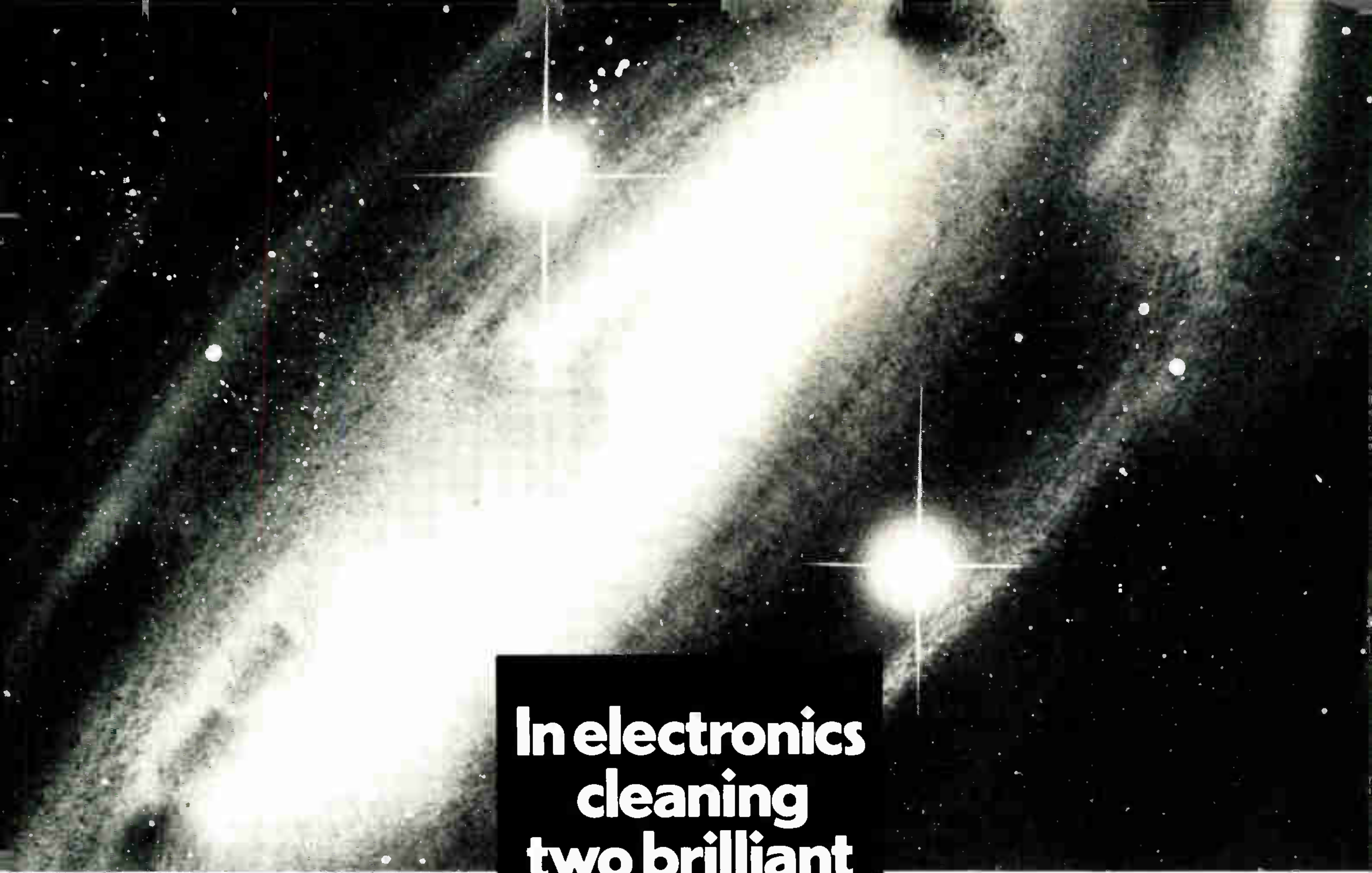
Types W61C, W62C, W63C, W64C and W65C multilayer ceramic capacitors have minimum self-inductance and high reliability. Standard are 50 V dc, 100 V dc, and 200 V, dc versions with capacitances from 10 pF to 2.7 $\mu$F. Sprague, 19 chemin F. Lehmann, 1218 Geneva, Switzerland [468]




The DVM96 is a digital multimeter using dual-slope-integration principles. It has a four-digit, seven-segment LED display and a symmetrical differential input stage. Automatic polarity and over-voltage indication are optional features. SEL, 85 Nuernberg, P.O. Box 2340, West Germany [469]



The Ceratron-E is a secondary electron multiplier for measuring electrons and ions. Amplification is $1 \times 10^8$. Unit is mechanically stable and features high efficiency, low noise and high-temperature stability. Available with and without funnel. Stettner & Co., 856 Lauf, P.O. Box 7, West Germany [470]



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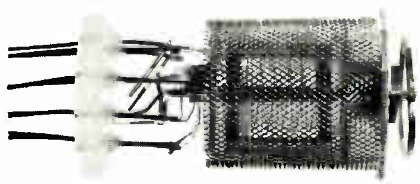

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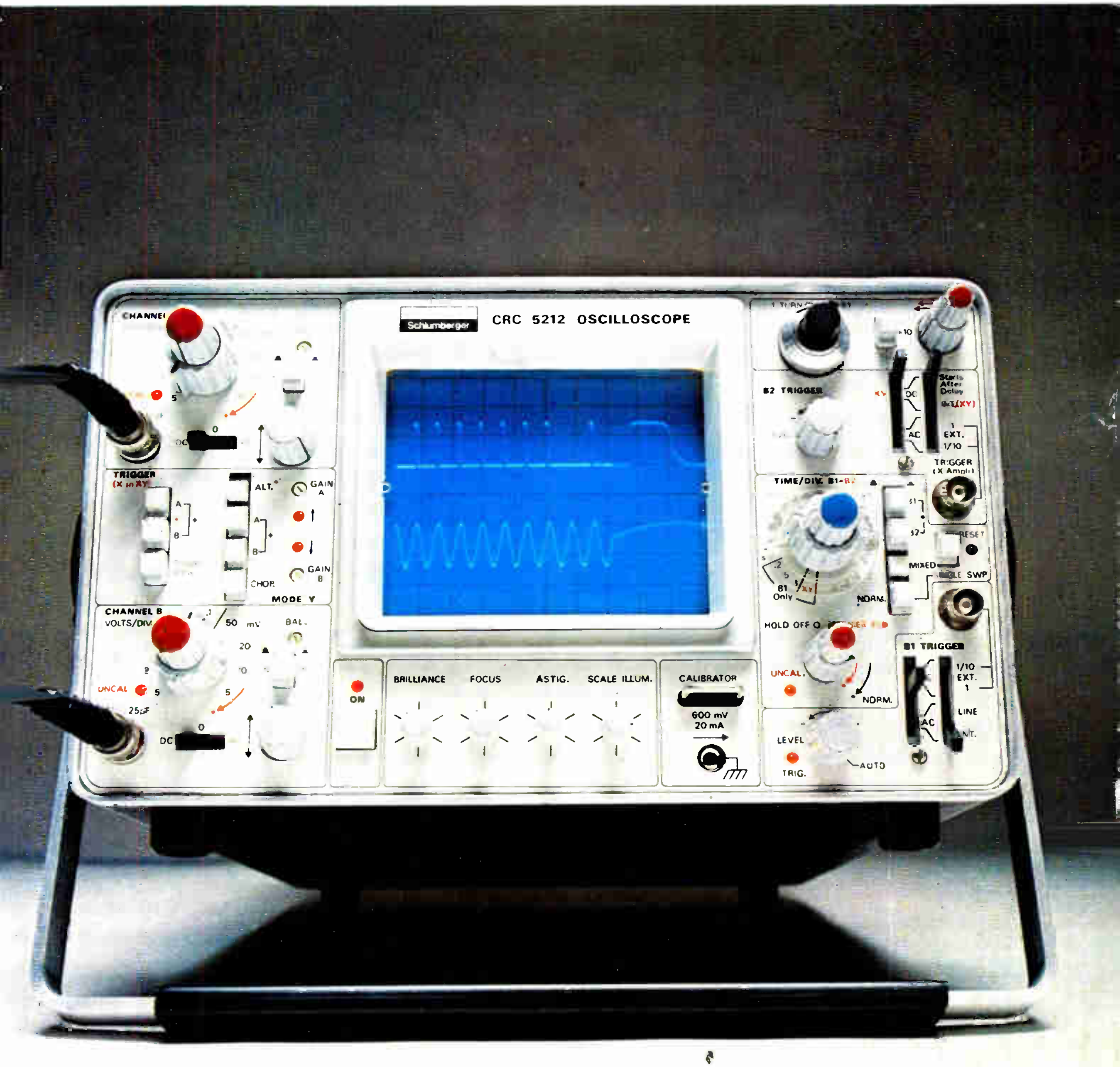
# PORTABLE OSCILLOSCOPES

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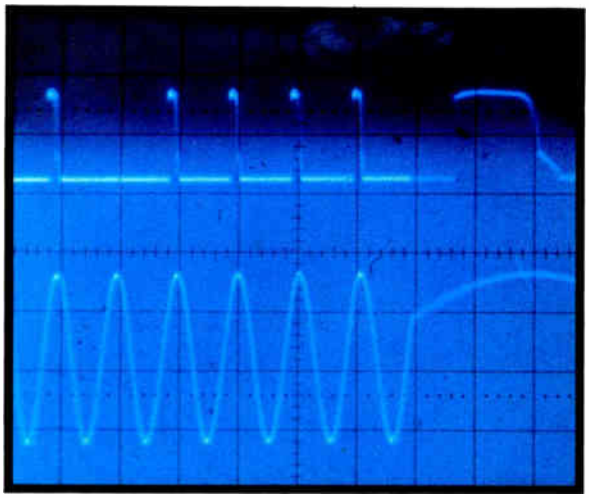
# THERE ARE NO BETTER 'SCOPES ON THE MARKET - 5212, 5242 AND 5246 FROM SCHLUMBERGER.



- CRT with quadrupolar lenses.
- 8 x 10 cm screen.
- Superb brilliance & definition.
- Rock steady triggering.
- 5 cm/ns writing speed.

**5246**

- Both Channels: dc to 300 MHz 1 V/cm to 10 mV/cm. Relay operated attenuator in steps of 1, 2, 5.
- Input Impedance: 50 Ω. SWR < 1.25 up to 300 MHz.
- Dual Timebase: 0.1 s/cm to 2 ns/cm with adjustable hold-off.
- Trigger: up to 300 MHz with a selection of filters. Built in supply for active probe.

**5242**

- Both Channels: dc to 175 MHz 5 V/cm to 2 mV/cm.
- Input Impedance: 1 MΩ/15 pF.
- Dual Timebase: 0.5 s/cm to 2 ns/cm with adjustable hold-off.
- Trigger: up to 200 MHz.

Other features as for the 5246.

# 5212 HERALDS A NEW TECHNOLOGY...

**Vertical amplifiers 85 MHz**

- Both Channels: dc to 85 MHz 5 V/cm to 5 mV/cm.
x 5 button gives 1 mV/cm 20 MHz on Channel A.
Push button inversion of Channel B.
Push button display of trigger signal.
- Operating Modes: Channel A or B A & B alternate - A & B chopped 1 μs A ± B.
- Signal Output: 25 mV/cm dc to 30 MHz 50 Ω.
Visual indication of direction that beams are off-screen.

**Dual timebase 10 ns/cm**

B1: 1 s/cm to 100 ns/cm.
B2: 0.1 s/cm to 100 ns/cm.
Push button x 10 expansion.
Variable delay on B2.
Variable hold-off.
Lamps show when speed is uncal. and when single shot is primed.
- Modes: B1 alone
B1 bright-up by B2 - B2 delayed by B1
B1 & B2 mixed.

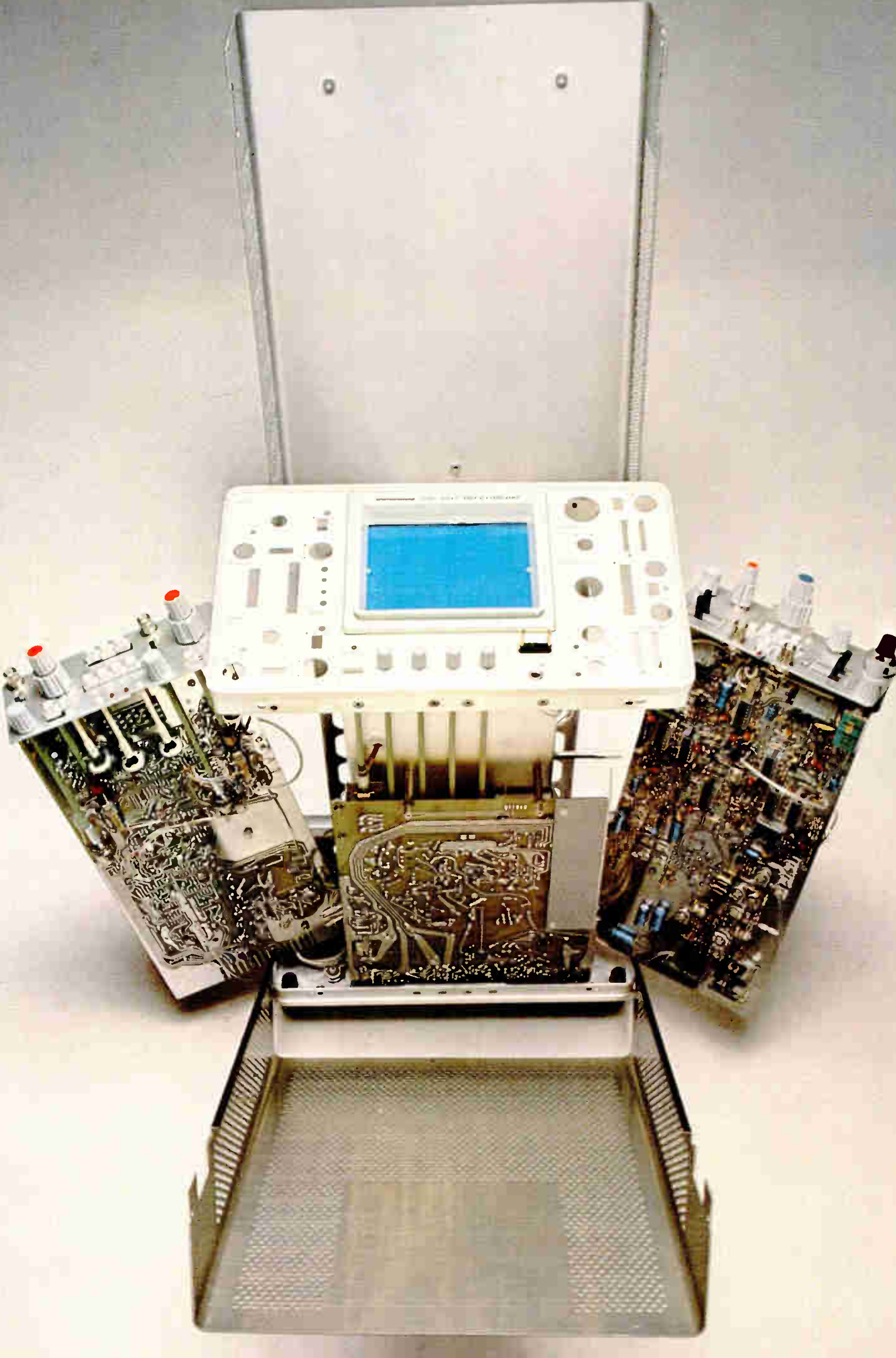
**Trigger 100 MHz**

- Internal: Channel A - Channel B Channels A & B.
- External: dc to 100 MHz.
Level controls and indicator lamp.

**CRT 8 x 10 cm**

This new tube was specially developed for this range of oscilloscopes.

Each group of deflection plates is followed by a quadrupolar electrostatic lens which, with the 15 kV PDA, gives extraordinary brilliance and focus.
There is complete absence of halo and recordings with ASA 3000 film may be made without special precautions.



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Widely used in teaching and in industry, as well as in numerous laboratories, this range of oscilloscopes can deal with all measurements generally met and combine accuracy with economy. The functions provided and the control layout make them all very simple to use.

Just added to the range are the 5100, rack mounted 4 units high, and the 5071 storage oscilloscope.

**5043**

- Both Channels: dc to 20 MHz 20 V/cm to 5 mV/cm.
Push button: 1 mV/cm 5 Hz to 1.5 MHz Channel A.
Inversion of Channel B.
A ± B operation. Delay line, 28 ns visible.
- Timebase: 0.5 s/cm to 200 ns/cm and x 5 expansion.
- Trigger: dc, ac, +, −. Internal, external.
TV lines and frames. XY phase shift: < 3° to 500 kHz.
Calibration signal.
CRT: 8 x 10 cm brilliant display.

**5100**

Rack mounting version of 5043.

**5041**

As for 5043 but without delay line or A ± B operation.

**5071**

This storage oscilloscope has the same specification as 5043 except for the following:
- Bandwidth: dc to 10 MHz.
- Timebase: addition of single-shot with indicator lamp for priming.
- CRT: 8 x 10 cm bistable storage type having the following operating modes:
- Normal: conventional P31 phosphor.
- Storage: writing speed continuously variable from 40 cm/ms to 500 cm/ms single-shot.

An integration mode enables the 'scope to write a fast signal which has a low repetition rate at the maximum speed of 40 ns/cm.
Erasure is automatic or by push button.
Maximum storage time approximately 1 hour.

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| 2 | 22 | 42 | 62 | 82 | 102 | 122 | 142 | 162 | 182 | 202 | 222 | 242 | 262 | 344 | 364 | 384 | 404 | 424 | 444 | 464 | 484 | 504 | 714 |
| 3 | 23 | 43 | 63 | 83 | 103 | 123 | 143 | 163 | 183 | 203 | 223 | 243 | 263 | 345 | 365 | 385 | 405 | 425 | 445 | 465 | 485 | 505 | 715 |
| 4 | 24 | 44 | 64 | 84 | 104 | 124 | 144 | 164 | 184 | 204 | 224 | 244 | 264 | 346 | 366 | 386 | 406 | 426 | 446 | 466 | 486 | 506 | 716 |
| 5 | 25 | 45 | 65 | 85 | 105 | 125 | 145 | 165 | 185 | 205 | 225 | 245 | 265 | 347 | 367 | 387 | 407 | 427 | 447 | 467 | 487 | 507 | 717 |
| 6 | 26 | 46 | 66 | 86 | 106 | 126 | 146 | 166 | 186 | 206 | 226 | 246 | 266 | 348 | 368 | 388 | 408 | 428 | 448 | 468 | 488 | 508 | 718 |
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| 12 | 32 | 52 | 72 | 92 | 112 | 132 | 152 | 172 | 192 | 212 | 232 | 252 | 272 | 354 | 374 | 394 | 414 | 434 | 454 | 474 | 494 | 704 | 951 |
| 13 | 33 | 53 | 73 | 93 | 113 | 133 | 153 | 173 | 193 | 213 | 233 | 253 | 273 | 355 | 375 | 395 | 415 | 435 | 455 | 475 | 495 | 705 | 952 |
| 14 | 34 | 54 | 74 | 94 | 114 | 134 | 154 | 174 | 194 | 214 | 234 | 254 | 274 | 356 | 376 | 396 | 416 | 436 | 456 | 476 | 496 | 706 | 953 |
| 15 | 35 | 55 | 75 | 95 | 115 | 135 | 155 | 175 | 195 | 215 | 235 | 255 | 275 | 357 | 377 | 397 | 417 | 437 | 457 | 477 | 497 | 707 | 954 |
| 16 | 36 | 56 | 76 | 96 | 116 | 136 | 156 | 176 | 196 | 216 | 236 | 256 | 338 | 358 | 378 | 398 | 418 | 438 | 458 | 478 | 498 | 708 | 956 |
| 17 | 37 | 57 | 77 | 97 | 117 | 137 | 157 | 177 | 197 | 217 | 237 | 257 | 339 | 359 | 379 | 399 | 419 | 439 | 459 | 479 | 499 | 709 | 957 |
| 18 | 38 | 58 | 78 | 98 | 118 | 138 | 158 | 178 | 198 | 218 | 238 | 258 | 340 | 360 | 380 | 400 | 420 | 440 | 460 | 480 | 500 | 710 | 958 |
| 19 | 39 | 59 | 79 | 99 | 119 | 139 | 159 | 179 | 199 | 219 | 239 | 259 | 341 | 361 | 381 | 401 | 421 | 441 | 461 | 481 | 501 | 711 | 959 |
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- **h** ☐ Components & Subassemblies
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- **k** ☐ Government

| | | | | | | | | | | | | | | | | | | | | | | | |
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| 3 | 23 | 43 | 63 | 83 | 103 | 123 | 143 | 163 | 183 | 203 | 223 | 243 | 263 | 345 | 365 | 385 | 405 | 425 | 445 | 465 | 485 | 505 | 715 |
| 4 | 24 | 44 | 64 | 84 | 104 | 124 | 144 | 164 | 184 | 204 | 224 | 244 | 264 | 346 | 366 | 386 | 406 | 426 | 446 | 466 | 486 | 506 | 716 |
| 5 | 25 | 45 | 65 | 85 | 105 | 125 | 145 | 165 | 185 | 205 | 225 | 245 | 265 | 347 | 367 | 387 | 407 | 427 | 447 | 467 | 487 | 507 | 717 |
| 6 | 26 | 46 | 66 | 86 | 106 | 126 | 146 | 166 | 186 | 206 | 226 | 246 | 266 | 348 | 368 | 388 | 408 | 428 | 448 | 468 | 488 | 508 | 718 |
| 7 | 27 | 47 | 67 | 87 | 107 | 127 | 147 | 167 | 187 | 207 | 227 | 247 | 267 | 349 | 369 | 389 | 409 | 429 | 449 | 469 | 489 | 509 | 719 |
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| 12 | 32 | 52 | 72 | 92 | 112 | 132 | 152 | 172 | 192 | 212 | 232 | 252 | 272 | 354 | 374 | 394 | 414 | 434 | 454 | 474 | 494 | 704 | 951 |
| 13 | 33 | 53 | 73 | 93 | 113 | 133 | 153 | 173 | 193 | 213 | 233 | 253 | 273 | 355 | 375 | 395 | 415 | 435 | 455 | 475 | 495 | 705 | 952 |
| 14 | 34 | 54 | 74 | 94 | 114 | 134 | 154 | 174 | 194 | 214 | 234 | 254 | 274 | 356 | 376 | 396 | 416 | 436 | 456 | 476 | 496 | 706 | 953 |
| 15 | 35 | 55 | 75 | 95 | 115 | 135 | 155 | 175 | 195 | 215 | 235 | 255 | 275 | 357 | 377 | 397 | 417 | 437 | 457 | 477 | 497 | 707 | 954 |
| 16 | 36 | 56 | 76 | 96 | 116 | 136 | 156 | 176 | 196 | 216 | 236 | 256 | 338 | 358 | 378 | 398 | 418 | 438 | 458 | 478 | 498 | 708 | 956 |
| 17 | 37 | 57 | 77 | 97 | 117 | 137 | 157 | 177 | 197 | 217 | 237 | 257 | 339 | 359 | 379 | 399 | 419 | 439 | 459 | 479 | 499 | 709 | 957 |
| 18 | 38 | 58 | 78 | 98 | 118 | 138 | 158 | 178 | 198 | 218 | 238 | 258 | 340 | 360 | 380 | 400 | 420 | 440 | 460 | 480 | 500 | 710 | 958 |
| 19 | 39 | 59 | 79 | 99 | 119 | 139 | 159 | 179 | 199 | 219 | 239 | 259 | 341 | 361 | 381 | 401 | 421 | 441 | 461 | 481 | 501 | 711 | 959 |
| 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 342 | 362 | 382 | 402 | 422 | 442 | 462 | 482 | 502 | 712 | 960 |

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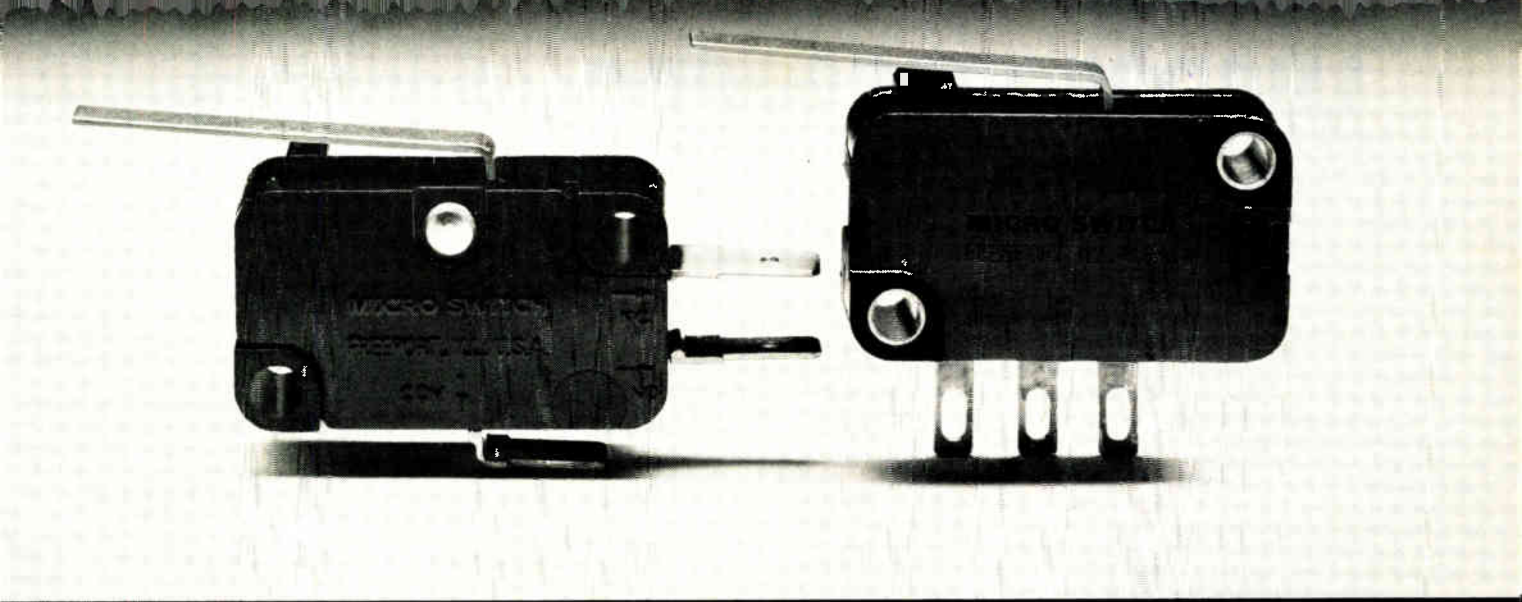

# One of these is a new solid state switch. It's important that you can't tell which one.

The switch on the left is the V3. A mechanically-actuated snap-action switch the size of a postage stamp. It was an industry first when MICRO SWITCH introduced it in 1943. And it's gone on to become the industry standard, with hundreds of millions in use worldwide.

The switch on the right looks like the V3. Mounts like the V3. It's even actuated like the V3. And that's exactly where the similarities end. Because it's all solid state inside.

Designed around a Hall-effect integrated circuit perfected by MICRO SWITCH, the XL has been made to provide every benefit of true solid state design without the necessity of getting out of mechanical control.

Because the XL is all solid state, there are no contacts to bounce or become contaminated. And the Hall-effect integrated circuit has been performance tested through over 12 billion operations without a single failure. Unlike standard mechanical switch designs, the XL can also interface directly with other solid state components. Its 20MA output eliminates the need for amplifiers, in most applications. And you can order it with either current sinking or current sourcing outputs.

It needs very little force for actuation—down to 10 grams. Even less with a lever. And the choice of actuator styles is the same as for the V3: over 500 different actuators in all. Including simple pin plunger, straight lever, simulated roller or roller lever.

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So the XL obviously offers some unique advantages. It's just one of a wide range of MICRO SWITCH solid state designs that do. Including a complete range of magnetically operated solid state position sensors, like the ones pictured here.

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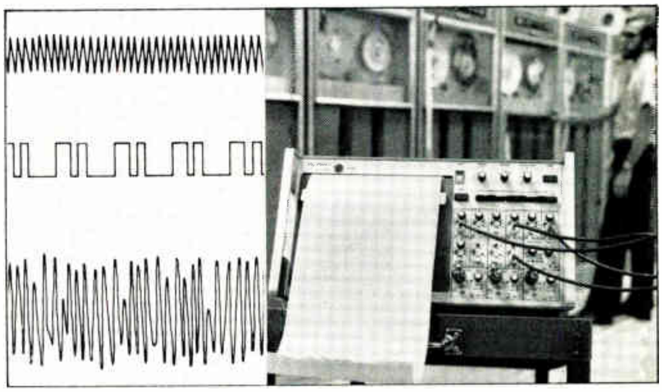
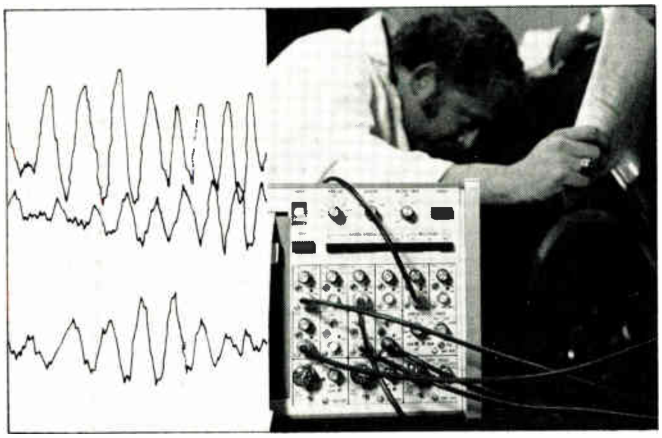


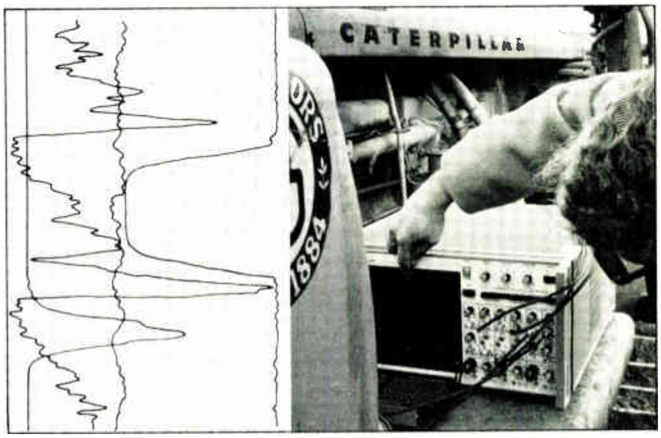
## Computer and Data Communications Trouble-shooting.

By recording the transmitted and received data, bit by bit, in detailed analog form, the causes of those difficult-to-solve communications problems — equipment or programming related — can be readily identified.



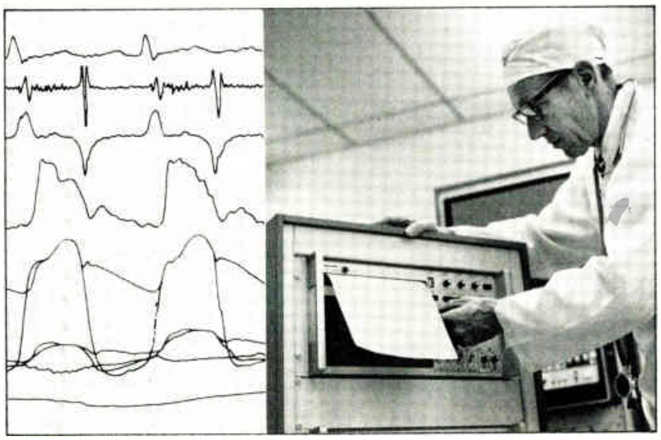
## Automotive Vibration Testing.

In this instance, recording yaw and rotational movement of an eight-cylinder engine on its flexible mounts about a vertical axis through the center of gravity.



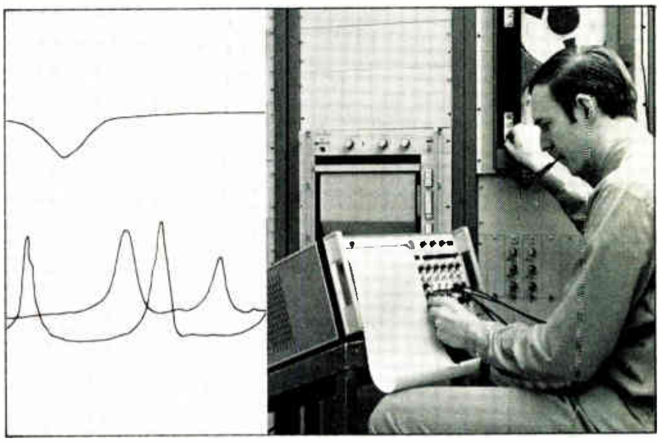

## Diesel Engine Testing.

Visicorder records pressure variations in the exhaust manifold, cylinder, and intake manifold. These "heart beats" were taken through a series of complete combustion cycles.



## Biomedical Research.

In cardiovascular diagnostics, the Model 1858 provides simultaneous multichannel recordings for valuable diagnostic information.



## Research and Development.

More and more laboratories are discovering the Honeywell Visicorder is an unusually versatile instrument capable of delivering the most readable and accurate record available.

## Applications Plus.

The 1858 has the capability. Its portability, versatility, ease of operation and matchless record make it the best system for most situations.

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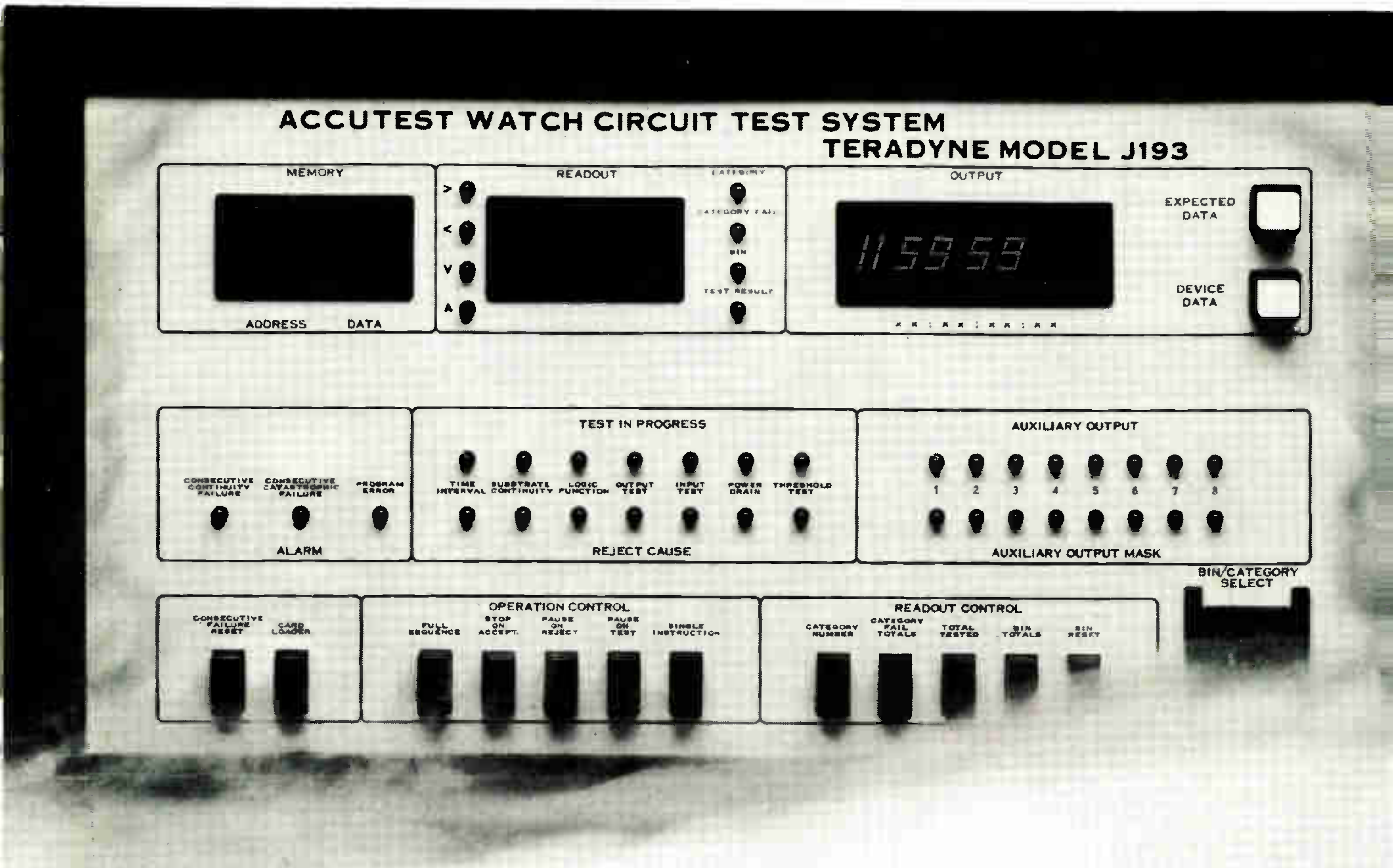
For Demonstration circle 61

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Teradyne's new J193 Watch Circuit Test System performs a variety of functional, parametric, and time-base tests on semiconductor timekeeping circuits. These include watch, clock, and timer circuits and modules.

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The main advantage of our programming keyboard is that you needn't be a programming wizard to use it. Virtually all test plans are generated, easily edited, and entered using the keyboard, which can be kept in tamper-proof security away from the testing area. The J193 allows you to think in terms of what you want to test without first having to translate it into test-system terminology.

Test programs can be stored on magnetic cards using the card loader. And, as you would expect, the system interfaces to most wafer probers and automatic handlers.

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Whether you're a watch maker or a semiconductor manufacturer, you can count on the J193 to eliminate bad parts before they cost you an extra cent of time, expense, or damaged reputation.

The J193's completely optimized design means that the system throughput is limited only by the speed of the devices being tested. And you receive that high throughput at the lowest possible cost.

That's yield. And that's important.

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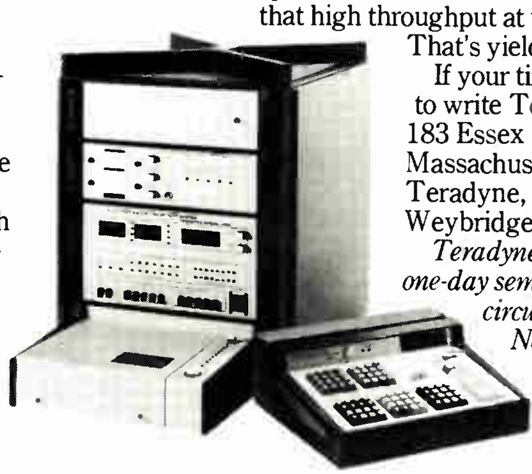
*Teradyne will be conducting a one-day seminar on watch circuit testing November 12th in Palo Alto, California. Write for details.*



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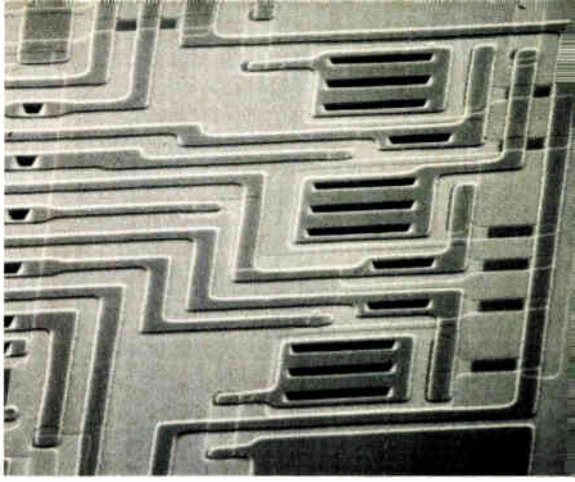


# Fast MOS moving in

New designs and processes are opening the way for products that retain traditional advantages

By Bernard Cole, San Francisco bureau manager

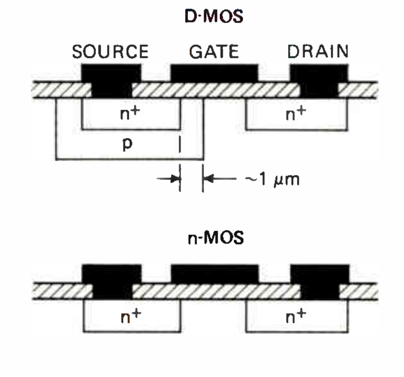
**The bipolar** manufacturers' challenge to metal-oxide semiconductors—faster, denser devices—has provoked a counterchallenge from the MOS makers. They are developing MOS static designs and processes potentially with bipolar speeds in addition to the existing advantages: high speed-power products and high packing densities.

In the next few months, several 1,024-bit static MOS random-access memories will be introduced that are pin-for-pin compatible with Fairchild's successful 1-kilobit Isoplanar bipolar random-access memory—the 93415/93425. Close behind are 4,096-, 16,384- and 32,768-bit read-only memories with speeds in the 50-to-100-nanosecond range, as well as several medium-scale-integrated random-logic designs that compete on a one-to-one basis with many standard low-power Schottky transistor-transistor-logic products. Six to nine months from now, systems designers may begin to see 4-k static MOS RAMs that, besides blunting I²L's drive toward higher-density designs, may attract users away from what may seem to be more complicated 4-k n-MOS dynamic RAMs. In addition, LSI microprocessors are in the works that not only take up less chip space than present MOS devices, but are as fast as Schottky bipolar versions.

To achieve all this, several companies—among them Intel Corp., Signetics Corp., Monolithic Memories Inc., Mostek Corp., American Microsystems Inc., Dmost Inc., Hitachi Ltd., Toshiba Ltd., and Nippon Electric Co. Ltd.—are looking at three or four specific approaches. These include the use of ion implantation to get as much speed as possible out of the standard n-MOS structures; D-MOS, to get shorter channels out of ordinary 5-micrometer photolithography by using a double diffusion through the same oxide window; and V-MOS, a new short-channel V-groove logic structure that uses only 10-μm contact-print lithography for high-performance devices with channels 1 μm long. Farther ahead is the possibility of using electron-beam lithography for submicrometer n-MOS, D-MOS and V-MOS short-channel structures.

**Speedy MOS RAM.** Intel Corp.'s newly announced 1-k static RAM, the 2115/2125 [*Electronics,* Sept. 4, 1975, p. 120], shows what is possible with ion implantation and a tight n-MOS process that's been optimized for speed. Boasting a system power dissipation that is 35% lower than their bipolar counterparts, Intel's devices are pin-for-pin compatible with Fairchild's 93415 and 93425 Isoplanar 1-k static bipolar RAMs. The parts come in three speeds: the 2115-2 and 2125-2 with maximum access times of 70 ns; the 2115 and 2125, with 90 ns, and the 2115-4 and 2125-4, with 120 ns. But since n-MOS is being pushed to the very limit of present lithographic techniques, the Santa Clara, Calif., company is also working on D-MOS.

Signetics Corp. in nearby Sunnyvale is hedging its bets, too. While it has built 1-k D-MOS static RAM prototypes, it is focusing most of its memory efforts on n-MOS technology. According to Fred Kashkooli, n-channel and new-process development engineering manager, the firm will have an ion-implanted 60-ns to 80-ns 1-k static n-MOS RAM in production by the year end.




**Structures.** Top photo is closeup of 256-bit shift register built using V-MOS techniques. Beneath it is diagram comparing structures of n-MOS and D-MOS devices.

But D-MOS has not been abandoned, says Tom Cauge, D-MOS project manager at Signetics. "Much of our effort has been spent on developing, on a custom basis, D-MOS LSI equivalents of many of the bipolar TTL designs," he says. One such circuit, built for demonstration purposes, was a pin-for-pin replacement of the transistor-transistor logic 7485, a 4-bit binary magnitude comparator, but with the output sink and logic levels of the 740LS series. At 64 by 55 mils, the 45-gate chip is 60% the size of the TTL part. Average delay per gate is 4.1 ns, and average power per gate is 2.5 milliwatts. And while the average power-delay product is 70 picojoules, Gauge says that when properly controlled, the parts had a power-delay product of 26.7 pJ.

At Dmost Inc. in nearby Saratoga, president Joseph Kocsis and his co-workers are building prototypes of a 120-by-144-mil 4-k ROM that is pin-compatible with Intel's Schottky bipolar 3304 and has an access time of 65 ns. In design, he

## Probing the news

says, are 16-k and 32-k ROMs as well as several RAM prototypes.

**Japanese efforts.** At Nippon Electric, researchers have developed a 4-bit D-MOS arithmetic and logic unit. At 2 volts, it runs at a gate speed of less than 2 ns—almost as fast as emitter-coupled-logic gates—but the entire chip dissipates less than 1 mW per gate, giving it a speed-power product of 2 pJ. Total propagation delay is only 32 ns, and density is 141 gates per square millimeter. Nippon is also developing buffer memory peripheral decoding chips using its version of D-MOS, called DSA MOS. It is advancing from 50-to-100-gate chips to experimental LSI chips with more than 1,000 gates or about 256 memory bits.

Hitachi, at its central research laboratory, has two projects going on in high-speed n-MOS. One is DSA on SOS, in both logic applications and linear microwave circuits, where one aim is to take advantage of the lower capacitance of the SOS. The second is a short-channel n-MOS project that has already produced a 21-stage ring oscillator with a total of 43 transistors on one chip. The device's propagation delay is 0.66 ns per stage, and its power drain is 0.18 mW for a speed-power product of 0.12 pJ. Channel length is 2 $\mu$m with a drain voltage of + V and a substrate bias of -3 V. Punch-through breakdown voltage exceeds 10 V even for channel lengths as short as 1.5 $\mu$m. And at Toshiba, a 16-bit central processing unit is being developed using an n-MOS-on-SOS substrate.

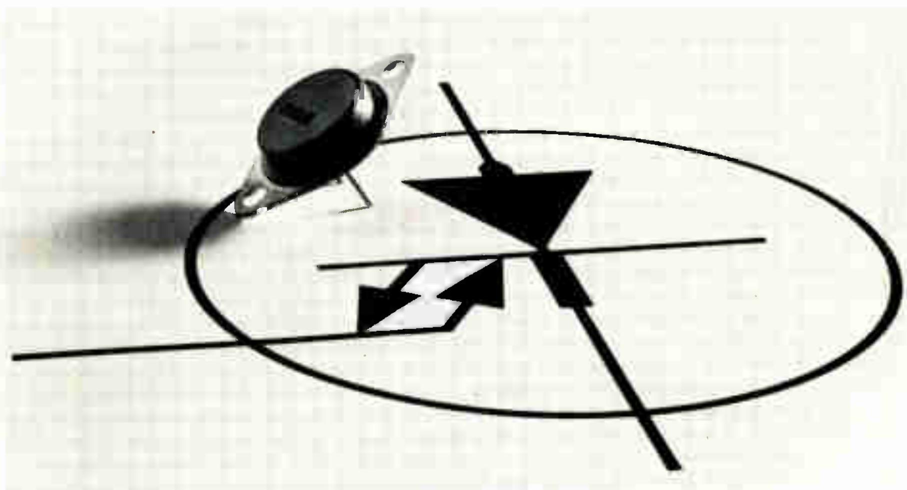
**Bipolar lessons.** But promising as these devices are, they all suffer from the same drawback: they are basically surface structures and as such highly dependent on the resolution of photolithographic techniques. Taking a lesson from high-speed bipolar processing and design, T. John Rodgers of Stanford University's Electronics Lab has built 5-V random-logic circuits using V-MOS that are 20% faster, use a quarter the chip area, and have one sixth the power dissipation of pin-for-pin compatible gold-doped TTL MSI circuits. On-chip V-MOS delays are in the 2-to-3-ns range, and off-chip drive capability exceeds 50 megahertz with six TTL loads.

To achieve these characteristics, Rodgers exploits the fact that diffusions can be controlled to within 1-$\mu$m widths. "V-MOS transistors are nothing more than vertical n-MOS transistors whose gates are formed on the face of V groove, which is anisotropically etched through these diffused layers by means of ordinary 10-$\mu$m contact-print lithography."

In one layout study using a static NOR logic schematic for a full adder, V-MOS needed only 23,200 square mils as against n-MOS' 48,000 and I²L's 32,400. Rodgers, who has acted as a consultant to several semiconductor firms in San Francisco's silicon valley, says interest and activity in V-MOS is high and predicts that within six months to a year "we'll be seeing a lot of interesting designs."□

What's new in solid state...

# RCA delivers the Gate-Turn-Off SCR in



## Twelve SCRs offer exceptionally cost-effective switching.

You've heard the promise of the GTO: a dependable, cost-effective switch that requires only a short negative power pulse to the gate for turn-off. You've heard it a number of times, from a number of sources. Now RCA makes that promise. And delivers it with product.

Right now, you can choose from 12 RCA 8.5-ampere GTO SCRs available from RCA or through your distributors. At prices ranging from $4.13 to $11.47 for 1 to 99 units, from $2.50 to $6.95 at 1K.

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And we've packaged the result in the popular JEDEC TO-3 hermetic package.

You get everything a conventional 8.5-ampere SCR offers: normal inrush handling capability, pulse turn-on, and an operating range to 125°C. The gate turn-off capability is a bonus.

**SWITCHING CHARACTERISTICS**
**For high-, medium- & low-frequency applications.**

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|---|---|---|---|---|
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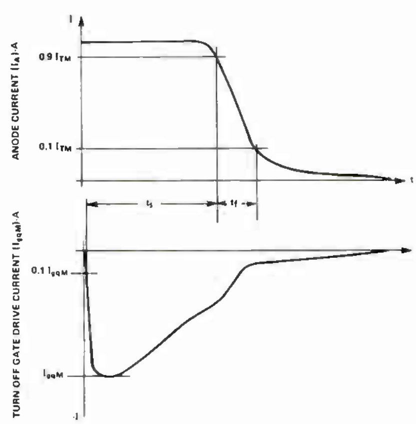
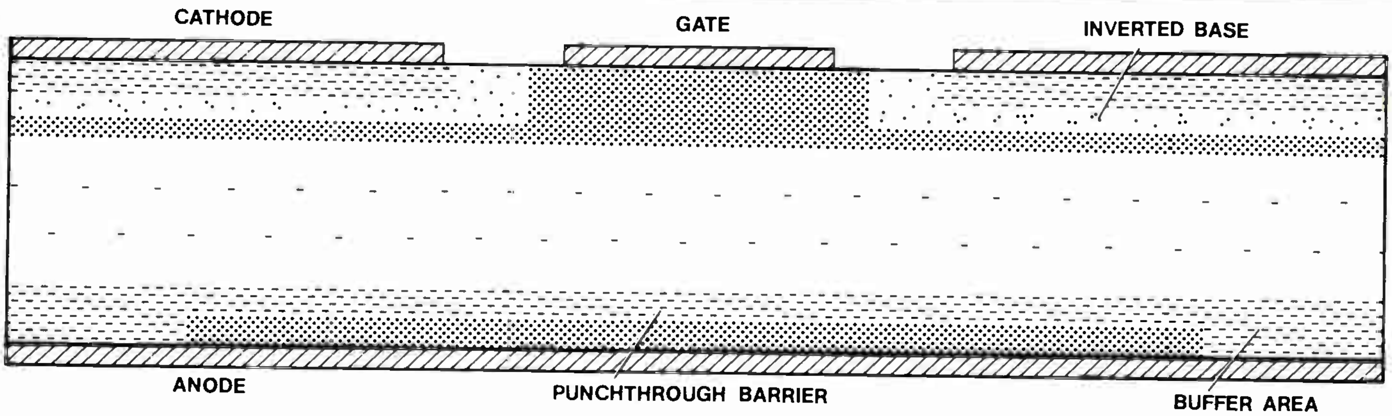
| $I_{TGQM}$ | | 15 A | 15 A | 15 A |
| $t_{gq}$ | $t_s$ | 1μs | 1.5μs | 5μs |
| | $t_f$ | 1μs | 2 μs | 5μs |
| $t_{gt}$ | $t_d$ | 1μs | 1μs | 1 μs |
| | $t_r$ | 1μs | 2 μs | 2 μs |




Relationship between anode current (on-state), turn-off gate-drive current, and time, showing reference points for definition of gate controlled turn-off time ($t_{gq}$).

RCA. Powerhouse

# promise of the
# an 8.5 ampere series.




Specifics of the devices are:

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|---|---|---|---|---|
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| Repetitive Peak Off-State Voltage ($R_{GK}$=1000Ω) | 100 V | 200 V | 400 V | 600 V |

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Right now, RCA GTOs are 8.5-ampere devices with a choice of 4 voltages, high peak-to-average current ratio, 20 kHz operating frequency, 125°C operation. But this is only the beginning. RCA is currently developing higher current and higher speed devices. And you'll be hearing about them soon.

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RCA

Circle 69 on reader service card

in Thyristors.

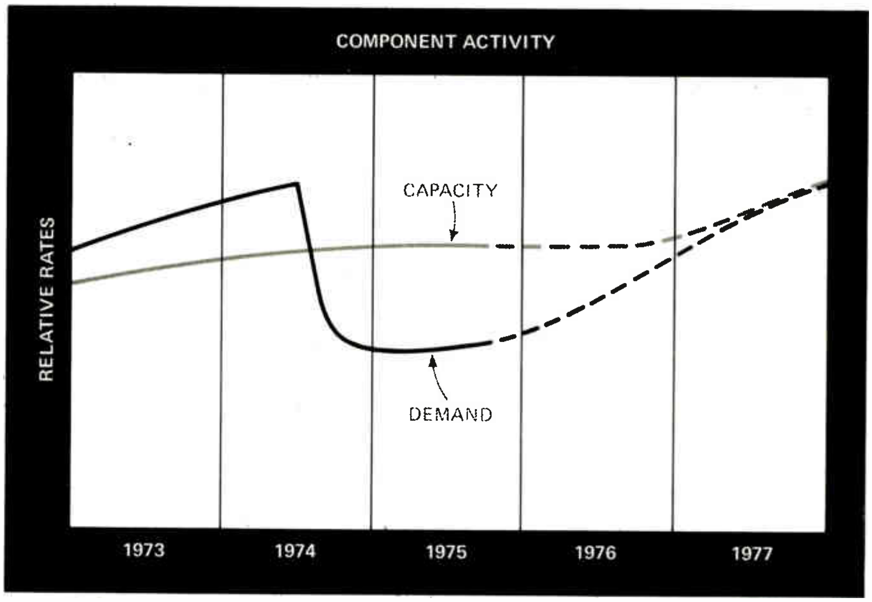
Components

# Slow '76 pickup seen

While manufacturers don't expect 1976 sales to equal those of 1973–74, some plan to add capacity next year to head off 1977 shortages

by Lucinda Mattera, Components Editor, and Larry Armstrong, Midwest bureau manager

**Like the rest** of the semiconductor industry, makers of traditional components are waiting for the boom to start [*Electronics*, Sept. 4, p. 75]. But they are forecasting conservatively. Although most agree that the hoped-for business upturn has started, they don't see sales for the upcoming year reaching the peaks of 1973 and 1974. But some are already planning to boost production capacity before 1976 is out to forestall any possible shortage in 1977.




"Every month, for the last four months, has been better than the previous one," notes Stanley J. Kukawka, president of Allen-Bradley's Electronics division, Milwaukee. "It's not a flash in the pan—it's a good strong trend," he adds. By the end of 1976, Kukawka feels, bookings at the resistor company may approach 1973's level. "But I've heard several people say that 1976 will be the best year ever, and I take issue with that," he says. "Starting from where we are now, we couldn't possibly exceed 1973 by a substantial amount."

Kukawka expects demand to meet the company's 1973 capacity in mid-1977, assuming no more capacity is added. However, Allen-Bradley is adding production lines now, particularly in new products that promise to have long life and good market potential. For example, capacity for cermet film resistors, thin-film resistor networks, and trimmers is being doubled. "In terms of total capacity, that's on the order of a 10% to 15% increase," Kukawka notes.

**Gradual rise.** Although capacitor shipments are still considerably off from 1974 at the Centralab Electronics division of Globe-Union Inc., Milwaukee, the company is seeing a gradual increase in the requests for shipments. "The last two months have been unusually strong for our distributor business," says William L. Fowler, marketing vice president, "and we consider that evidence that most inventory buildups, if not totally, are mostly depleted in the capacitor area."

Centralab had enough excess capacity in June to double its capacitor output, but shipments since then have been growing by around 5% to 10% a month. Fowler expects demand to reach capacity in the second or third quarter of 1976. "By the third quarter next year, we'll be shipping at the highest level we ever have," he says. Lead times—which now are six weeks—will probably start stretching out in the first quarter of 1976, he adds.

At the Helipot division of Beckman Instruments Inc. in Fullerton, Calif., sales for 1976 are expected to be 15% to 20% ahead of those for 1975. However, points out Leslie W. Chapin, division manager and corporate vice president, "We don't think the turnaround will be very sharp. The second half of 1976 will be strong, but not going like gangbusters."

Also forecasting conservatively for its resistor, capacitor, connector, and motor businesses is the Electronic Components division of TRW Inc. in Los Angeles. "Yes, we have hit bottom and are now noticing a mild upturn, but nothing dramatic," notes James E. Gwyn, manager of market research and analysis. Much of the increase is coming from the automotive and home entertainment areas, but there is still no noticeable pickup in such industrial areas as computers, telecommunications, and instrumentation, says

Gwyn. "We foresee a very slow pickup in the second half of 1975, a moderate increase in 1976 overall, with possible acceleration going into 1977." Demand and capacity will not meet in 1976 for TRW, and it's even doubtful that they will cross in 1977.

Relay shipments at C.P. Clare & Co. were down drastically—25% or more—in the quarter ending May 1, compared to the same quarter in 1974. "We expect 1976 to be up over 1975, but not to 1974 levels. However, the order level of 1974 might be reached by the end of 1976," says Robert E. Axthelm, national sales manager for the Chicago-based General Instrument subsidiary.

**Light business.** Replacement business—as heavy as 60% in computer and business equipment markets—tends to flatten economic cycles for manufacturers of miniature incandescent lamps. For example, Chicago Miniature Lamp Works reports that its quarter ending in May was down only 11% to 12% from the same quarter in 1974, which was a peak period. The company, another Chicago-based General Instrument subsidiary, is predicting a year that will be up about 3% over 1974, and 1974 was 8% to 10% better than 1973.

"We think it's premature to say that business has turned around," says William E. Curran, vice president and general manager. "When demand for lamps in end equipment goes up, it's almost a 2:1 swing, so we think we'll see a significant upturn within a couple of months," he notes.

Although second-quarter business at Cherry Electrical Products Corp., Waukegan, Ill., was about half of what it was in the same period for 1974, the switch company thinks the upturn has started. "Shipments increased slightly in July and August, and orders were up sharply, although they're still down from previous years," says Walter Cherry, president. Switch demand won't meet the company's capacity for about three years. "We've got a lot of capacity, and the switch market grows about 7% in good years—which is to say, we hardly keep up with inflation," Cherry points out. □

### Probing the news

the Santa Clara Electron Devices group, also would support Feerst—if he did his work outside the IEEE.

Perhaps representing the feelings of a majority of his peers is Ted Kamins, an engineer at Hewlett-Packard Co. "I have mixed feelings," he says. "In certain ways, I'm unhappy about the way the organization goes, like in technical activities. However, I don't know if the political aspects should be handled through this organization or another." Another Bay Area EE, Justin Rattner of Intel Corp., who believes the IEEE should become more active politically, is leaning toward Feerst.

**Opinions vary.** On the East Coast, James E. Shepherd, Boston area section chairman, says, "I can't agree that we need reform the way Feerst uses the word. He implies that something is wrong with the organization." And an academician member in Boston points out that Feerst has a better chance this year than in past years. "He advocates restricted entry into the profession, so he may gain the votes of the people who are out of work." And another engineer and Feerst supporter says, "Feerst is concerned with the fellow who is a practicing engineer. The IEEE should be concerned with the welfare of the engineer. Feerst is."

Speaking for the establishment that Feerst hopes to reform is Arthur P. Stern, now IEEE president. "No real issues," are involved, he says. "Rather, the election is between an outstanding man, Joe Dillard, whose most impressive quality is high integrity, and who has taken a forthright, progressive stand, and the opposition candidate, who is making irrational statements."

Whoever wins, the candidates agree that the IEEE presidency is a time-consuming job. Dillard plans to work seven 12-to-15-hour days, while Feerst would devote four 10-hour days to the IEEE. And running can be expensive: Feerst estimates his campaign cost at $6,000 to $8,000 in personal expenses; Dillard says the travel is expensive. □

Reporting for this article were Judy Curtis, San Francisco; Pam Leven, Boston; Ron Schneiderman, New York; and Larry Waller, Los Angeles.

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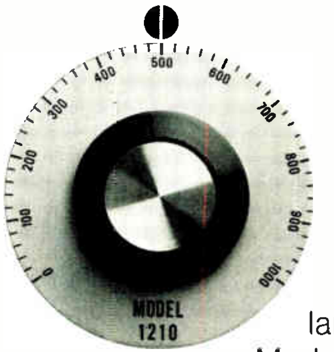


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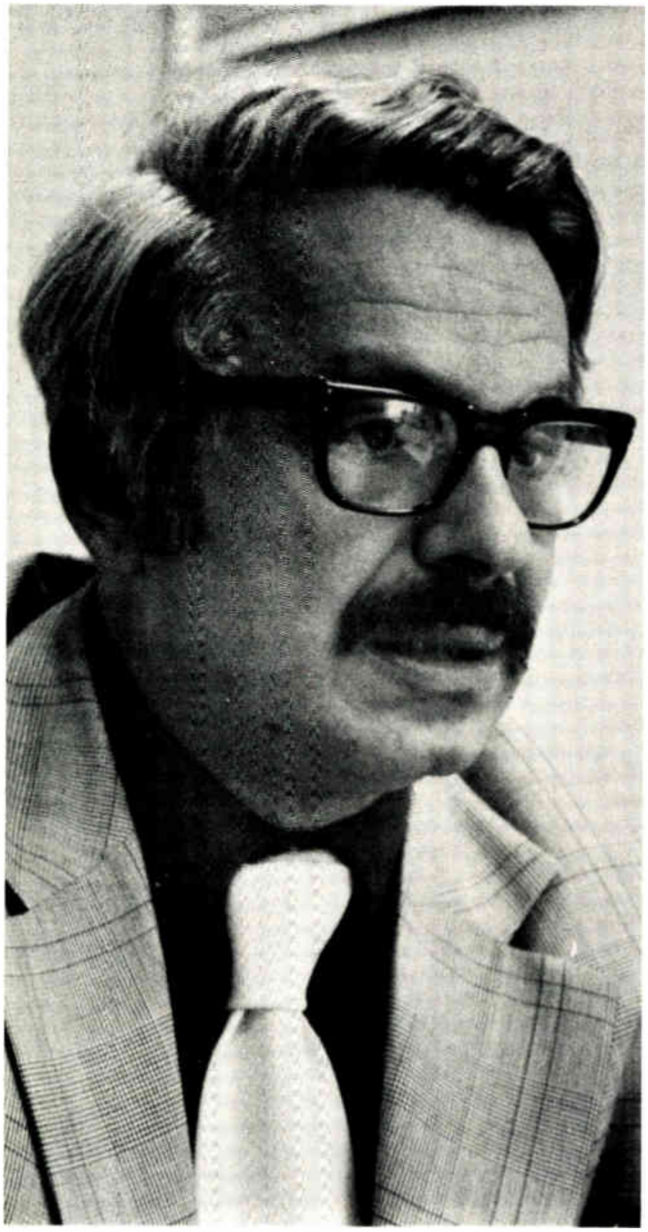

Irwin Feerst

Joseph K. Dillard

Probing the news

Careers

# Feerst, Dillard discuss the issues

IEEE's presidential candidates reply to six questions on topics ranging from the institute's structure to pension plans and age discrimination

**Because the IEEE** presidential election is important for the future of the institute—and because an informed voter is better able to choose intelligently—*Electronics* has asked both candidates, Joseph K. Dillard and Irwin Feerst, to respond to a series of questions on issues before the IEEE today. Each candidate prepared written statements reproduced below with only minor editing to make them conform to space requirements. Here's how they feel about the issues:

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*What are the strengths of the IEEE today?*

**Dillard:** The great strength of the IEEE is its technical excellence. Each year we sponsor over 200 financially successful conferences for the benefit of our members, and we produce more than 40 publications, most of which are recognized worldwide as standards of excellence in their respective fields. The IEEE is also developing strength in the professional activities area where I believe we have made a sound start. I am particularly pleased with our progress in establishing fruitful relations with the executive and legislative branches of the (Federal) Government. We are beginning to be a real factor in providing technical expertise to the establishment of national priorities and to the solution of many societal problems.

**Feerst:** I suppose it is fashionable to state that IEEE's principal strength lies in the excellence of its technical activities. However, two factors mitigate against this response. One is the high proportion of foreign authors whose works appear in the IEEE journals. In view of the fact that the majority of the world's EEs are Americans, this gives rise to the suspicion that IEEE is engaged in "reverse discrimination" in an attempt to justify an increasingly untenable stand as an international society.

The second is the almost reckless participation in, and co-sponsorship of, any international conferences, to which the same comment applies as to the first factor.

We conclude, then, that IEEE's principal strength is in the quality of its members. We EEs are the product of the single most difficult course of study ever devised. Our continued presence in this field is proof of our love of the profession, since it surely cannot be because of the economic advantages which our career offers.

---

*What are top priorities in serving member needs?*

**Dillard:** Certainly one top priority is to maintain our technical strength, because this provides the credibility and acceptance for all the other things we want to do. These things include assistance to our governments—national and local—the continuing education of our members to combat mid-career obsolescence, the building of mutually beneficial relationships with industries and universities, enhancement of the public image of engineering, and improvement of the economic well-being of all members of the profession.

**Feerst:** Our organization must let the control of the professional lives of EEs be in the hands of the practitioners. Specifically, I would accredit only *bona fide* four-year EE departments. The accreditation would include a stated maximum number of graduates each year based on a finite amount of lab space, a finite amount of lab test equipment, a finite number of qualified faculty members, and a finite amount of financial support from the parent college or university, and therefore the capability of training only a finite number of EEs a year.

We must prevent any more "back door" entry into the profession, but with a "grandfather clause" whereby all existing practitioners are fully accepted, irrespective of their formal training.

We should publish a list of employers who violate employment guidelines and treat their EE employees unfairly.

We must publicize the fact that we shall no longer tolerate any form of age discrimination, from the blatant to the subtle. We must make IEEE more active as a professional defender, by legal means if persuasion fails.

A portable pension plan has still not been perfected.

Economies in the operation of IEEE are necessary and realizable.

---

*How would you implement these projects?*

**Dillard:** These top-priority projects are already under way. I would allocate more of our financial resources to Government liaison activities, to continuing education projects, and to programs for the certification of electrical engineering curricula and the qualifications of practicing engineers. I think we have to marshal the considerable potential of our volunteer members to implement these programs. The job is too big to be handled entirely by any amount of paid staff which we can afford. And, we have to have the support of industry which underwrites most of the expenses of the volunteers.

**Feerst:** Accreditation—Send out teams equipped with a new set of questions and guidelines. Faculty and students should be interviewed, and the faculty given technical quizzes to determine their competency to teach in a professional school. After each EE department has been examined, accreditation notice and the maximum number of graduates each year for which they have been accredited would be sent to each of the 50 state professional engineering accrediting agencies and to every high-school guidance counselor in the U.S.

Back door entry—We must make it clear to high school guidance counselers that engineering technology, engineering science, computer science, etc., are not EE degrees.

Employment guidelines—IEEE should follow hearing procedures that have been established by other societies and, like these other groups, publish lists of offending companies.

Age discrimination—It seems unwise for IEEE to attempt to influence other publications to cease accepting ads which specify maximum number of years of experience until Spectrum [the society's monthly publication] does it.

Pension protection—All the IEEE's efforts have accomplished nothing. Instead, we must look elsewhere—and the Individual Retirement Account, by which an individual may contribute up to $1,500 a year, seems the best. The best thing that IEEE can do about pensions is to admit they have failed and counsel members as to the advantages and methods of opting out of their employers' plans and taking the IRA route.

Economies in IEEE operation—Sell the branch office in Piscataway, N. J., and use the funds to establish an endowment for a legal defense fund to defend over-40 EEs fired because of age bias. Discontinue some, and decrease the frequency of other, IEEE journals that exist solely for the academicians. Reconsider IEEE's contributions to other organizations such as the Engineer's Council for Professional Development.

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*How would you assess the present structure and operation of the IEEE organization in dealing with technical and professional matters, and as president would you propose any changes?*

**Dillard:** Let me deal with the technical matters first. Our present group society structure is strong and effective in the technical area. I do think we can improve our effectiveness by some mergers of technical groups into larger industry-oriented societies, such as power, communications, computers, aerospace, etc., which would bring into them all aspects of engineering, marketing, production, and education in their respective industries.

Now for professional matters. These affect all engineers regardless of technical discipline. We can improve our influence in these matters by closer cooperation with other professional societies.

We should move toward the organization of a single umbrella organization representing all engineers in professional matters.

**Feerst:** The technical structure seems satisfactory. However, I would re-examine the practice of electing directors from various technical divisions as this practice leads to directors representing only a few thousand voters.

On the professional side, I would divide IEEE into two sections, technical and professional, and have as many vice presidents in one area as there are in the other. I would have a paid president, although this will come about too late to benefit me. In addition, the vice president of professional activities ought to be elected by the members.

At present there are inequities in the allocation of seats on the Board of Directors for regional directors. As a remedy, I plan to have about 30 regional directors each representing about 5,000 members. The work load per director will be less, and it is safe to assume there will be more grass-roots participation in IEEE affairs, inasmuch as a director will have to absent himself from his job less frequently.

---

*What steps, if any, would you take to implement a portable pension plan for EEs?*

**Dillard:** The problem here is acceptance. Immediate vesting and portability result in either (a) higher cost for the employer or (b) reduced benefits for employee. We are making progress in finding entrepreneurs to promote plans with earlier vesting and we should continue this and perhaps subsidize it if necessary.

I don't think we will get universal portability without Federal legislation requiring it on Government R&D contracts. I think it is appropriate to lobby for that.

**Feerst:** I have commented on this issue above.

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*Please comment on the following statements: (a) The IEEE should be a spokesman on technology matters to the Federal Government and lobby for passage of legislation to increase spending in R&D.*

**Dillard:** I do believe it is appropriate for IEEE to speak out on technological matters, because we have a great deal to contribute to the solution of societal problems such as the siting of nuclear plants, mass transit, protection of the environment, urban renewal, etc. I would lobby for legislation to encourage the allocation of a higher part of our GNP for R&D, because it is essential for our nation to maintain its competitive edge.

**Feerst:** Perhaps eventually, but certainly not now. We need to devote all our energies to correcting the faults of our own industry. Only when our own house in in order should we begin to influence matters of importance to the industry. We must recognize that most lobbying efforts are expensive and time-consuming. When we are strong enough, we shall find others beating a path to our door. There is perhaps no better example than our fruitless and expensive efforts to obtain pension protection.

---

*(b) The IEEE should arrange to negotiate for members in disputes with employers regarding salary or age discrimination.*

**Dillard:** The IEEE constitution prohibits our engaging in collective bargaining in matters customarily dealt with by labor unions. However, we can exert considerable influence on industry and government to create an environment in which engineers are treated as professionals, and this will improve their economic well-being in all aspects, including salaries and age discrimination.

**Feerst:** In salary disputes, no; in age bias, yes. As to the former, IEEE should emulate the American Association of University Professors in the publishing of average salaries by category of EE paid by all employers to the EEs employed. Thus, an EE considering a job change could weigh his or her job offer against other companies. In age bias, the negotiations should take the form of legal action, as mentioned above. □

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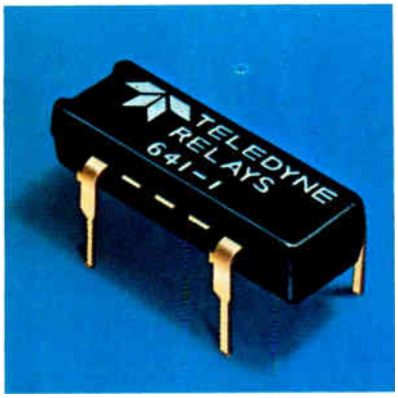


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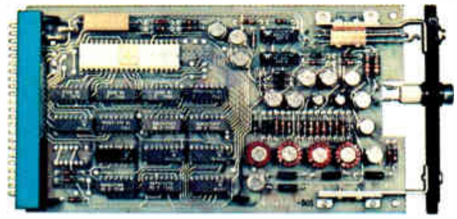

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# Scamp microprocessor aims to replace mechanical logic

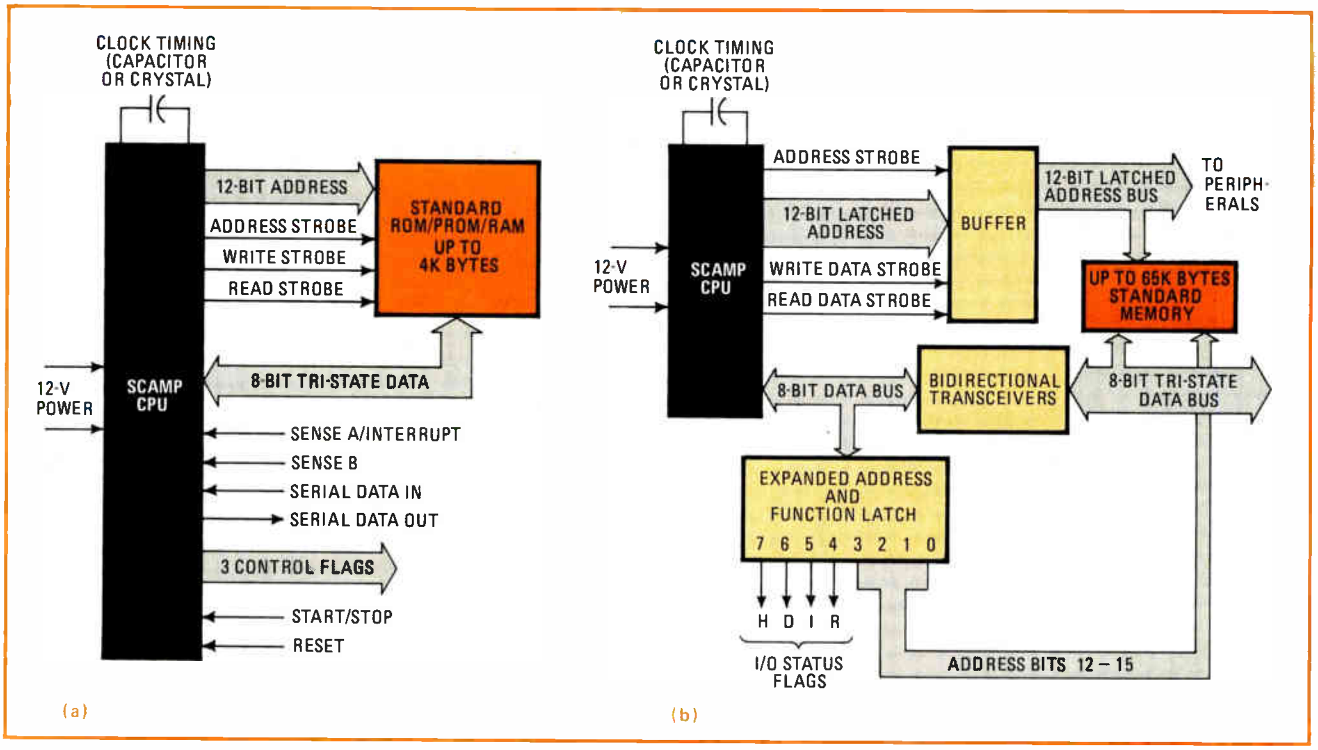
More flexible and reliable control for about the same price as 'sheet metal' logic: that's the promise of a new microprocessor intended for use in pinball machines, auto ignition, and appliances

by Jack H. Morris, Hash Patel, and Milt Schwartz, *National Semiconductor Corp., Santa Clara, Calif.*

☐ A new generation of low-cost, easy-to-use microprocessors is promising to change the world of product design previously dominated by "sheet-metal" logic—springs, relays, switches, gears, levers, and the like. When such systems are based on microprocessors, their designers will not only be able to cash in on the obvious advantages of small size, low weight and power, and high reliability, but they will also gain the ability to easily modify and enhance the system's functions through software changes. In addition, the reduction in parts count will cut inspection costs for incoming parts and reduce materials costs for chassis, interconnects, and power supplies.

The needs of these low-cost applications, in which high speed is not essential, are now met by a p-channel MOS 8-bit microprocessor called Scamp (for simple, cost-effective, applications micro-processor). The Scamp is a complete, self-contained, central processing unit that can directly interface to many standard, off-the-shelf, memory and buffer chips.

A simple control system can be configured using only the Scamp and a program memory, which can be selected from a wide range of standard memory parts (Fig. 1a). This system can access up to 4 kilobytes of memory to provide the control logic for almost anything previously controlled by sheet-metal logic: electronic games, small-intersection traffic-control signals, simple industrial systems, appliances, and vending machines. A




**1. Scamp simplicity.** The Scamp CPU, along with a 4-kilobyte memory (a), can handle many simple control functions. An extended Scamp system (b), which accesses up to 65 kilobytes, uses additional peripheral chips for more complex functions.

five-chip system, composed of the Scamp, a two-chip bidirectional transceiver, address latch, and buffer element (Fig. 1b), can interface to 65 kilobytes of memory for more complex control functions, as in credit-card verification, business and accounting machines, text-editing typewriters, intelligent stand-alone terminals, and measurement systems.

## Keeping the cost down

Up till now, microprocessors have been priced in the $50-and-up range (in volume) and have been restricted to more complex systems, such as peripheral controllers, communications processors, and military applications (see "Microprocessor prices and uses," p. 83). The target price for a microprocessor that would be economical in the sheet-metal-logic applications is in the neighborhood of $10. And not only must the price be reduced to this level, the costs of the surrounding circuitry required to build the system must be kept low to keep the total system to well below $50.

To meet the objective of low cost for such applications, the chip designer faces a dilemma; chip cost depends primarily on chip area, but low system cost demands that many functions be placed on the chip to minimize the number of external circuits. Also, chip size affects, and is affected by, instruction execution speed because higher speed requires multiple data paths as well as complex control logic to simultaneously process the many subfunctions required to carry out a particular instruction.

For Scamp, the philosophy was to lean toward small chip area even if over-all processing speed turned out to be lower, since the applications intended for Scamp do not necessarily demand high speed. Thus Scamp has a minimum of area-consuming, parallel data paths and complex control logic, and instructions are executed in several steps, with data moving between functional blocks on common read and write buses.

The registers are made with static, rather than dynamic cells, again to save on chip size and complexity. Dynamic cells by themselves would occupy less chip area but would require extra on-chip circuitry to refresh them. Static cells are larger but, with Scamp's limited number of registers, the total chip area dedicated to register functions is minimized with static rather than dynamic cell design.

A significant portion of the chip area is consumed by the programed logic array (PLA), which implements the instruction decode and control logic. Chip area here depends on the quantity and arrangement of PLA inputs, outputs, and product terms (crosspoints forming AND functions). In Scamp, the number of inputs, outputs, and product terms is kept small by decreasing the complexity and diversity of instruction types and data paths. Also, the physical arrangement of product terms, inputs, and outputs is adjusted to minimize the number of area-consuming unconnected crossovers within the PLA boundary.

There are several ways in which Scamp meets low-cost system objectives. Perhaps most important, it operates from a single power supply (12 volts), and it has on-chip generation of timing and strobe signals, requiring only an external crystal or capacitor.

Scamp can also interface directly, with no external logic, to a wide selection of standard memory parts (ROM, PROM, RAM) because of its write-data strobe, read-data strobe, and address-ready strobe. Scamp, in fact, interfaces to memories of almost any speed, without complex clocking controls, since it accepts a wait (memory ready) signal. The same signal also can be useful for single-cycle I/O control, since the processor stops all operations until the signal is completed. Needing no special interface circuitry, it provides the user with a static, hardware-controlled, single-cycle function, keeping data and address lines stable for an indefinite period. And, when Scamp is interfaced to submicrosecond memories, this input can be permanently enabled.

Scamp's start-stop signal, which is separate from the reset signal, allows single-cycle control at the instruction level. This is convenient for system testing. The reset control can initialize all registers to zero.

Finally, for multiprocessor networks, the chip has enable-in, enable-out, and bus-request signals to allow direct interconnection of multiple CPUs to a common data and address bus (Fig. 2a). To implement direct-memory-access (DMA) systems, or multiprocessor networks with user-defined priority schemes, the bus-request and enable-in signals can be used with minimal external circuitry as indicated in Fig. 2b. The DMA design philosophy can be used to advantage in realizing plug-in options for Scamp-controlled systems. For simple systems, the bus-request and enable-out lines do not need to be used, and the enable-in input can be permanently set.

### Scamp's circuitry explored

The Scamp CPU (Fig. 3) is based on an 8-bit arithmetic logic unit (ALU), an 8-bit accumulator, and an 8-bit extension register. The extension register, essentially an extra accumulator, also provides an 8-bit serial input-output function under program control and has a flip-flop latch at its output so that the register's contents can be manipulated while the serial output remains constant. The serial input-output ports can minimize system cost by reducing the number of external data lines that must be routed around the system. The ports also can be easily expanded with standard multiplexer and demultiplexer chips that are controlled by Scamp's latched flag outputs.

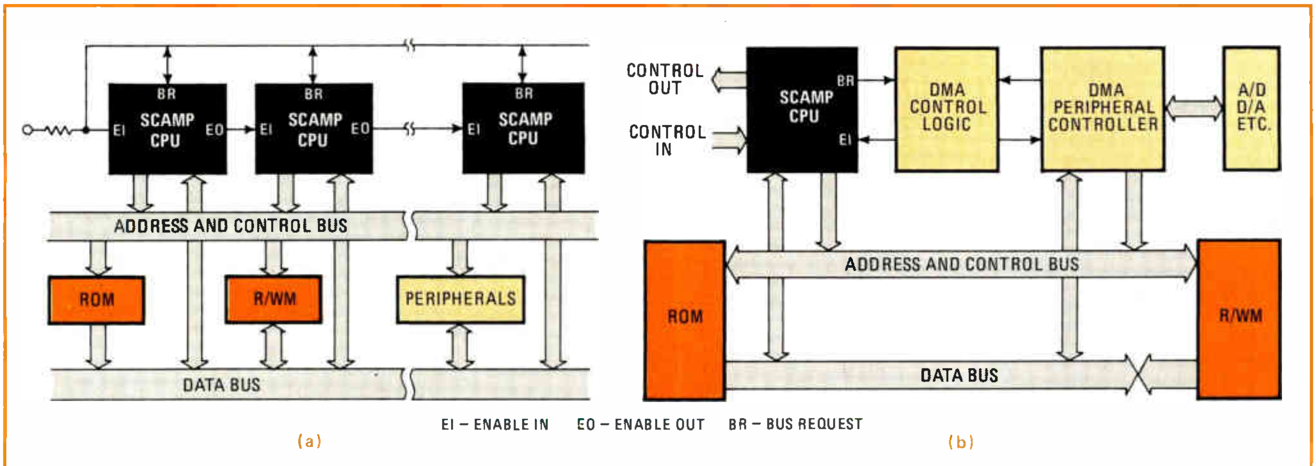
External parallel data and instructions are accessed over an 8-bit Tri-state data bus. An incoming 8-bit instruction is assembled in the instruction register and then decoded by the instruction decode and control PLA. If a two-byte instruction is decoded, the second byte is guided to the data I/O register, where it can be used as an address modifier or as immediate data.

Scamp can access up to 4,096 bytes with its 12-bit latched address bus output, but four extra address bits are multiplexed and sent out on the data bus with the address-ready strobe to attain full 16-bit addressing for 65 kilobytes. Addresses are generated by adding the signed-twos complement displacement value in the instruction to the contents of one of the four 16-bit pointer registers (P0–P3), one of which (P0) also serves as the program counter. Two pointer bits in the instruction designate which of the four pointer registers is to be used. Depending on the state of a mode bit in the first instruction byte, the pointer register contents either will remain unchanged or will be replaced by the updated address. The sequence of generating the memory ad-

## Microprocessor prices and uses

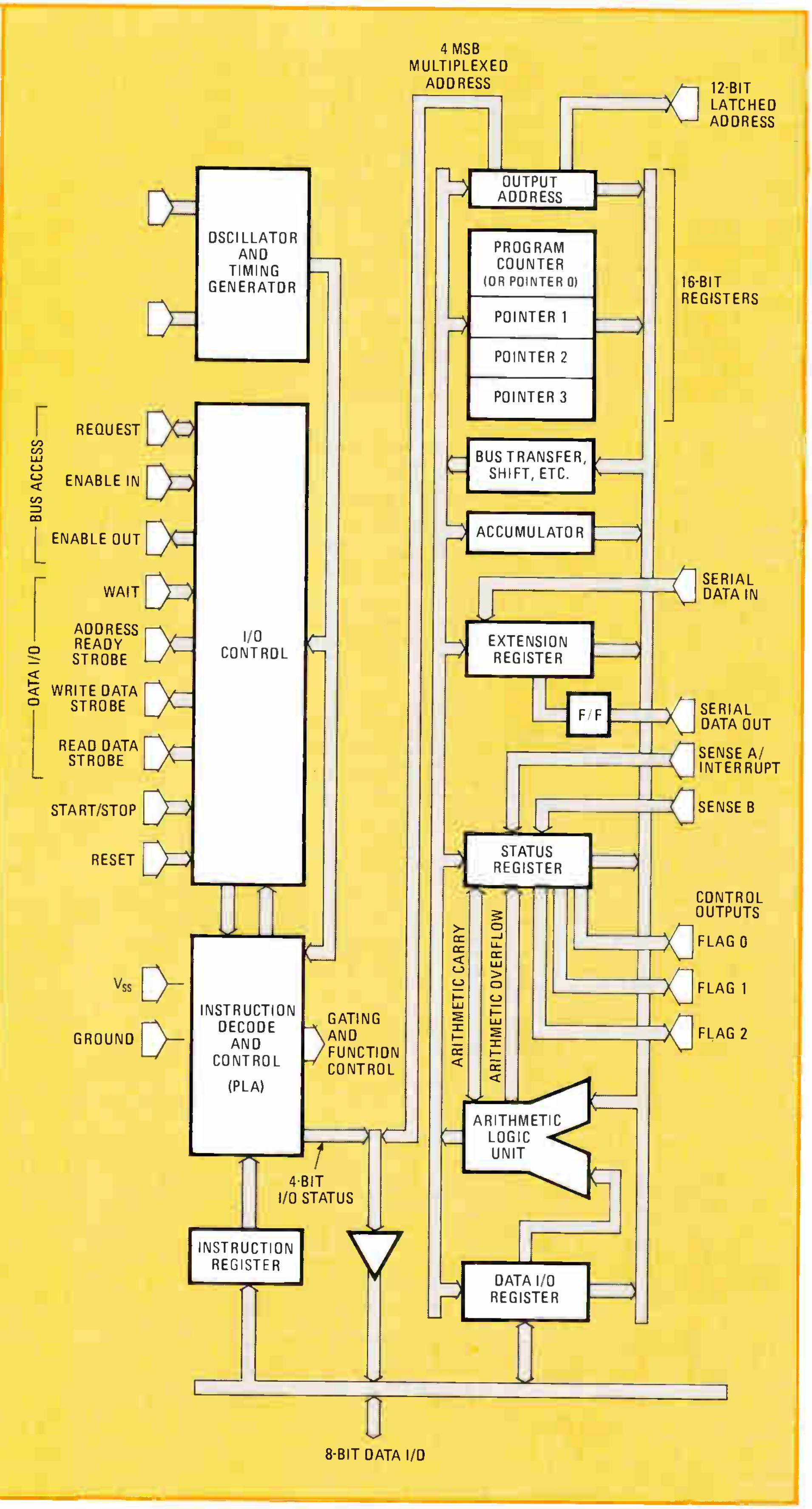
To be cost-competitive in a given application, microprocessor chips must not exceed the upper price limits shown here.

| Minimum target price | Typical application |
|---|---|
| $500 | Low end of minicomputer range (dedicated machines). |
| $200 | Numerical machine-tool controllers, military applications. |
| $100 | Communications, industrial scales. |
| $50 | Terminals, traffic-light controls, medical instrumentation, peripheral controllers, business equipment. |
| $25 | Cash registers, low-cost peripheral controllers, scales, copiers, auto analyzers. |
| $10 | Instrumentation, games, replacement of mechanical logic. |
| $8 | Games, hobby applications, appliance control. |




**2. Multiprocessors.** With the enable and bus request signals, Scamp chips can be directly interconnected in multiprocessing schemes (a). The same signals also allow easy implementation of direct-memory-access systems with a minimum of external circuits.

| INSTRUCTIONS | MNEMONIC |
|---|---|
| **Double byte:** | |
| *Memory Reference* | |
| Load | LD |
| Store | ST |
| AND | AND |
| OR | OR |
| Exclusive-OR | XOR |
| Decimal Add | DAD |
| Add | ADD |
| Complement and Add | CAD |
| *Memory Increment/Decrement* | |
| Increment and Load | ILD |
| Decrement and Load | DLD |
| *Immediate* | |
| Load Immediate | LDI |
| AND Immediate | ANI |
| OR Immediate | ORI |
| Exclusive OR Immediate | XRI |
| Decimal Add Immediate | DAI |
| Add Immediate | ADI |
| Complement and Add Immediate | CAI |
| *Transfer* | |
| Jump | JMP |
| Jump if Positive | JP |
| Jump if Zero | JZ |
| Jump if Not Zero | JNZ |
| *Miscellaneous* | |
| Delay | DLY |
| **Single byte:** | |
| *Extension Register* | |
| Load AC from Extension | LDE |
| AND Extension | ANE |
| OR Extension | ORE |
| Exclusive-OR Extension | XRE |
| Decimal Add Extension | DAE |
| Add Extension | ADE |
| Complement and Add Extension | CAE |
| *Pointer Register Move* | |
| Exchange Pointer Low | XPAL |
| Exchange Pointer High | XPAH |
| Exchange Pointer with PC | XPPC |
| *Shift, Rotate, Serial I/O* | |
| Serial Input/Output | SIO |
| Shift Right | SR |
| Shift Right with Link | SRL |
| Rotate Right | RR |
| Rotate Right with Link | RRL |
| *Miscellaneous* | |
| Halt | HALT |
| Exchange AC and Extension | XAE |
| Clear Carry/Link | CCL |
| Set Carry/Link | SCL |
| Disable Interrupt | DINT |
| Enable Interrupt | IEN |
| Copy Status to AC | CSA |
| Copy AC to Status | CAS |
| No Operation | NOP |




**3. Scamp itself.** The Scamp central processing unit is based on an 8-bit arithmetic logic unit and 8-bit accumulator. Input and output data is passed along an 8-bit bus, and a 12-bit bus carries addresses. Four extra address bits may be multiplexed on the data bus.

dress and updating the pointer register contents is designed to facilitate the use of the pointer registers for software stack pointers.

Scamp uses a software stack—an area in read-write memory set aside under program control. An on-chip hardware stack would provide increased performance, but only until the stack overflowed. This may not be a problem for carefully structured systems, but casual use of a hardware stack can cause anguish at system test. Thus, for the hardware stack to be generally useful, there should also be on-chip indicators for stack full and stack empty, which increases the chip area. However, the on-chip hardware required for a software stack consists primarily of a stack-pointer register and appropriate increment/decrement control. An indication of overflow and underflow is not so critical as for an on-chip hardware stack, since the software stack can be easily expanded in the system memory.

An 8-bit status register provides three latched flag outputs and accepts two sense inputs—Sense A and Sense B—which can be tested for presence or absence under program control and may represent any function. Sense A also serves as an interrupt input. In addition, the status register contains the interrupt enable flag as well as arithmetic carry and overflow flags. The carry flag is also used as a link bit for multiple-byte shift and rotate instructions.

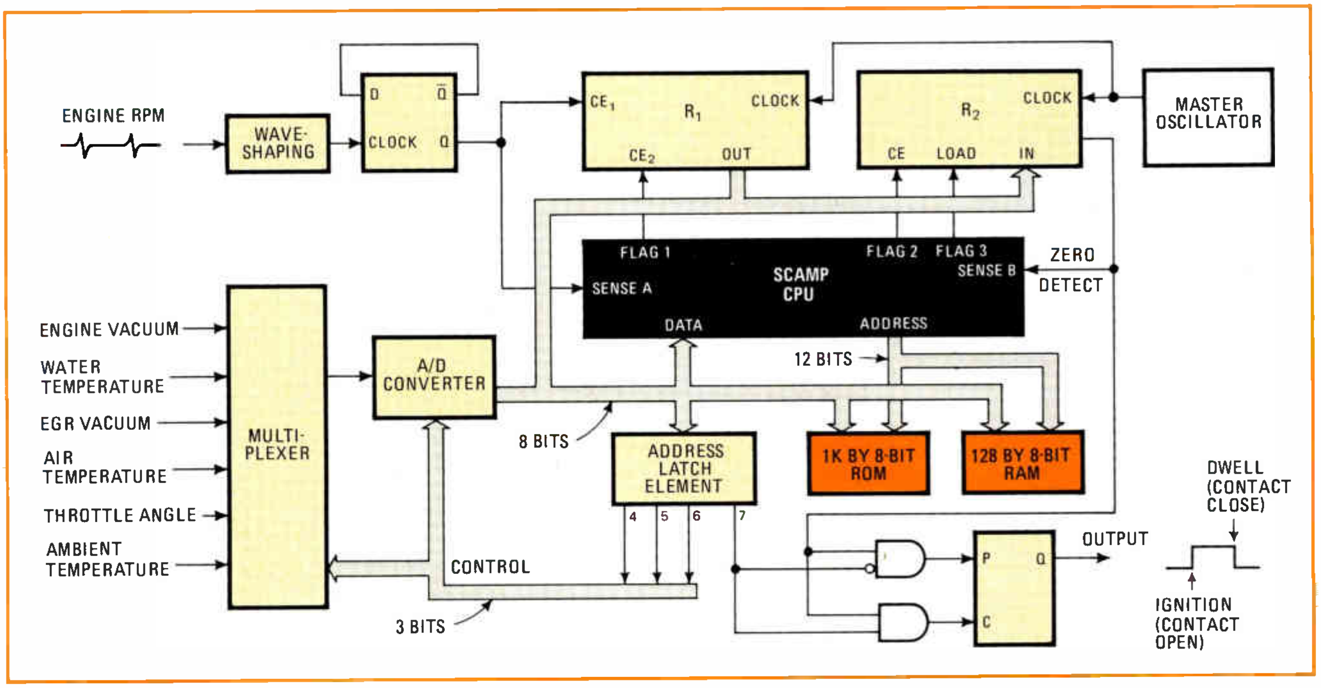
The provision of the interrupt input means that the processor does not have to use valuable computing time looping through a scan sequence. The interrupt, when sensed, clears the interrupt enable flag and causes the contents of the P3 register to be exchanged with the contents of the program counter, P0. Thus, further interrupts are inhibited and the preinterrupt status of the program counter is saved. The starting address of the new subroutine, which had been previously stored in P3, can then be executed. Depending on system requirements, the interrupt subroutine can save other pre-interrupt status information in memory.

## Scamp's instructions explained

The instruction set (Fig. 3) has, first of all, a class of two-byte memory-reference instructions that generate addresses based on the second byte of the instruction and the contents of any of the four pointers. The pointer may be incremented or decremented by any value between 1 and 128, a feature that is useful for stepping through tables in the memory. This feature can also be used by any of the memory reference instructions to implement a software-stack capability as mentioned earlier. A second class of two-byte instructions, called immediate instructions, is similar to the class of memory-reference instructions, but uses the second byte of the instruction for data rather than address modification.

There are two instructions—increment and load, and decrement and load—in which the contents of memory are incremented or decremented and the result left in the accumulator. While the increment or decrement is taking place between the memory-read and memory-write, the chip's bus-request line remains active, so that these instructions may be used in a multiprocessor scheme—one processor can test and update a location in memory and be assured that another processor will not interfere, a feature difficult or impossible to provide with most microprocessors.

A class of single-byte instructions operates on the data in the extension register. (This is the same type of operation as the memory reference except that data is taken from the extension register.) Data brought into the extension register through the serial-in port, for example, can be manipulated as parallel data with one of these instructions. Another instruction simply shifts the




**4. Revving up.** Scamp can generate ignition dwell and timing angles based on engine parameters as inputs. The external registers, $R_1$ and $R_2$, allow the system to handle high engine speeds by sampling engine conditions every other cycle.

extension register and provides input through the serial-in port and output through the serial-out port.

A two-byte programed delay instruction combines its second byte with the contents of the accumulator to form a 16-bit number which then determines the length of a delay. This can give a delay in processor execution of about 6 microseconds to as much as 256 milliseconds. While this instruction is being executed, the D-flag, one of the four I/O status bits on the 8-bit I/O bus (see Fig. 3) is set to indicate that the delay instruction is currently being executed.

A separate single-byte instruction enables the H-flag, another of the four I/O status bits, to serve as an external timing strobe or a synchronization pulse for debugging software. Alternatively, it could be latched and fed back to the continue input to provide a software halt.

Other single-byte instructions load and unload the pointers by exchanging their contents with the accumulator or with the program counter. This allows the system to jump to a subroutine and also save the current values of the program counter. And still other single-byte instructions set or clear the carry flag and interrupt enable flag in the status register, or move data between the status register and the accumulator.

### Scamp's uses expounded

Low-cost microprocessors will be useful in many applications that were previously served by sheet-metal logic:

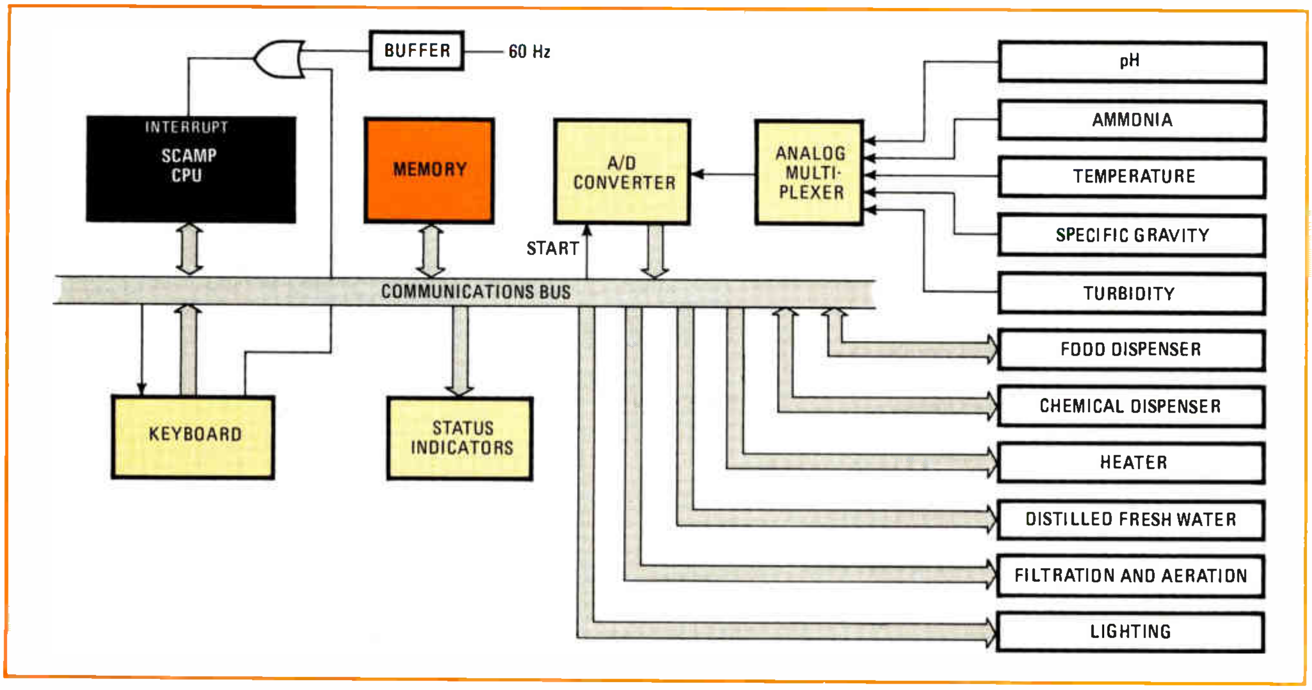
- Entertainment devices, such as pinball machines
- Automotive ignition controls.
- Water-quality control systems, as for tropical fish tanks and swimming pools.
- Heavy-appliance controls in the home.

In a pinball machine, for example, the microprocessor can make an accept/reject decision when the coin is inserted, display the number of players and the number of games paid for, and flash a game-start signal. While the game is being played, the processor can track the scoring for each player, decide which final scores merit a free game, and award special prizes for attainment of specific targets. Meanwhile, the machine owner can easily adjust the program to different levels of prizes, gather data on the number of games played per day, week, or month, and maintain a running total of the amount of money in the coin box. Because of the relatively low speed requirements, much of the communications could be handled by serial I/O. Also two or more low-cost Scamp processors can be dedicated to specific applications in different parts of the box.

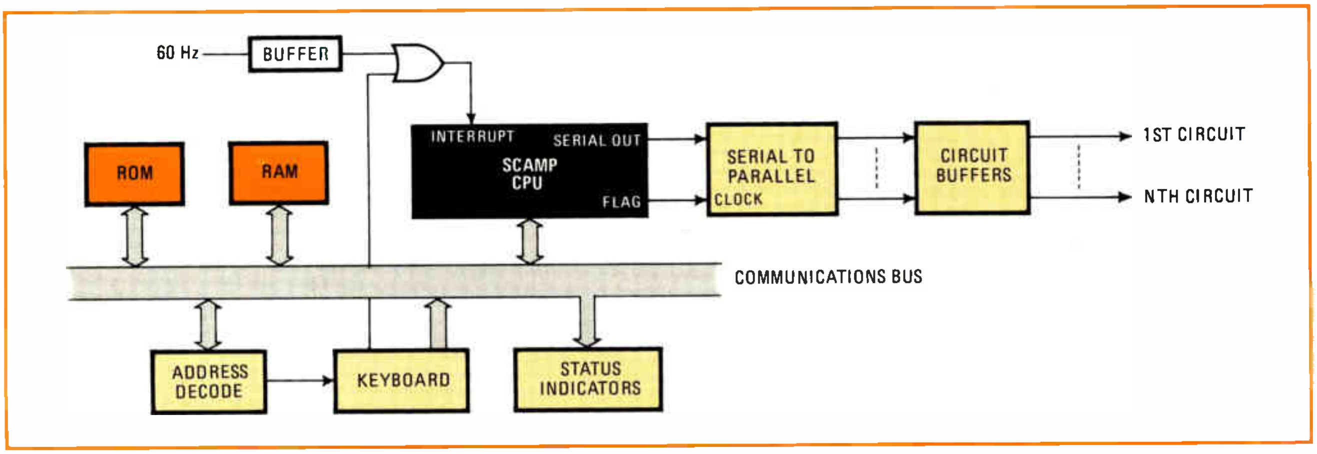
In automotive applications (Fig. 4), the processor operates on such inputs as engine rpm, vacuums, pressures, and temperatures and generates ignition dwell and timing angles. The CPU performs the necessary computations with look-up tables and/or by solving the engine equations directly. The system uses a 128-by-8-bit RAM, and all memory addressing is done with the 12 address lines.

Scamp executes an instruction in somewhere between 10 and 50 $\mu s$. However, at a speed of 6,000 rpm for an eight-cylinder engine, a spark must occur every 2.5 ms. If the CPU is to perform computations between every spark, then with an average instruction-execution time of 20 $\mu s$, the CPU can perform about 125 instructions between sparks. This may not be enough to fully compute spark advance and dwell, but the microprocessor undoubtedly could handle the job if it were to compute these values only every other cycle.

In Fig. 4, registers $R_1$ and $R_2$ act as counters. $R_1$ is an engine rpm sampling counter, while $R_2$ is enabled when the CPU outputs a flag and detects a top-dead-center (TDC) signal from the engine. An oscillator of known




**5. Goldfish bowl.** The Scamp can assimilate data on conditions in a fish tank and perform the necessary calculations to adjust the environment for the particular type of fish. The same type of circuitry would also be useful in controlling swimming-pool conditions.




**6. Timing without gears.** An interval timer can be built to control home appliances by using Scamp's serial output port to transfer the contents of the extension register to a decoder circuit, activating one of several loads. The flag output clocks the decoder circuit.

frequency clocks $R_1$ until the next TDC signal arrives, which inhibits the counting and interrupts the processor. Thus, engine rpm is sampled every other revolution. The CPU saves the count and determines rpm. The required ignition advance angle is then determined, based on rpm and the engine environment data available through the transducers. $R_2$, a down counter, is then preloaded by the CPU with a count equivalent to the advance angle. The processor enables the counter and the oscillator decrements it to zero. Upon zero detect, the ignition circuitry is enabled and generates the spark.

### Controlling water quality

Another use for the microprocessor is to control the quality of water in fish tanks or swimming pools (Fig. 5). In the past, salt-water aquariums for tropical fish have been difficult to maintain because of the number of critical environmental controls that many species require. This can become a big problem in a tropical-fish store where many tanks must be controlled. Some of the main items that require regulation are specific gravity, temperature, ammonia, pH, lighting (incandescent and ultraviolet), food dispensing, filtering, and aeration. An automated system built around a microprocessor provides the attention to details normally performed by a human operator. Thus, several aquariums could be controlled automatically by only one microprocessor.

For example, transducers would measure pH, ammonia, temperature, turbidity, and specific gravity. The microprocessor monitors these levels and makes suitable changes, such as adding fresh water or chemicals, changing temperature, and adjusting the amount of food input as well as the time interval of feedings.

The operator, with a keyboard entry, may change setpoints as required by a particular type of fish. In the block diagram shown, the inputs from the pH, temperature, ammonia, specific gravity, and turbidity sensors are multiplexed through an analog-to-digital converter and applied to the CPU on the data bus. Status indicators, driven by the CPU, can also be included in the system for each variable.

As a side benefit, a built-in inventory control could be programed. All the input information necessary would already be available from the transducers. Thus, the exact operating costs of each aquarium could be made immediately available to the user, allowing price adjustments that reflect true costs rather than simply educated guesses.

In the home, a single microprocessor could assure efficient use of several heavy appliances, such as air conditioners, ovens, dishwashers, and washing machines. The system could be programed from a keyboard to operate in off-peak hours. For example, the air conditioner could be programed to maintain a maximum temperature of say, 85° F while the occupants are not at home, and to start cooling the rooms about an hour before they were due to return. An interval timer that would be useful for such applications is shown in Fig. 6. The timer can control eight circuits with five different time intervals per circuit over a 24-hour period.

In the circuit, note that the serial-to-parallel converter is driven from the processor's serial-out port. In Scamp, the extension register is loaded with the information at the proper time and then sent out through the serial-out port. This allows the controlled circuits to operate while the register is being loaded, since the loading occurs quite quickly. The flag output from the processor is used to clock information into the serial-to-parallel register. Inside Scamp, the typical operation would be to shift the register again, pulse the flag, and so on. This would be done eight times to transfer the contents of the register to the serial-to-parallel converter.

Another application is in a precision scale, where the applied weight is countered by an applied feedback force that is under control of the microprocessor. When the force transducer indicates zero output, the system is stopped, and the amount of feedback force applied is measured to indicate the unknown weight.

Thus, logic in almost any form—pneumatic, mechanical, electromechanical, or whatever—is amenable to electronic program control. Regardless of the original logic type, all inputs and outputs can be converted to bits of electronic data that can also be stored in a low-cost semiconductor memory. This natural evolution of the IC process means that flexible, user-controlled intelligence will continue to appear in an increasing number of unfamiliar applications. □

# Needed for logic testing: a new breed of instruments

For small-scale requirements, when computer control is not feasible, a number of new instruments are entering the field to make accurate fault analysis easier and less expensive. But more is wanted

by Andy Santoni, *Instrumentation Editor*

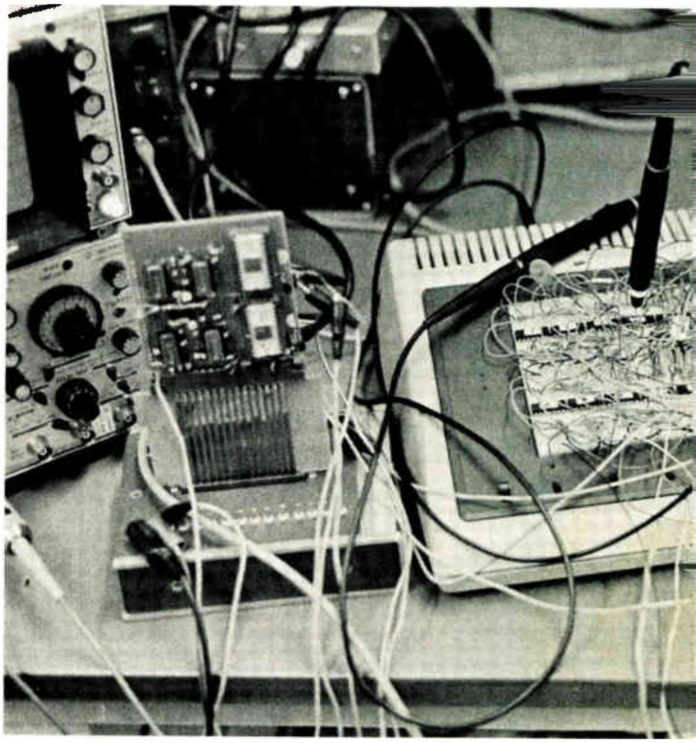
☐ With more digital logic finding its way into more products, the time has arrived when few EEs can do without a basic understanding of the techniques and equipment available for fault finding. Especially in the area of field service, the high costs of labor and inventory are raising the premium on faster, easier ways to examine and repair digital systems. There is also the growing certainty that an engineer will at some time be involved in digital design.

Computer-controlled testing obviously is the answer for high-volume production-line testing, but this is normally out of the question when field service, laboratory design, or small quantities are involved. In low-volume instances such as these, other tools and methods for digital troubleshooting are available (see table). Test clips, logic probes, and other hardware are becoming standard items in the tool kits of field-service engineers, and data-domain instrumentation such as logic monitors and trigger generators will soon become common in the lab. The power of these tools in helping to solve digital troubleshooting problems covers a wide range of circumstances, and the price ranges are also wide.

However, the basic questions concerning test-systems are the same whether the systems under test are digital or analog. The questions pertain to performance, interface, flexibility, and size. For example, in digital-equipment design and development (Fig. 1), test gear must offer as much flexibility as the oscilloscope brings to analog circuits. In the lab, problems are generally too varied and dynamic for less sophisticated tools, and future requirements also may include higher performance and different capabilities.

Microprocessors, for example, embody significant changes in design that must now be considered in selecting test equipment for the lab. For one thing they have made bus-oriented architectures common, and these multi-line systems cannot easily be tested with equipment designed to examine single-line events.

Digital test instruments also should not fix a limit on the performance of prospective designs by limiting the designer's ability to test. That is, digital test equipment must be able to examine the detailed operation of developmental circuits as well as their functional behavior. It isn't enough to check a circuit's adherence to a truth-table under average environmental conditions. The designer must also be able to check circuit parameters such as logic-level voltages and current drain over a range of power supply voltages, at temperature extremes, and under other adverse conditions.



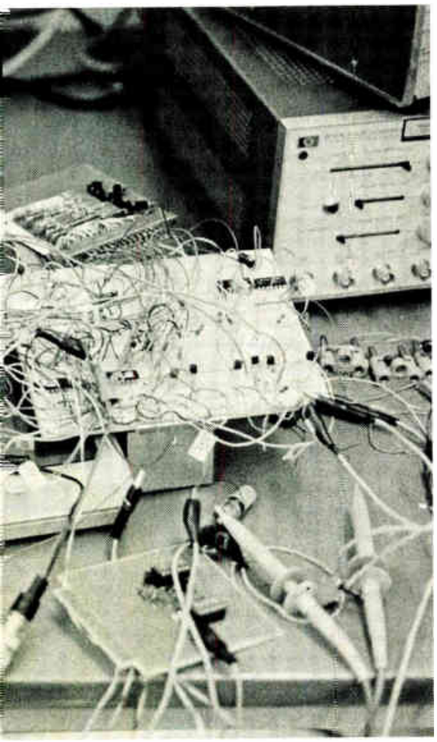
## Outliving logic

Instrumentation may also outlast particular logic families. Equipment that can handle only one logic type—transistor-transistor logic, for example—may become obsolete as newer logic families come into use. To keep products competitive in price and performance, a company must be able to take advantage of the most appropriate logic family and not be limited by the test equipment available to its designers.

Often more important, a logic tester must be able to exercise a logic board at the highest repetition rate the board will encounter in operation. Stepping a microprocessor through its program at a low clock rate may fail to uncover timing problems that will cause incorrect commands or data to be placed on a bus. This is because glitches and undefined states may occur only at high clock rates if, for example, a random-access memory or other device in the system is not working up to its specifications.

Hence, testing a multiline digital product during the design and development phase of its life cycle requires instrumentation that can examine logic states, voltages, and frequencies on a number of leads simultaneously. Having as much capability as possible is a big plus. A technician or engineer with experience in testing digital products should not be handicapped by a system that yields only minimal data, because he or she can often infer useful information from an instrument beyond its explicit display. In short, scope traces can be more useful than a go/no-go lamp.

Digital test equipment for the production line, on the other hand, should be relatively simple to use, with little or no need for an operator to interpret the output data. Where production volumes are relatively small, the simplest go/no-go indication of basic board parameters—checks of power supply continuity and freedom from shorts, for example—may suffice, and engineering can be given the responsibility for troubleshooting more subtle faults at a higher assembly level. Production-line test equipment should also be easy to operate, with as few front-panel controls as possible so as to lessen the chance for maladjustment.



**1. In the lab.** Equipment for testing digital circuits in the lab should be sufficiently flexible and extensive to meet unforseeable demands. This setup, on designer Barry Bronson's bench at Hewlett-Packard's Santa Clara division, includes a scope, pulser, probe, and clip connected to a breadboard instrument design.

## No pinpointing

There's another reason instruments used for testing on the production line can often be simpler than those used in design and development—they need not be required to pinpoint design faults. By the time a product goes into production, the only tests that should be necessary are those that verify that the product is constructed according to the appropriate drawings, and that the components installed on the board function correctly.

Once a product leaves the factory, a new set of testing ground rules comes into effect. In the field, size, weight, and operating speed become the chief concerns.

The kind of equipment required for field service varies of course with a firm's approach to such service. The kind of instrumentation needed to troubleshoot, test, and repair on-site differs considerably from the kind needed in field offices where instruments might be returned for service.

## Sending them back

One method for servicing field-installed equipment that cannot tolerate down-time is to swap boards. A technician carries a set of good boards to the installation, replaces boards one at a time until the system works, then sends the defective board or boards back to the factory for trouble-shooting and repair.

Board-swapping, though, has some disadvantages. A large number of printed-circuit boards must be kept "in the pipeline" between the factory and the field—good boards going out and bad boards coming back. Since these boards are not being used in operating systems, their manufacturer earns no return on the expense of building them. The cost of building the boards and the cost of financing a large inventory of boards are both high. Some say that inventory costs can exceed all other field maintenance costs.

Adding to the inventory problem is the number of supposedly defective boards returned to the factory that are actually good. This is usually the result of field technicians failing to plug all suspected boards back into the system to determine which one actually caused the malfunction. Instead, all the boards are sent back and, if the tests available in the factory cannot uncover all possible failure modes, the question of whether a board is really good or not may never be answered.

One alternative to board swapping is to move repairs out of the factory and back to the field. When field-testing requirements and equipment were simpler, a technician with a voltmeter and a soldering iron could get a system back in operation just by replacing a few parts. New types of field testers are an attempt to make this possible again today.

Transition counting, for example, permits the tracking of faults to the component level without detailed knowledge of a circuit's operation. To implement a transition-counting system, the number of transitions occurring at points on a printed-circuit board under a fixed set of input conditions is counted. A technician then need only attach a counter to points on a suspect board and compare the results to those obtained on a known good board to determine which components caused a failure.

## Using microprocessors

While transition counting eases the problem of testing complex digital circuit boards, it is not the final answer. Not all faults can be isolated by the technique, and the problems of removing and replacing integrated circuits soldered to a pc board remain. If and when this

| DIGITAL TROUBLESHOOTING EQUIPMENT | | | | | |
|---|---|---|---|---|---|
| | Tests performed | Probing nodes | Negative-time memory | Display tracking | Common price |
| Oscilloscope | Parametric | Few | No | Voltage rate | $2,000 |
| Timing analyzer | Parametric | Many | Yes | n (Word rate) ~Voltage rate | $2,000 – $10,000 |
| State analyzer | Functional | Many | Yes | Word rate | $2,000 – $5,000 |
| Trigger generator | Functional | Many | – | – | $200 – $2,000 |
| Probe | Limited parametric | One | No | Bit rate | $50 – $200 |
| Clip | Functional | One DIP | No | Bit rate | $50 – $250 |
| Pulser | Functional | One | – | – | $75 – $100 |
| Comparator | Functional | One DIP | No | Bit rate | $400 – $500 |

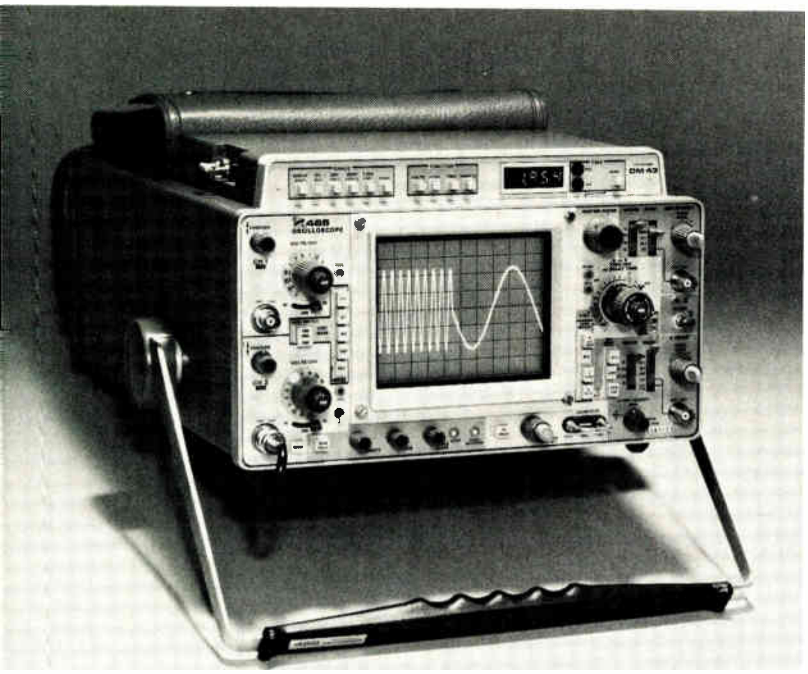
mechanical problem is solved, another approach to digital field service may be available—microprocessor-controlled testers.

Microprocessors, which constitute one cause of new problems in digital testing, may also offer a solution. By shrinking the physical space requirements for computing power, microprocessors could make smaller digital-logic test systems available, leading to automated, fault-diagnosing portable testers.

Portability is probably the most important consideration for field service equipment (Fig. 2) since the most capable test equipment is of no use if it cannot easily be moved to an installation. The perfect field tester would be small and light, simple and quick to operate, and give direct indications of faulty parts.

Unfortunately, no such tester exists, but a growing number of instruments becoming available do attack certain parts of the problem. Compact, lightweight probes, pulsers, test clips, and comparators, along with oscilloscopes that have features aimed at the digital service market, are helping make field testing easier, and other kinds of test gear are being introduced to aid the designer in the lab and the technician on the production line.

**2. In the field.** The overriding requirement for field testers is portability. Combining a digital multimeter with an oscilloscope, as in this Tektronix unit, makes it easier to bring more powerful test tools to the site by eliminating the separate box for a DMM.



Oscilloscopes (Fig. 3) are still the most common digital test instruments, in part because they are familiar to most users. And many new oscilloscopes have features tailored to the demands of digital testing.

Because of the increasing speed of pulses in digital circuits, digital testing requires scopes with large bandwidths and short rise times. Until a few years ago, this suggested only bulky, heavy scopes. The model 453 scope, a portable unit with 65-megahertz bandwidth introduced by Tektronix Inc. in 1964, changed that.

"The 453 allowed an engineer to bring a scope to the field," says Dave Dunlap, marketing staff engineer at Tektronix. It changed the concept of the scope from a resident test instrument to a portable one. Field service organizations were no longer required to keep an oscilloscope available at every digital system installation large enough to require frequent maintenance.

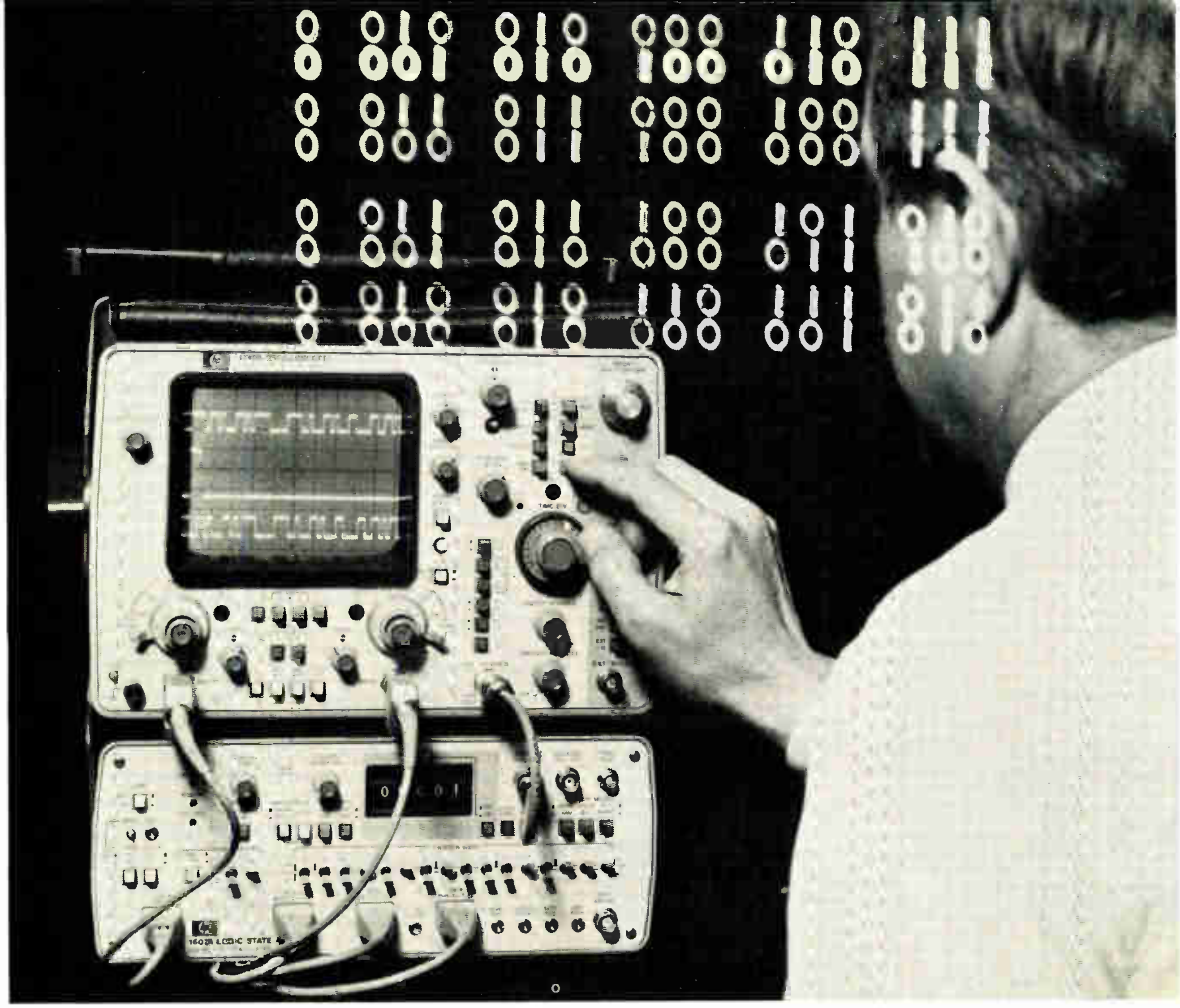
Today, Tektronix' 100-MHz model 465 is standard equipment for digital field-service applications. But the continuing demands of digital service are bringing newer products into that market, like Hewlett-Packard's model 1740A [*Electronics*, Sept. 4, p. 30] and Dumont Oscilloscope Laboratories' model 1100P [*Electronics*, Aug. 21, p. 133]. But the demands of digital service and the cost of technicians' time for repairs are outstripping the capabilities of the oscilloscope.

One answer is to combine oscilloscopes with other measurement instruments in one package, as in Tektronix's DM40 and DM43 multimeter and 719A transition-counter piggyback for portable scopes, or HP's 1722A oscilloscope with digital voltage and time readout. Another answer is to design an instrument like the logic analyzer (Fig. 4) with the display, triggering, and delayed sweep features of an oscilloscope but tailored to the demands of the digital world.

### Testing in the data domain

Logic analyzers fall into three categories: state analyzers, timing analyzers, and trigger generators. State analyzers display digital data, in the form of 1s and 0s on a cathode-ray tube or via light-emitting diodes, in a word-versus-event format. This concentration on word sequences makes state analyzers useful in examining the functional behavior of binary systems. They are especially useful in the design of microprocessor-controlled digital products for examining the flow of command and data words on multi-line buses.

A logic-timing analyzer is more like an oscilloscope; it displays digital data in a word-versus-time format, or reconstructs the original waveform and displays it in a pseudo voltage-versus-time mode. Such displays are somewhat more difficult to interpret than 1s and 0s, but offer information which can be useful in examining the functional behavior of digital products. Timing analy-



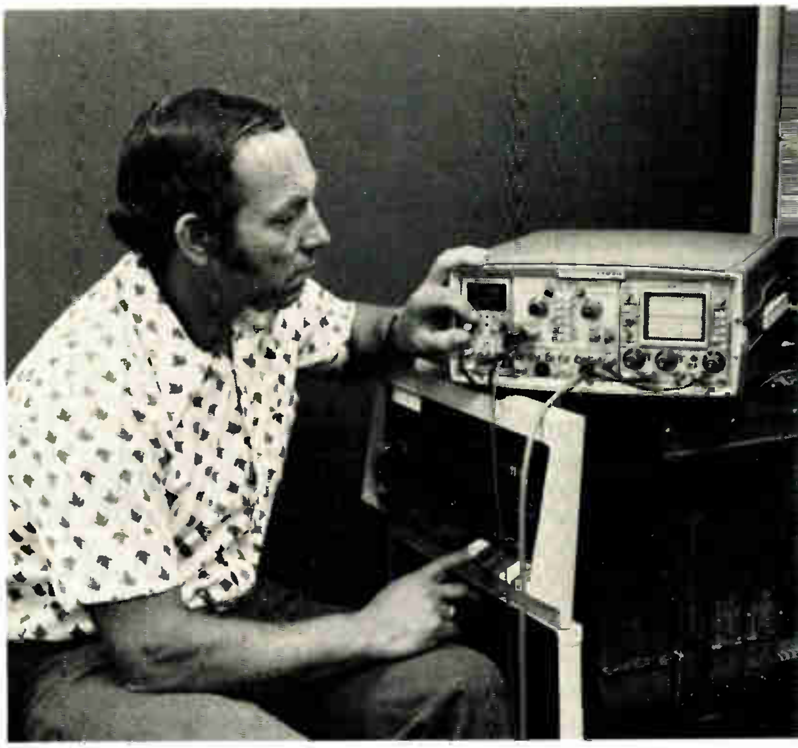
**3. Viewing data.** The latest oscilloscopes offer features aimed at digital testing in the lab or for field service. HP's model 1740A, for example, has a bandwidth of 100 MHz and an optional push button to alternate logic-state with time-domain displays.

zers usually include the capability to display glitches, rise times, and pulse ringing.

Logic-trigger generators are simpler and are designed for use with oscilloscopes. They may be as simple as a four-input AND gate connected to a scope trigger input to synchronize the scope with the occurrence of a particular four-bit parallel word, or may contain digital counters to delay triggering by a set number of events, or shift-register comparators to allow recognition of serial words for triggering.

Logic analyzers are most useful in the first steps of troubleshooting—locating the problem. By examining the sequence of events leading up to a failure, an engineer can usually identify the most likely sources of the problem—the "where." More detailed testing to pinpoint the exact cause of the failure—the "why"—usually requires more detailed analysis of such parameters as timing relationships and logic voltage levels, often concerning just a few signal lines, and can be carried out by logic-timing analyzers or oscilloscopes.

In deciding which logic analyzer is most appropriate



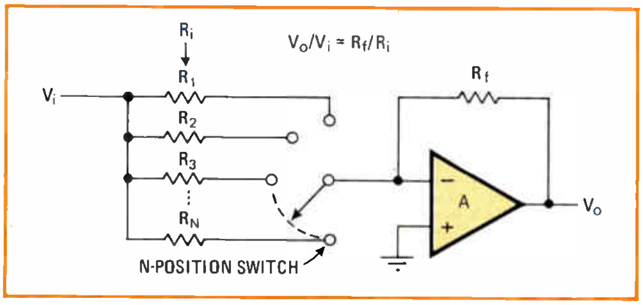
**4. Multi-line analysis.** Logic analyzers examine the activity on each line of a data bus. With Tektronix' LA-501, the display for each line can be shifted to make timing measurements easier.

# Combination logic cuts parts in digitally controlled amplifier

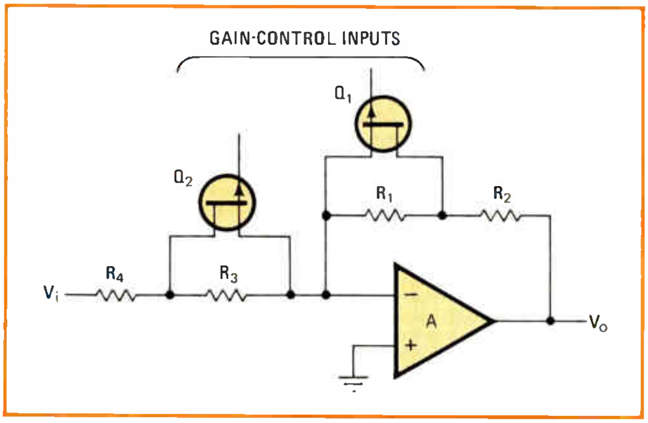
by Reinhard Metz
*Bell Laboratories, Naperville, Ill.*

Measurements on communications and transmission systems often require circuits that permit digital control of amplification or attenuation. These circuits may require many components when many different levels of amplification are required. However, N levels can be realized by using approximately $\log_2 N$ components in various combinations, instead of using N components without forming combinations.

A circuit arrangement that uses N different resistors to provide N different values of amplification (or attenuation) is shown in Fig. 1. The gain of the inverting operational-amplifier stage is equal to the ratio of feedback resistance, $R_f$, to input resistance, $R_i$. Here a different $R_i$ is switched in for each desired level of gain.




**1. Controllable gain.** Ratio of feedback resistance to input resistance in op-amp circuit determines gain. Here N different values of $R_i$ provide N different values of amplification (or attenuation).




**2. Combinations control.** Control voltages on two FETs switch $R_1$ and $R_3$ in or out of circuit in four possible combinations, providing four different values of gain. These values of gain, when expressed in dB, obey a simple rule: the sum of the highest and lowest is equal to the sum of the middle two. An amplifier can therefore be designed to provide equal increments of dB gain (or loss).

The technique of using various combinations of a set of resistors is shown in its basic form in Fig. 2. Using one op amp and four resistors, but only two field-effect transistors, this stage provides four digitally controllable gain values. The four on- and off-state combinations of the control inputs to the two FETs determine four possible values for the ratio of feedback resistance to input resistance in the inverting amplifier configuration, and thus determine the four values of gain and/or loss. The sources of the FET are at virtual ground, and therefore signal fluctuations cannot affect their on-off states. Also, no switch-drive decoding is required because there are already only two switches for four levels.

The four values of amplification or attenuation through the circuit in Fig. 2 obey a useful relationship: if a, b, c, and d are the gains or losses expressed in decibels, the sum of the highest and lowest is equal to the sum of the other two. To demonstrate the relationship, let

$$a = 20 \log\frac{R_1+R_2}{R_4}, \text{ or } \frac{R_1+R_2}{R_4} = 10^{a/20}$$

$$b = 20 \log\frac{R_1+R_2}{R_3+R_4}, \text{ or } \frac{R_1+R_2}{R_3+R_4} = 10^{b/20}$$

$$c = 20 \log\frac{R_2}{R_4}, \text{ or } \frac{R_2}{R_4} = 10^{c/20}$$

$$d = 20 \log\frac{R_2}{R_3+R_4}, \text{ or } \frac{R_2}{R_3+R_4} = 10^{d/20}$$

Multiplying the first equation by the last yields

$$\frac{R_1+R_2}{R_4}\,\frac{R_2}{R_3+R_4} = 10^{(a+d)/20}$$

and multiplying the second equation by the third yields

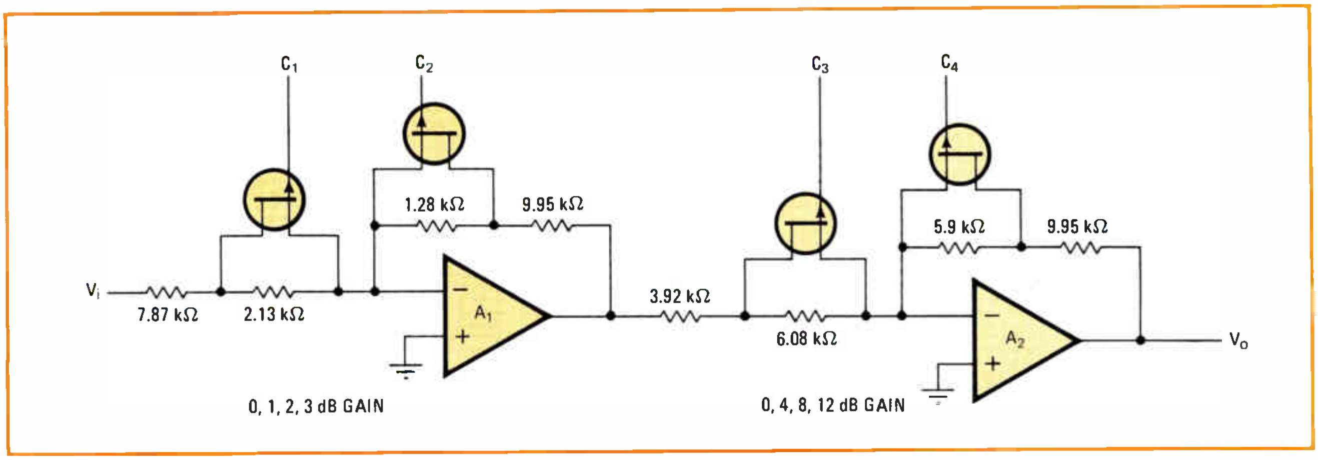
$$\frac{R_1+R_2}{R_3+R_4}\,\frac{R_2}{R_4} = 10^{(b+c)/20}$$

The left sides of these two expressions are equal, and therefore

$$10^{(a+d)/20} = 10^{(b+c)/20} \text{ or } a+d = b+c$$

Thus, for any set of resistors $R_1$, $R_2$, $R_3$, and $R_4$, the sum of the highest and lowest gains or losses (expressed in dB) is equal to the sum of the middle two. In particular, this relationship is satisfied by any "symmetrical" set of gains, such as 0, 1, 2, 3 dB, or −10, -5, +5, +10 dB. Also, any equal-stepped set of gains or losses is symmetric.

A cascade of s stages, controlled by only 2s digital inputs, can extend controlled amplification/attenutation to any desired set of $4^s$ symmetrically spaced dB steps. Figure 3 shows a two-stage amplifier in which the gain is adjustable from 0 to 15 dB in 16 1-dB steps. The values of the resistors are calculated directly from the




**3. More steps.** Cascade of two symmetrically stepped stages provides $4^2$ values of gain, with only 2 × 2 control terminals. Levels in each stage are chosen so that gain is adjustable from 0 to 15 dB in 16 1-dB steps. More generally, cascading s stages, controlled by only 2s digital inputs, can provide any desired set of $4^s$ symmetrically spaced steps of dB amplification or attenuation.

equations for a, b, c, and d, with the unity gain (0 dB) set at

$$\frac{R_3 + R_4}{R_2} = \frac{10\ k\Omega}{10\ k\Omega} = 1$$

The approximately 50-ohm on resistance of a FET is taken into account by increasing the $R_4$s and $R_2$s, and decreasing the $R_1$s and $R_3$s from the calculated values.

Although Figs. 2 and 3 show $4^s$ different values of gain, where s is the number of stages, $2^s$ can be easily achieved by including one stage with only two values of gain if one value of gain in each stage is 0 dB. □

# Bilateral current source is digitally programable


by Andrew Olesin
*Soltek, Montrose, Colo.*


Engineers use adjustable current sources for measuring device characteristics such as transistor beta or diode-breakdown voltage. To automate the procedure, a digitally controlled current source that can be programed for currents of ±1 nanoampere to ±1 milliampere can be made from two operational amplifiers and a multiplexer. The digital inputs can be directly driven by transistor-transistor logic or complementary-MOS, and the polarity of the input voltage determines whether the circuit is a current source or a current sink.

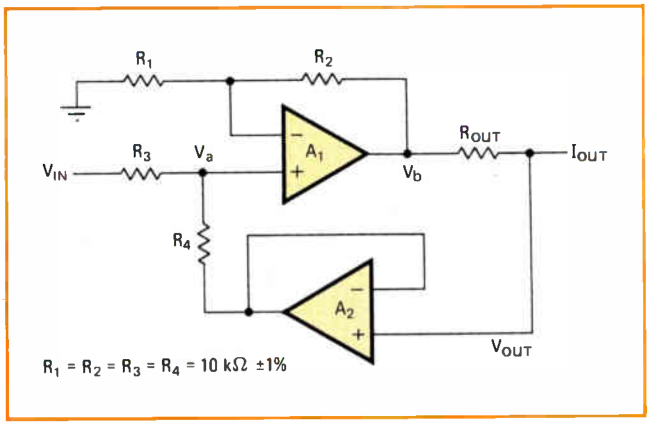
The basic bilateral current source is shown in Fig. 1. Operational amplifier $A_2$ is a high-input-impedance voltage follower that drives the node where voltages $V_{IN}$ and $V_{OUT}$ are summed. The node voltages are

$$V_a = (V_{OUT} + V_{IN})/2$$
$$V_b = V_a[1 + (R_2/R_1)] = 2\ V_a$$
$$= V_{OUT} + V_{IN}$$

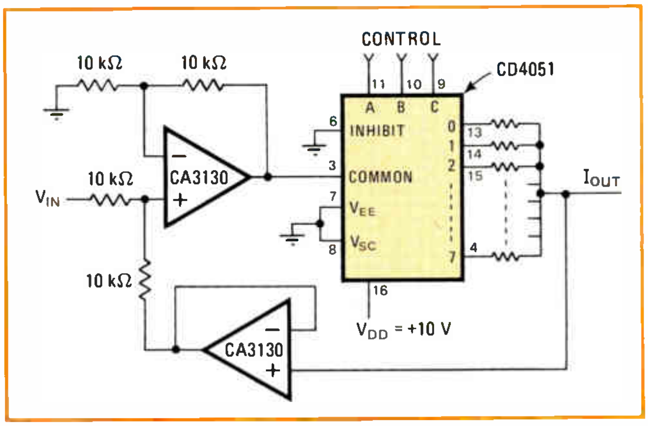
This last equation shows that the voltage across resistor $R_{OUT}$ equals $V_{IN}$; therefore, because $A_2$ has a high input impedance,

$$I_{OUT} = V_{IN}/R_{OUT}$$

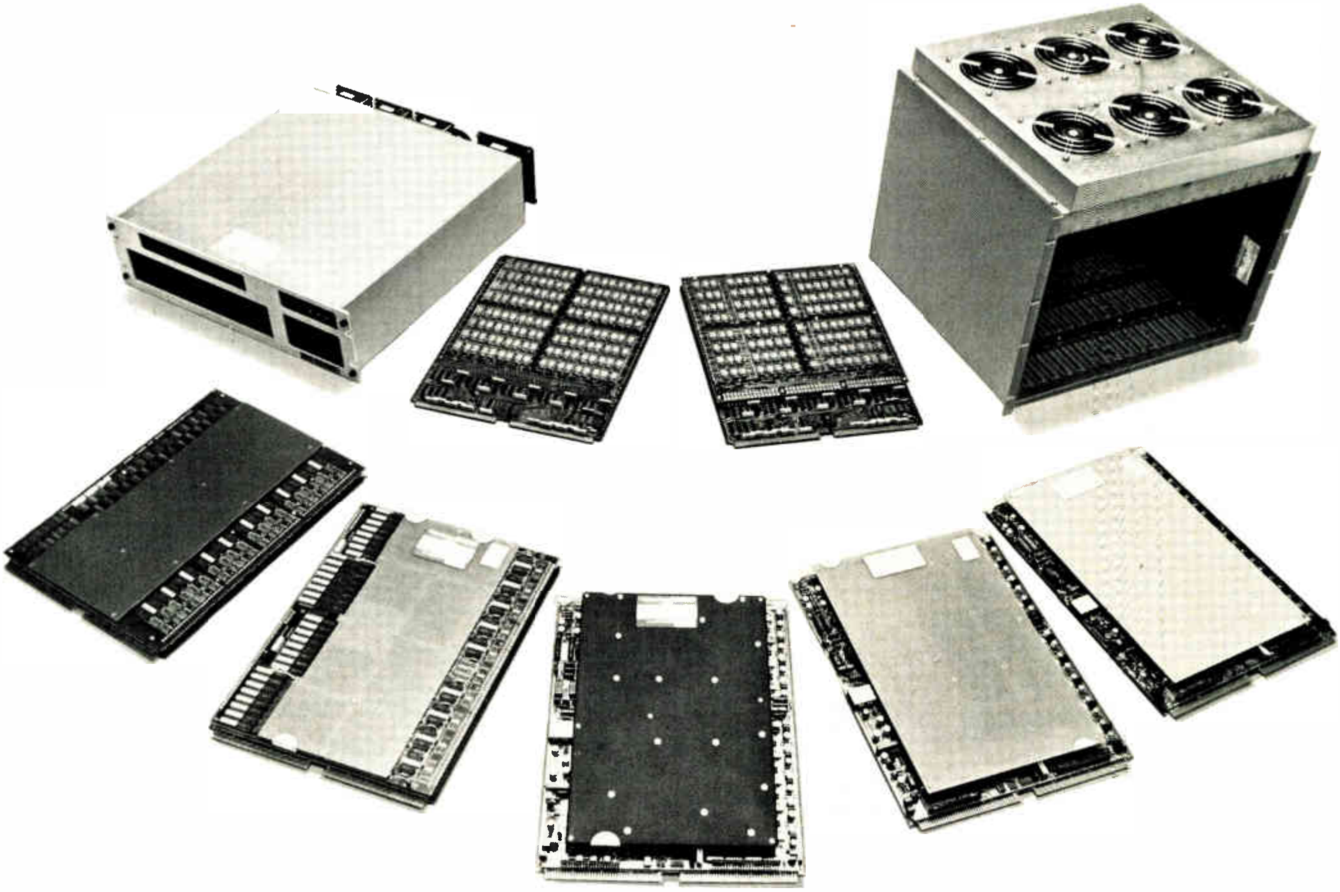
Maximum output current is limited by the current available from op amp $A_1$ at its maximum output volt-




**1. Current source.** Basic circuit provides output current of $V_{IN}/R_{OUT}$. Direction of current is given by sign of $V_{IN}$. Resistance $R_{OUT}$ can be made digitally adjustable, as shown in Fig. 2.




**2. Programable.** C-MOS multiplexer connects various resistors into circuit to serve as $R_{OUT}$. Thus current is adjusted by digital control.



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age. The minimum current is governed by the input current of $A_2$, which should be less than 1% of the minimum current from the source.

Although the circuit will function well with any general-purpose operational amplifier, the CA3130 C-MOS/bipolar op amp is especially suited for this application because of its field-effect-transistor input, full voltage output swing, and low cost.

Programable current ranges are obtained by inserting one or more CD4051 C-MOS analog multiplexers in series with resistors of selected values, as shown in Fig. 2. The CD4051 multiplexer has internal level-shift circuitry to accommodate different logic families.

For the higher current ranges ($R_{OUT}$ less than 10 kilohms), it may be necessary to take the on resistance of the switches into account by adjusting the combined resistance of the switch and resistor to yield accurate currents. If $V_{IN}$ is less than ±0.5 V, the op-amp input-offset voltages should be nulled. □

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.

## Graphic symbols clarified

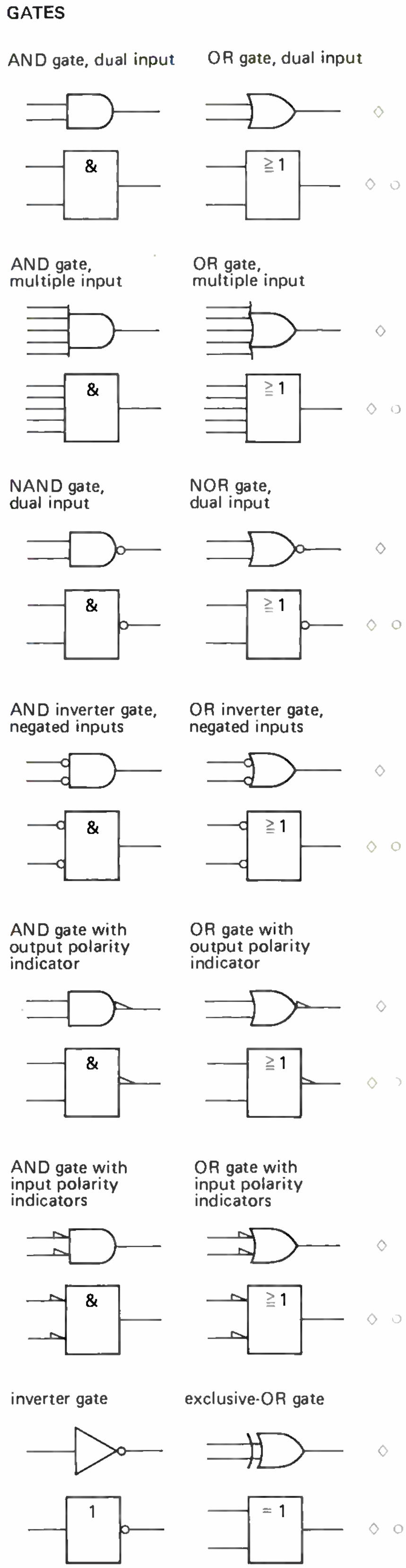
A number of readers were apparently confused by the gates section of two-state logic devices in the "Graphic Symbols for Electronics Diagrams," April 3, 1975. To clear up this confusion, the gates section has been modified and reproduced here. It can be clipped out and placed over the original section for an instant revision. To summarize, the revision includes changes in the labels for the inverting-type gates, and the symbols showing polarity indicators (small right triangles) or negation indicators (small open circles) have been separated.

One source of confusion, as a number of readers pointed out, is that either polarity indicators or negation indicators, but not both, should be used on a drawing. The polarity triangle inverts only voltage level and does not invert logic state. The negation circle, on the other hand, inverts only logic state, not voltage level. When the polarity triangle is placed on a line, that line is associated with a logic 1 when the voltage is low.

If a logic drawing makes use of the polarity indicators, there is no need for a statement as to whether the design is based on positive logic or negative logic. However, when negation circles are used, the drawing must state whether the design is employing positive or negative logic.

One other symbol should be modified. The labels for the input terminals to the upper R-S flip-flop are transposed. The letter S should designate the top input line, and the letter R the bottom input line.

Again, as indicated in the introductory comments to the original symbols guide, it is a compilation of those symbols most often needed by today's designer. It is not meant to be a complete listing of all possible symbols and their applications. For such thorough documentation, the standards published by the Institute of Electrical and Electronic Engineers should be consulted. They are: "Graphic Symbols for Electrical and Electronics Diagrams" [IEEE No. 315, 1971]/[ANSI Y32.2, 1970] and "Graphic Symbols for Logic Diagrams (Two-State Devices)," [IEEE Std. 91, 1973]/-[ANSI Y32.14, 1973].



## OPTICALLY COUPLED ISOLATORS

# Transfer ratios, data rates are improving; low prices lure designers

by Lucinda Mattera, *Components Editor*

☐ Although the technology of optically coupled isolators is only four or five years old, these devices have captured a major segment of the semiconductor optoelectronics market. This year, despite the general business slowdown, worldwide coupler sales are expected to continue their increase and reach $20 million to $25 million. In 1976, manufacturers are anticipating a boom to top off at $30 million to $35 million, despite continuing reductions in unit prices. What's more, total coupler sales should continue to grow at a healthy rate of 20% to 30% a year for the next two to three years.

Couplers are only beginning to penetrate high-volume markets such as data processing, telecommunications, industrial process control, and solid-state relays. They are being used as interface devices on data lines between logic circuitry and peripheral equipment, as switching devices on telephone lines, as ground-loop isolators in power supplies, as level-shifting devices between different types of logic, as transmitting devices in data communications, and as sensing devices in telephone circuitry. A relatively new and potentially large market for couplers is analog signal isolation for applications like medical electronics and other types of analog signal-processing and measurement.

As the market widens, manufacturers are continuing to improve performance of their devices and bringing down prices. Operating speeds as high as 25 megahertz are not too far in the future. Increases in current-transfer ratios and lengthening of operating lifetimes are also on the way.

A number of factors are contributing to the rapid growth of the coupler market. Perhaps most important are the dramatic improvement during the past few years of coupler performance and the increase in un-

**RANGE OF OPTICAL COUPLER PERFORMANCE**

| Type of Output | Parameter | | | | |
|---|---|---|---|---|---|
| | Current-Transfer Ratio | Operating Speed | Isolation Voltage | Package | Approximate Price In Quantity |
| Phototransistor | 10% to 100% min | 100 to 500 kHz typ | 1 to 5 kV | dual in-line metal can, epoxy axial, and hermetic axial | $0.60 to $2 |
| | | | 5 to 50 kV | axial | $2 to $10 |
| PhotoDarlington | 100% to 600% min | 2.5 to 10 kHz typ | 1 to 4 kV | dual in-line, metal can, epoxy | $1 to $2 |
| | | | 5 to 50 kV | axial | $2 to $10 |
| PhotoSCR | 11 to 30 mA max triggering current | 2 to 20 μs typ turn-on time | 1.5 to 2.5 kV | dual in-line | $3 to $4 |
| Transistor Amplifier | 7% to 400% min | 150 kHz to 1 MHz typ | 2.5 kV | dual in-line | $2 to $5 |
| Logic Gate | 400% to 600% typ | 100 kHz to 5 MHz typ | 1.5 to 2.5 kV | dual in-line | $2 to $5 |

derstanding by customers of the value of couplers in various applications. And although manufacturers still feel that customer education is one of their major concerns, the initial difficulties of acceptance have been overcome. At this stage, the apparently simple operation of couplers may be dangerously misleading. Actually, picking the right device can be tricky, and parameter specifications are not yet standardized.

**Choosing a coupler**

A coupler can be thought of as a signal-transfer device that has its input and output electronically isolated from each other through an optical link. Each coupler consists of an input light-emitting diode, usually one that emits in the infrared or near-infrared region, and an output silicon photodetector, which can be a photodiode, a phototransistor, a photoDarlington, or a photoSCR. The LED emitter and the light sensor are optically linked together but dielectrically isolated from each other.

In addition to being available in the popular integral version, in which the LED, the sensor, and the gap between them are housed under the same roof, couplers can be purchased in air-gap versions. This type of device is also supplied in a single package, but the user has access to the gap between the emitter and the sensor. Such a coupler is switched by interrupting the LED beam.

Air-gap couplers are primarily used as sensing devices in business machines, fluid-flow monitors, and engine controls. Since the gap must be fairly large, compared to that of the integral type, the current gain of these devices tends to be low. Also, their maximum isolation voltage is limited to the dielectric strength of air. An integral type of coupler, on the other hand, has a plastic or glass in the gap to beef up isolation voltage.

Optical isolators can be purchased in single, dual, or quad form. For a single coupler, the most widely used type of housing is a 6-pin plastic dual in-line package, but various other epoxy and hermetic packages are also available. Dual devices are supplied in 8-pin DIPs and quad devices in 16-pin DIPs. Both general-purpose and high-performance isolators come in dual form, but usually only general-purpose types come in quad form.

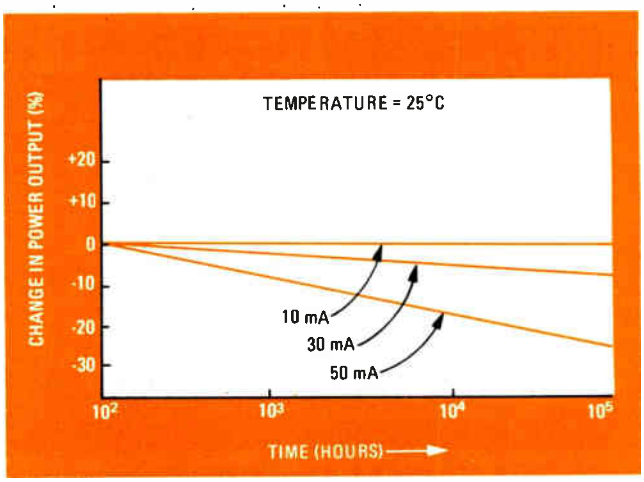
Coupler prices are still eroding. Today, low-performance general-purpose devices sell for 60 to 70 cents each in quantity, high-performance devices are $1 to $2, high-speed devices are about $5, and high-reliability devices can be $30 or more. Within the next five years, though, the price of most high-performance couplers should be reduced to the $1 range and about $5 for high-reliability units.

Optical isolators are deceptively simple devices. After all, they seemingly have only three key performance parameters—current-transfer ratio, which is the current gain expressed in per cent; operating speed, which reflects how rapidly the output can be switched; and isolation voltage, which indicates the dielectric strength between input and output. However, couplers are, in fact, anything but simple, and picking the right one for a given application requires considerable knowledge of coupler specifications and operating conditions.

Parameter specifications and measurement techniques are not standardized yet because manufacturers do not necessarily specify or measure the same parameter in the same way. Also, at least two other factors must be examined when selecting a coupler—the initial degradation of the power output of the LED emitter and device lifetime. The efficiency of an infrared LED source degrades with time—and 10% or more of this degradation can take place within the device's first 1,000 hours of life, depending on the current level.

Any amount of emitter degradation affects current-transfer ratio adversely, so that to drive the LED, the current level must be raised to obtain the original value of transfer ratio. Obviously, emitter degradation also affects over-all coupler lifetime. LED efficiency can become so poor that a coupler cannot be operated at a current level needed for a given application. More commonly, a coupler's current-transfer ratio is dramatically lowered if the unit is first operated at a high current and then at a low current.

Manufacturers are not trying to hide these problems. On the contrary, many are now gathering more exact data on emitter degradation, as well as running long-term life tests. Because of the increased pervasiveness of couplers and the growing experience of users in ap-




**1. Emitter degradation.** Power output of infrared light-emitting diode declines with time. For high operating current, emitter efficiency can be down 10% or more within the first 1,000 hours. These curves are for discrete LEDs made by Texas Instruments.

plying them, the effects of coupler aging have only recently come to the forefront.

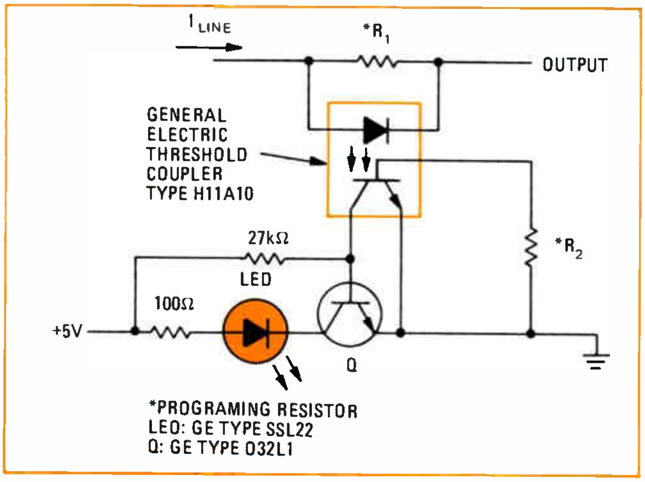
The amount of emitter degradation is predictable with a reasonable degree of accuracy. Curves, like the ones given in Fig. 1, are available from vendors showing the extent of degradation associated with time and operating current. Such curves make it possible to select an appropriate coupler and extrapolate its expected lifetime. Additionally, suppliers are eager to furnish advice and guidance.

Nowadays, there's an impressive variety of couplers from which to choose—enough of a variety to satisfy a myriad of different application needs. The table on page 98 shows the range of performance available, depending on the type of coupler output. When selecting an isolator, its over-all performance should be evaluated, as well as the way each parameter is specified.

### Considering transfer ratio

Current-transfer ratio, for example, depends not only on the level of the input LED current but also on whether or not the output device is in saturation. The higher the input current is, the higher the transfer ratio will usually be. But, for a given input-current level, the current-transfer ratio can drop when the output device saturates.

For today's isolators, the minimum current-transfer ratios when their outputs are saturated can be guaranteed at 500% to 600% for an input level of 10 milliamperes or more. Usually, such a coupler will have a photoDarlington output. It's also possible, for high-sensitivity photoDarlington and phototransistor couplers, to obtain a minimum ratio of 100% to 200% at drive levels of 1 mA or less when the output is saturated.




**2. Monitoring current.** When line current drops below programed turn-on point of new threshold coupler, the LED switches on, indicating loss of power to critical isolated circuit function.

In the future, the guaranteed minimum current-transfer ratio should continue to get higher, particularly for low input-drive levels, because the efficiency of the infrared emitter is improving. And, equally important, manufacturers are trying to make transfer ratios more controllable for devices having high-beta outputs. For instance, since a photoDarlington can have a β on the order of several tens of thousands, it can be quite difficult to maintain a certain current gain over normal supply and temperature variations.

Like current-transfer ratio, isolation voltage cannot simply be taken at face value. Unfortunately, many coupler data sheets call out this parameter as so many volts or kilovolts, without indicating if the voltage is ac or dc or how long the device can withstand such a voltage. Manufacturers are in the process of standardizing in a meaningful manner the specification, as well as the measurement, of isolation voltage. If isolation voltage is of major importance in an application, the customer should make certain what the guaranteed minimum value is and how it is measured. Insufficient isolation leads to certain failure in short order.

Since isolation voltage is a measure of dielectric strength, it depends on the dielectric between the emitter and the sensor, as well as the type of package. For a plastic DIP, the guaranteed minimum isolation usually ranges from 1 kV to 3.5 kV. A general-purpose coupler, for example, will commonly provide 1 kV or 1.5 kV of isolation, whereas a high-performance device will offer 2.5 kV or 3.5 kV of isolation. With a plastic DIP, the maximum isolation voltage is limited to about 5 kV because of the close spacing between pins. To get more isolation, it's necessary to go to another type of package—for example, isolation voltage can even be as high as 50 kV for a coupler in an axial-lead package.

### Evaluating the data rate

Operating speed is yet another parameter that must be examined closely. The speed with which a coupler's output can be switched depends on load conditions. Although many couplers are purported to be directly compatible with transistor-transistor-logic devices, a number of them are not—they do not operate properly over the standard TTL range of load, supply, and temperature tolerances.

To date, most isolators having a phototransistor or photoDarlington output have moderate operating speeds, ranging from 2.5 to 500 kilohertz or so. For operation at higher speeds, a photodiode is normally used as the coupler's light sensor. Isolators having only a photodiode in the output circuit are not widely in use any more because a photodiode's current is too low to drive a load directly. Instead, one or more amplifying devices are integrated after the photodiode sensor of these high-speed couplers. Some couplers even have complete amplifiers between the photodiodes and output transistors.

The maximum specified data rate of a high-speed coupler is presently limited to approximately 5 megahertz. With optimum circuit conditions, however, the data rate can be extended to about 10 MHz. Some manufacturers specify data rate in terms of bits per second. This means that every logic 0 and logic 1 at the coupler's output is being counted as a single bit; therefore, a data rate of 10 megabits/s is equivalent to an operating frequency of 5 MHz.

Since a high-speed coupler is utilized more or less like a logic gate, its propagation delay is also specified. Nowadays, maximum propagation delay is around 75 nanoseconds when the input LED current switches from 0 to 7.5 mA (or vice-versa) with a maximum rise (or fall time) of 5 ns.

**Working for speed**

Manufacturers are trying to increase data rates still further to bring them closer to standard logic operating speeds. Within three years or so, it will probably be possible to buy a coupler that operates at a data rate of 25 MHz.

Isolators that employ a photodiode sensor are available with several different versions of associated output circuitry—for example, a NAND gate, an inverter gate, or a transistor amplifier. Some high-speed logic-gate couplers not only include a Schmitt trigger to avoid oscillation, but also provide a TTL-type triple-state output.

In transistor-amplifier couplers, either current gain or operating speed is optimized. Therefore, some of these devices can be ideal for moderate-speed, high-sensitivity applications. They can provide a minimum current-transfer ratio of 400% for an input current of only 0.5 mA, with the output saturated. Operating speed is typically around 150 kHz.

When a fairly large output current is needed, the best type of isolator to use is one that has a photoSCR output. A photoSCR coupler can trigger a triac or even run a small load directly. Today's devices can develop a forward output current of 200 to 300 mA root-mean-square at an anode-to-cathode bias voltage of 100 to 200 V. Maximum triggering current can be as low as 11 mA or so, while blocking voltage can be up to 400 V.

**Developing better devices**

Manufacturers are exerting a great deal of effort to improve the performance of optical couplers. For example, the Optoelectronics division of Fairchild Semiconductor in Palo Alto, Calif., has developed a new high-sensitivity phototransistor isolator that, at low input drives, performs comparably to units with a photo-Darlington output. The minimum current-transfer ratio is 100% for a 1-mA input with the output saturated, and operation is guaranteed over the full temperature range of −55°C to +100°C. The device sells for approximately $1 each in quantity. Selected units having a guaranteed transfer ratio of 100% at inputs as low as 250 microamperes are also available at extra cost.

The Semiconductor Products department of General Electric Co. in Auburn, N.Y., is announcing an unusual current-threshold phototransistor isolator—the device's turn-on current can be programed with a resistor over the range of 4 to 100 mA. When there is a 2:1 change in the input current, the coupler will switch on, causing more than a 20:1 difference in the output current. The current-transfer ratio is 10% minimum at the turn-on point. Figure 2 shows how this threshold coupler can be connected to monitor line current. In quantities of 1,000, price is 85 cents each.

Since an infrared LED is a nonlinear emitter, the use of optical couplers in analog applications has been relatively limited. Now, however, the HPA division of Hewlett-Packard Co. in Palo Alto, Calif., is introducing a pair of dual-channel couplers specifically intended for analog isolation. One device offers a minimum current-transfer ratio of 7% for a 16-mA input with the output saturated, while the other has a 15% minimum transfer ratio under the same conditions. Each unit offers the performance advantage of thermal tracking between channels, and the space advantage of two channels in a single 8-pin DIP.

Other new types of couplers, as well as conventional types that provide still higher performance, should be available in the near future. For example, by the end of this year, Optron Inc. of Carrollton, Texas, hopes to introduce a high-current fast-switching coupler with a phototriac output. And at least one leading manufacturer is looking into a high-linearity coupler for low-level analog-signal isolation—it will probably contain a single LED emitter and two photodiode detectors.

Since optical isolators offer an easy way to eliminate unwanted ground loops and the adverse effects of noise in a whole array of applications, they are fast becoming a commonplace component. The trade-off between their price and performance is already at a point where designers cannot afford to overlook them. □

**SOME MORE READINGS**

There are a number of sources for obtaining additional information on understanding and applying optical couplers. Texas Instruments publishes "The Optoelectronics Data Book for Design Engineers," second edition, which sells for $2.95. General Electric has an application note, "Photon Couplers," No. 200.62. Moreover, William H. Sahm, a consulting application engineer at GE, presented a paper, "Optoelectronics in Field and Factory," at the 1973 IEEE Intercon. He also has recently written an article, "Get to Know the Optocoupler," Electronic Design, June 7, 1975, pp. 66-71. Hewlett-Packard has available three application notes on couplers: "High-Speed Optically Coupled Isolators," No. 939; "Performance of the 5082-4350/51/60 Series of Isolators in Short to Moderate Length Digital Data Transmission Systems," No. 948; and "Applications for Low Input Current, High Gain Optically Coupled Isolators," No. 951-1.

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**Processing cement.** Computer-based controls balance the many variables affecting temperatures inside the massive rotary kiln where raw materials are converted into cement. A well-defined temperature profile is essential for cement production.

# Cement imposes big dimensions on control engineer's task

From rapid adjustments of bulk mixing to accurate weighing and billing, electronic equipment has work cut out for it in this energy-gulping industry, where great sizes and temperatures demand unusual approaches

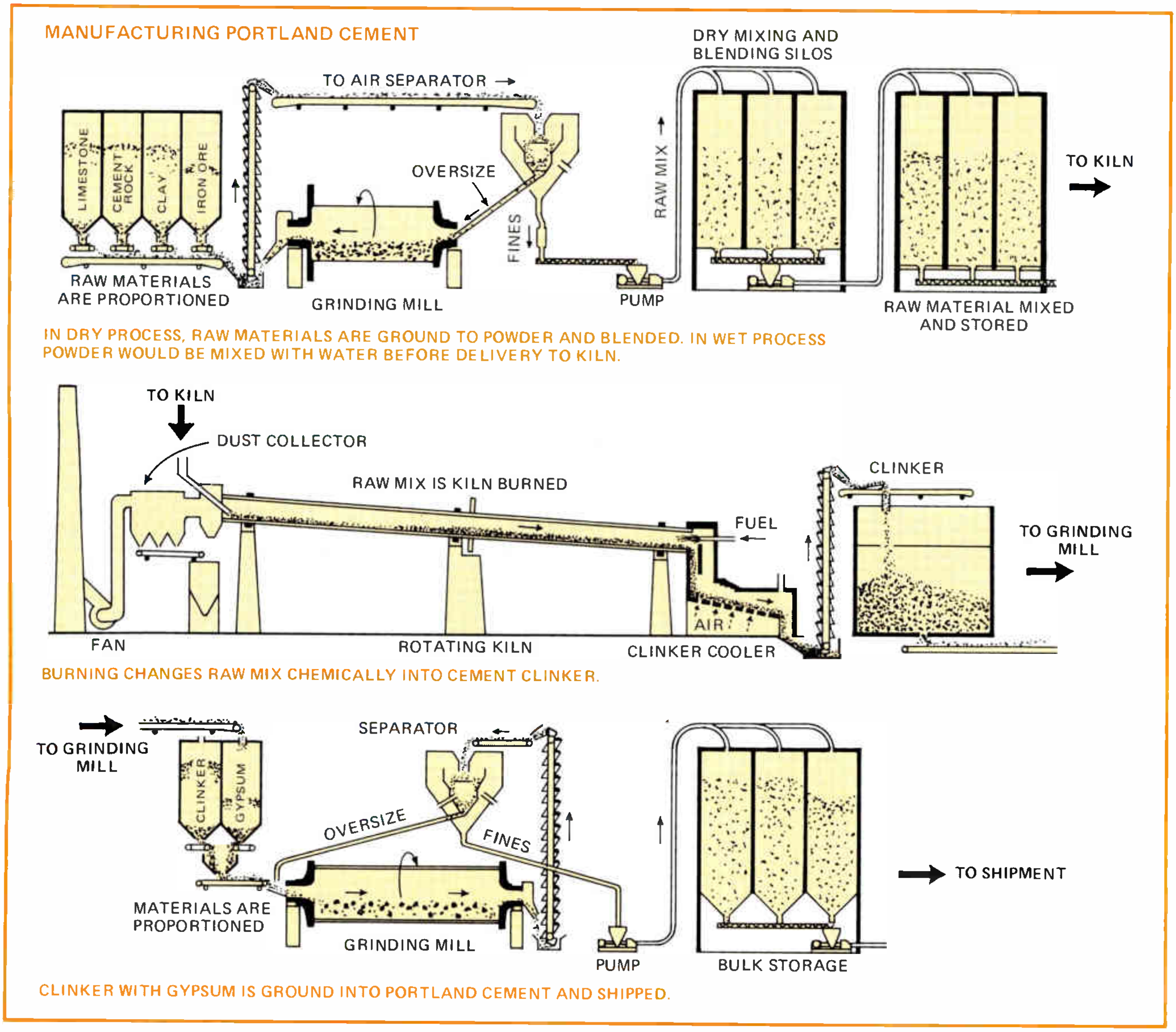
by Margaret A. Maas, *Industrial Editor*

☐ Operating efficiency and reliable process control are paramount goals in most manufacturing efforts, but seldom are the goals as physically imposing as in cement making. Here, machinery and raw materials of gigantic proportions must be handled with a special finesse. Several hundred motors, which drive conveyors, grinding mills and pumps, must be sequenced and interlocked. The chemical composition of incoming ingredients must be constantly monitored and changes made in the mix when the composition varies. At the kiln where the raw materials are transformed into clinker, the basis of cement, temperatures must be adjusted according to a predetermined pattern by balancing fuel consumption, material feed, kiln rotating speed and other factors.

In all there are some 80 separate and continuous operations that must constantly be monitored and regulated throughout a plant that is physically spread out over a large area. Juggling all these factors while producing a high-volume product within stringent quality specifications has made the cement plant a natural target for the same type of computer-control center that has proliferated in the utility industry.

With centralized control, operators at one location

*This concludes a five-part series. Part 1, "Automating the machine shop," appeared in the May 29 issue. Part 2, "Steel's special problems beckon control-system designers," appeared June 12. Part 3, "Tight supervisory control boosts oil's output," appeared July 24. Part 4, "Food industry takes a bite out of waste," appeared August 21.*



IN DRY PROCESS, RAW MATERIALS ARE GROUND TO POWDER AND BLENDED. IN WET PROCESS POWDER WOULD BE MIXED WITH WATER BEFORE DELIVERY TO KILN.

BURNING CHANGES RAW MIX CHEMICALLY INTO CEMENT CLINKER.

CLINKER WITH GYPSUM IS GROUND INTO PORTLAND CEMENT AND SHIPPED.

can direct and troubleshoot the hundreds of motors scattered about a plant. Computer controls aided by on-line chemical analysis can help blend raw ingredients and insure a better product quality. "And a computer system will maximize plant throughput," says D. Munn Steelman, manager of application engineering at Leeds & Northrup Co., North Wales, Pa., "because it will operate a system closer to its limits than an operator will."

## Making cement

More than 99% of the cement produced in the U.S. is portland cement. The term is a generic name for a carefully controlled combination of calcium, silicas, aluminum, iron and other ingredients, which when mixed with water, sand, crushed stone, and gravel forms concrete.

To make portland cement (above), the raw materials, mostly limestone, and clay or shale, are crushed, finely ground and heated in a large rotating kiln to about 2,700° F. During this "burning" process the ingredients decompose and then recombine to form partially-fused, marble-size pellets called clinker. Finally the clinker is finely ground, usually with a small amount of gypsum which controls setting time.

Control of the cement-making process begins with the raw mix silos, typically 90 feet high, where the raw materials are stored. "It's not the measurement of high and low levels in the silo that's a problem," explains Norman S. Roistacher, engineering consultant to Lone Star Industries, Inc., Greenwich, Conn. "It's the ability to take a continuous level measurement. We have to know what silos to withdraw from, which ones to fill, and what cements we can make based on the amount of ingredients available."

The most common level-sensing technique is a weighted tape which is manually dropped into the silo until it strikes the product level—certainly not a method that lends itself to continuous readings. Among the continuous devices available, load cells sufficient to weigh a silo are prohibitively expensive, and static electricity rules out capacitance-type transducers. Ultrasonic level sensors have been unsatisfactory because of the dust created during the filling operation and by wind currents that develop inside these huge silos. It's almost impossible with an ultrasonic transducer to determine where the dust stops and the solids begin.

Big Noise Instruments, Westport, Conn. believes it can overcome the limitations on ultrasonic level sensors with a new design now under test at major cement manufacturers. In this unit a high-energy piezoelectric transducer is aimed at a parabolic reflector-antenna assembly. The reflector collimates the energy into a narrow beam and directs it down to the product level. By bouncing a narrow rather than a wide beam off the product surface, more reflected energy is received by the antenna--a key requirement for long range signal processing.

The system transmits a series of eight pulses and then sums the reflected sound levels to enhance the signal and protect against extraneous error signals. "The true product produces repetitive reflections, with each reflection traveling the same distance and having the same intensity," says Lou Sill, product application specialist at Big Noise. "While any one error signal may be larger than the true signal, it's highly improbable that there would be an erroneous reflection from the same place eight times in a row. By summing the eight signals, we get a good indication of product height."

Because the velocity of sound is affected by ambient temperature, the system incorporates a thermistor network that measures the ambient at the antenna and compensates for temperature variations. Level, which is measured in 6-inch increments over a distance of 150 ft., is registered on a four-digit light-emitting-diode display that is updated every 3 seconds.

### Calculating the recipe

To mix cement, the materials are withdrawn from their respective silos and dispensed onto a weigh feeder, a short conveyor that leads to the main conveyor supplying the grinding mill. The materials are dispensed at a constant height and the feeder speed is increased or decreased to adjust the amount delivered to the main conveyor.

As the feeder belt advances, it passes over a load cell that is energized by a tachometer generator. If the feeder speed increases, the load cell voltage does likewise. The resulting signal is a multiple of weight and belt speed. This value, in effect, is the weight per unit time, which is compared to a preset figure based on the recipe.

The recipe, in turn, is determined by the chemical composition of the ingredients as measured by an X-ray spectrometer. Any difference between the actual weight and the setpoint produces an adjustment to the armature voltage on the feeder drive-motor.

Maintaining accurate feed control is one area where the computer control outperforms traditional analog systems. If the bin leading to one weigh feeder clogs, the computer memory can keep track of the unfilled demand and at the same time sound an alarm. If the stoppage is cleared within a predetermined time, the computer will accelerate the weigh feeder until the difference is made up. If not, a second alarm point is reached and the proportioning operation shuts down.

The weigh feeder system proportions the raw ingredients according to specifications established (in the United States) by ASTM, the American Society for Testing and Materials. These specifications set relatively tight limits on the chemical composition of each type of portland cement. But the chemical composition of the ingredients varies from quarry to quarry and also within the same quarry, so the blending recipe may have to be changed daily or more often. Some cement manufacturers are lucky; they may only have to blend a few ingredients to get the right mix; while others have to blend six or more.

Keeping the product within specification is the task that falls to the X-ray spectrometer. Essentially this instrument analyzes the mix, determines the concentration of each the important element that it contains, then compares each concentration with the limit established by the ASTM. Any deviation results in an adjustment to the speed of the appropriate weigh feeder.

"Though the analysis sounds simple, X-ray spectrometry is so mathematically complex that the instrument often requires its own dedicated computer," says Fred Johannsen, product manager at Applied Research Laboratory, Sunland, Calif., a division of Bausch & Lomb.

To perform an analysis, the operator identifies through the instrument keyboard the type of cement he wishes to make. This action calls the recipe from computer memory together with the concentration limits for each ingredient.

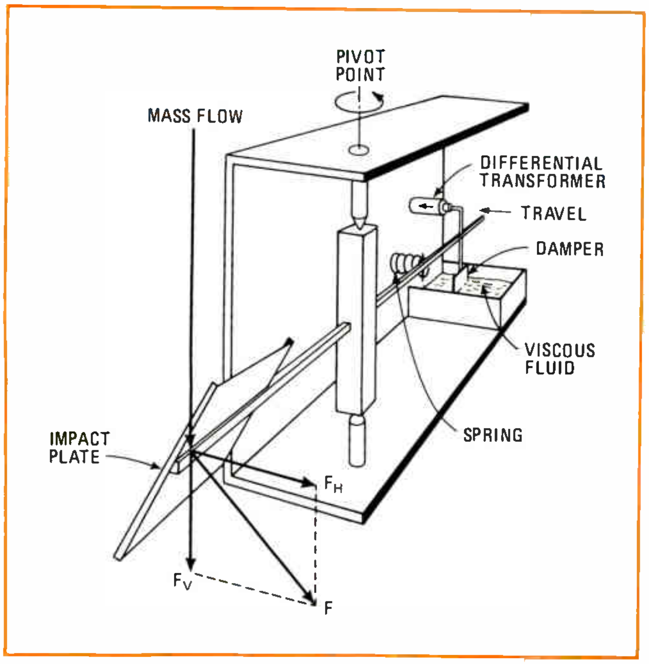
Once the sample has been fed into the instrument, an X-ray tube irradiates it, causing the material to fluoresce at wavelengths characteristic of its chemical composition. Detectors, each adjusted to a specific chemical wavelength, develop voltages proportional to the concentration of each element. These values are displayed on a digital panel meter and also logged on a printer.

### The grinding mill speaks

Once the mix has been determined, it is fed into a grinding mill at a rate dependent on mill capacity and material grindability. The grindability will vary with changes in composition, hardness and so on. If the material is not ground to the proper size on the first pass, it is recirculated. If the recirculating load gets too high, the rate of new material entering the mill has to be reduced to prevent the mill from being overloaded.

One way to tell how well the grinding mill is faring is to listen to it. Noise in a mill is created by the impact of the grinding medium (usually steel balls) on the material. The more material that is present, the more the impact is absorbed and, therefore, the less noise is generated. As the material load decreases, the level of noise increases.

By listening to the mill, the operator can detect changes in the size of feed particles, differences in hardness, changes in feedability due to varying moisture content, and also whether a bin hangup has occurred. But of course the human ear is not an infallible device, so operators depend on sound-level measurements. Sound-level measurements are made with a microphone and noise-measuring circuit, tuned to the frequency range of the particular mill. Excessive noise re-




**1. Impact flowmeter.** Dry ingredients in free-fall strike the inclined plate, causing it to pivot about the vertical axis and displace an LVDT in proportion to the falling weight.

sults in an increase in material feed rate, while a below-par noise level produces a decrease in feed rate.

Once the blend has been ground to the proper size, it is conveyed to the kiln where the raw material is transformed into cement. Depending on the type of plant—whether it uses a wet or dry process—the raw material may be delivered dry or as a slurry.

When dry, the feed rate can be measured by a weigh feeder or an impact flow meter. An impact flowmeter allows the material to fall from a hopper (from a height of at least 20 inches so that it achieves a constant velocity). In the impact flowmeter sold by Milltronics Ltd., Peterborough, Canada (Fig. 1), the falling material strikes an inclined plate imparting an impulse force to the plate. Since impulse is a function of mass and velocity—and velocity is constant—the impulse is directly proportional to mass and, therefore, to weight.

The plate is fixed along its horizontal axis, but is free to rotate about the vertical. The impacting material causes the plate to pivot, displacing the core of a linear variable differential transformer. This movement is directly proportional to the weight and is accurate to within ±1.0%. The unit compares the output to a preset value and if a deviation exists, a feed gate automatically opens or closes to correct the flow.

If the material is fed to the kiln as a slurry, its flow rate can easily be measured by a magnetic flowmeter. But a slurry is a varying composite of water and solids.

Ohmart Corp., Cincinnati, Ohio uses a high-energy gamma source—usually Cesium 137—to determine the density of the slurry. By combining density with flow rate, the solids content can be calculated.

The gamma source, mounted perpendicular to the flow path, emits radiation which passes through the pipe to the detector on the opposite side. Since gamma radiation is relatively independent of chemical composition, the amount of radiation absorbed will depend primarily on the density of the material through which it passes. The detector, actually a geiger counter, converts the radiation to a current proportional to density. By combining this count with the flow measurement, the number of tons of dry solids per hour can be calculated.

## The monster kiln

The rotary kiln, where the raw materials are converted into cement, is a giant piece of equipment (see photo, p. 103) that may measure 25 ft. in diameter, stretch out 750 ft. long, and rotate at about one rpm.

Temperature must be maintained according to a predetermined pattern along the length of the kiln in order for the chemical reaction, which transforms the raw material into clinker, to occur. In addition, as the material moves through the kiln, the process is initially endothermic (absorbs heat), then at a certain point, it turns exothermic (gives off heat). The point at which this chemical change occurs can vary drastically with small changes in the process or in chemical composition of the blend.

Adding to the problem is the fact that it is almost impossible to know precisely what is going on inside the kiln. "The raw mix enters at one end and there is little chance to observe what is happening until it exits as white hot, lava-like material," notes John Hawkins, minerals industry consultant, The Foxboro Company, Foxboro, Mass. "Consequently, all upsets at the kiln must be avoided."

Temperature can be useful in tracking progress through the kiln, but at the endothermic sections of the kiln, where temperature is measured by thermocouples, the measurement is not without problems, states Lone Star's Norman Roistacher. "The thermowell wears out quickly when exposed to the thermal shocks and corrosive atmosphere that occur in the kiln."

"In the burning zone where the temperature averages 1,500°C, there is no really good measuring device; thermocouples won't live in this environment," states Jay Warshawsky, Fuller Company, Catasauqua, Pa. "Optical pyrometers have problems with dust and flame interfering with the line of sight to the burning clinker. If this temperature could be accurately determined, it would be possible to use the fuel more effectively."

To regulate temperature requires careful balancing of all the parameters that influence kiln operation—material feed and composition, fuel input, induced-draft fan speed and other variables. These all interact in a strongly non-linear fashion. When combined with the long response times of this giant piece of machinery, kiln control becomes an extremely difficult proposition.

## Tying it all together

Monitoring and controlling the kiln and all the other aspects of cement making—from the quarry to the finished product—is a natural application area for computer control. One of the more recent systems is the one installed by Leeds & Northrop Company, at the Quebec plant of Canada Cement Lafarge Ltd. (Fig. 2). Unlike systems which perform just motor or process control, the L&N system places both motor and process control under computer supervision. Overall plant control requires 700 control signals directed to motor starters or solenoid valves, and 1,700 inputs from field switches or motor control center auxiliary contacts.

The system contains dual, 16-bit computers, one dedicated to control of the cement-making process, including two kilns, and performing process monitoring, process optimization, data logging and process alarming. The other computer handles sequencing, positioning, interlocking, and time-delay functions for the 560 motors in the plant. Both computers have 40,000 words of core, and the process computer is supplemented with 750,000 words of bulk storage.

Communications between computers and the operator is performed at the operator's console which consists of a keyboard, light pen, and three four-color cathode-ray-tubes which display motor status and process variables. Because of the numerous points monitored, only out-of-specification variables are displayed unless others are called up by the operator.

To preserve any record of changes to the program, all inputs made by the operator are logged in hard-copy form. Alarm messages generated by the computers and displayed on the CRTs are also logged on hard copy. Both computers are linked to teletypewriters and line printers.

Backup for the motor control is the process computer itself. Motor control status is periodically updated and stored in the process-computer core memory. If a motor-control computer failure appears imminent, the system automatically transfers control to the process computer. During this mode, the process control computer can retain full control of the process but loses some of the background programs and graphic functions that are not often used.

If the process-control computer fails, the process functions are not switched to the motor-control computer. Since the cement-making process is slow, with lags and time delays on the order of several minutes, manual backup stations were considered sufficient. In the manual mode, the controller will directly operate valves or other devices while the operator watches the movements on panel meters. Other meters show the actual process measurement, in engineering units, as they are manipulated. While operating in the backup mode, the alarm conditions are displayed by means of panel lights.

### The programable controller

In a cement plant there are several hundred motors that operate grinders, open and close gates for material routing, drive conveyors and so forth. They must be started or stopped in a definite sequence with proper timing between sequences. In some cases the motors must respond to temperature sensors that indicate overheating or to vibration monitors that warn of bearing damage. While computer control is one approach to motor handling, another approach is to use a programable controller.

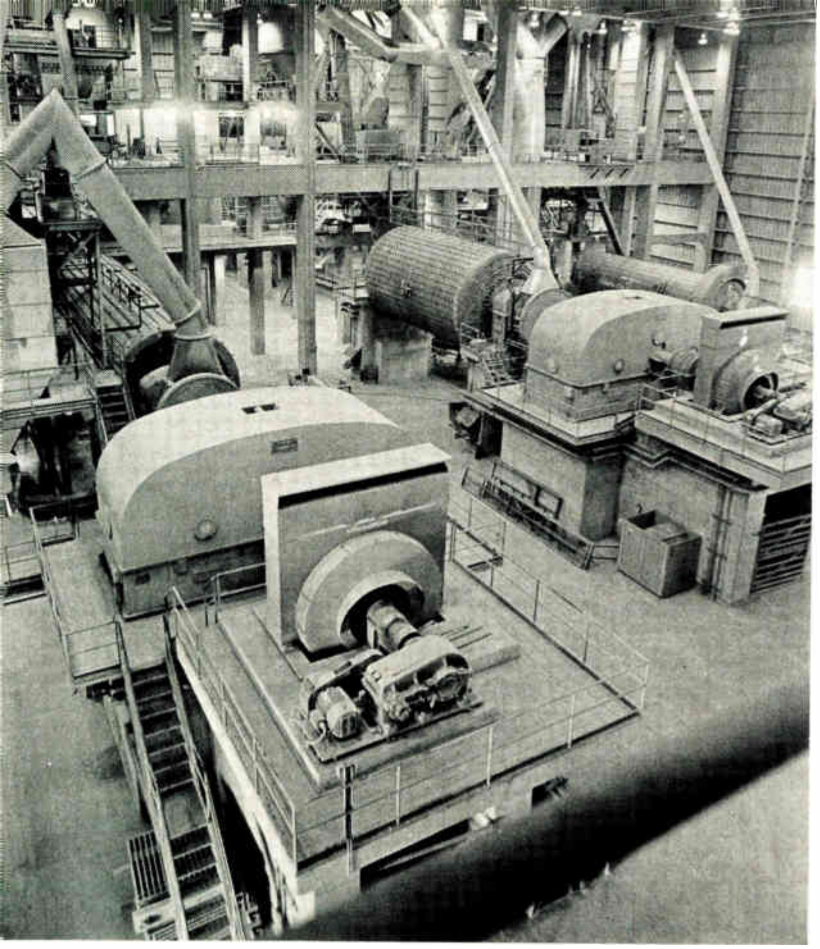
At Dundee Cement Company, Dundee, Mich., the motor control has been entirely dedicated to programable controllers. One start and one stop button will set the entire system going. Depending on the size of the plant, Dundee uses from six to 11 programable controllers (PCs) at a site.

"The PC is a fantastic development that solves a heck of a lot of problems inherent in the old relay system," says Ib Bentzen-Bilkvist, manager of the corporate engineering department at Dundee Cement Co. "Unfortunately many manufacturers have only made the PC an inexpensive relay substitute. But the PC we use (Allen-Bradley's PDQ II) has an instruction set like a computer with jump instructions, timer functions and so on. So you can do more sophisticated things than with relays."

### Paying for itself

Foxboro Co. also provided a programable controller in a low-cost system delivered to Southwestern Portland Cement Co., Fairborn, Ohio. In this system the processing functions—blending, grinding, X-ray analysis and kiln operation—are controlled by a 16-bit, Fox 2 computer. But a programable controller, data linked to the computer, tackles the various sequencing and inter-

**2. Control center.** Inside the control room at Canada Cement Lafarge Ltd., an operator monitors motor control and process variables on three four-color CRTs, part of Leeds & Northrup computer-based system that controls the entire cement plant.



**3. Grinding to size.** Computer prevents mill overload by regulating the material feed rate at these multiple grinding mills. Adjustments are made in response to the acoustical levels measured at the mills.

locking operations associated with the roller mill (a type of grinding mill).

"The PC probably paid for itself in two weeks," says Jim Rogers, senior application specialist at Foxboro. "During startup Southwestern had to make many changes in their control strategy in order to optimize the operation. By reprograming the PC, these changes were made easily and quickly."

As a further step in reducing the cost of the control system, Foxboro simplified engineering and installation by allowing the computer to operate with a minimum backup system. During normal operation the computer employs direct digital control of the process, but if a computer failure occurs, analog control of a few critical variables is automatically implemented. For more stable variables, manual backup and tracking according to the last computer signal is used.

The analog controllers are connected to the Fox 2 through an Interspec interface that allows the analog controllers to plug into the system like any other peripheral. Interspec essentially performs analog-to-digital conversion and serially transmits to the computer.

Supplementing the analog instrumentation and computer control is a solid-state, two-wire motor control system (Monitrol manufactured by Swanson Engineering & Manufacturing Co., Inglewood, Calif.) for starting, stopping and sequencing all motors in the plant, with the exception of the PC-actuated roller mill.

There are 89 process measurements; 32 are fed to their respective controllers, but all 89 are inputted to the computer. A patch panel permits any measurement to be logged on one of the 18 two-pen recorders.

Once the cement has been made, it can be sold by the bag or by the truck load. Keeping tabs on numerous order sizes and a wide variety of customers can be best done with an automated dispatching system. Interautomation, Mississauga, Canada, included such a system at Ciments d'Origny plant in Altkirch, France as a part of its process control installation based on a Data General Nova 800. The system has almost eliminated incorrect loading, unauthorized shipments, and billing errors.

When a truck driver arrives at the plant to pick up a load, the dispatcher issues him an identification badge based on the type of cement he wants. Then the dispatcher, through his CRT keyboard, enters the client account number, size of order, discount allowed and any other information affecting the order. The badge is tied into the transaction when its 4-by-4-bit code is read through a badge reader. After the dispatcher acquires the truck tare weight from an electronic scale, he hands the badge to the driver as a security pass valid for a particular loading station. The truck is then driven to the loading area specified for the type cement being ordered, and the driver identifies himself with his badge through one of the badge readers scattered about the plant. The computer checks his location with the location assigned to the type of cement he is supposed to pick up. If they agree, loading begins.

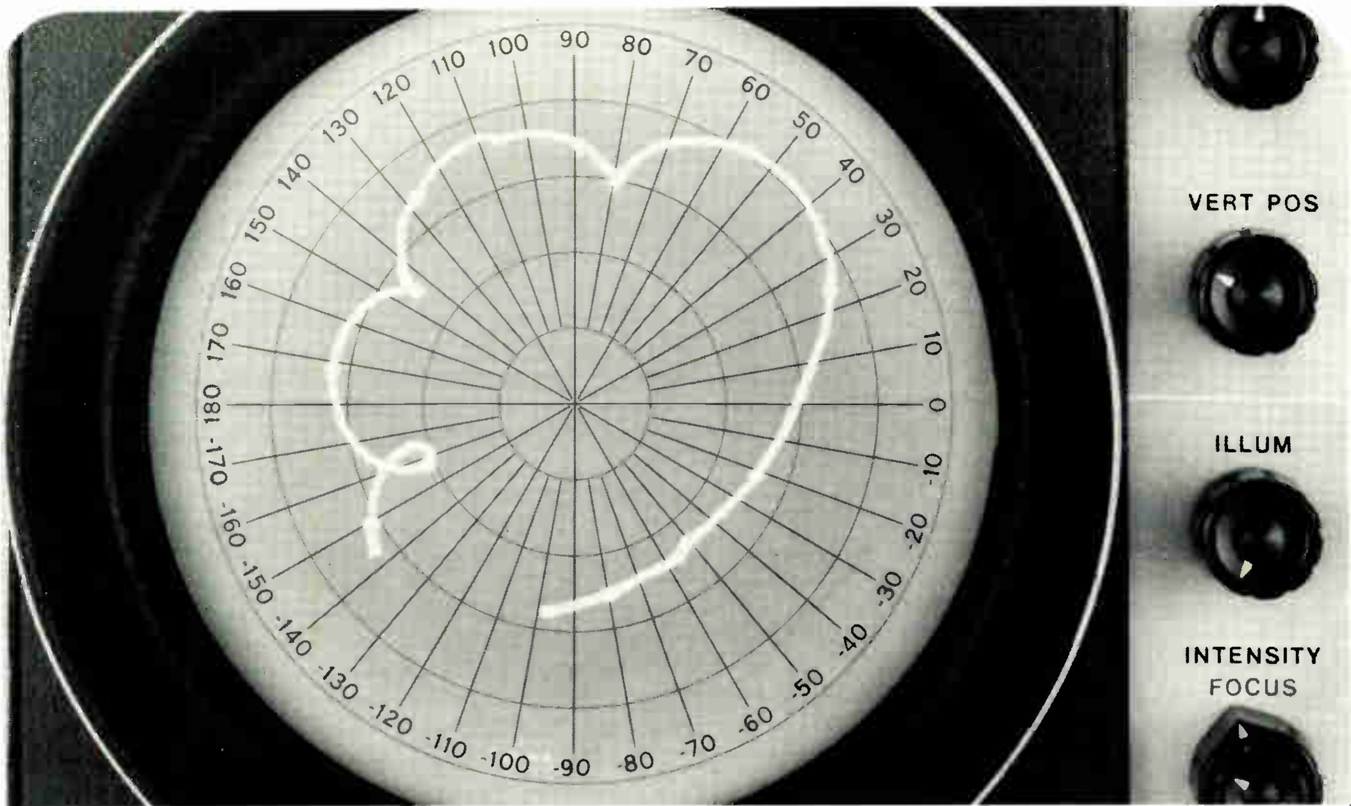
With the truck loaded, the driver returns to the weighing platform, identifies himself through the badge reader, and the scale measures the truck's gross weight. The computer system calculates his net weight and issues a bill of lading. As the driver leaves the plant, he signs the bill and returns the badge to the dispatcher.

Interautomation also installed a computer-control system at the St. Lawrence Cement Co., Mississauga, Canada that, in addition to process control, monitors peak power and operates a plant-alarm system that can handle 1,000 alarm points.

"When plant problems occur, a number of pieces of equipment may shut off at once," explains Bob Clayton, software manager at Interautomation. "It's important to know exactly which contact, within a group of related contacts assigned to a piece of equipment, opened first as well as the sequence of events. With this system the user can assign a priority to individual contacts and also to contacts within a group. In effect, he duplicates the ladder diagrams by the way he assigns priorities."

Troubleshooting of the I/O system is done through LED displays on the the electronic racks. The displays indicate the status of all process inputs and outputs so faults can be found quickly.

From alarm monitoring to motor control, electronics is helping cement producers operate more efficiently. Most importantly, it has helped tighten the chemical composition of cement through on-line analysis tied into blending systems. The cost to boost throughput and reduce rejects has only been a fraction of a plant's worth—a $40 million plant will entail a $2 million computer control system (installed cost). But its been a very worthwhile fraction to cement manufacturers. □



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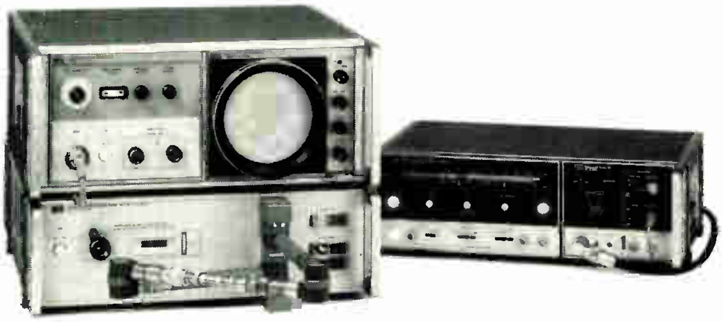

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# Ten ways to reduce noise pickup in ICs

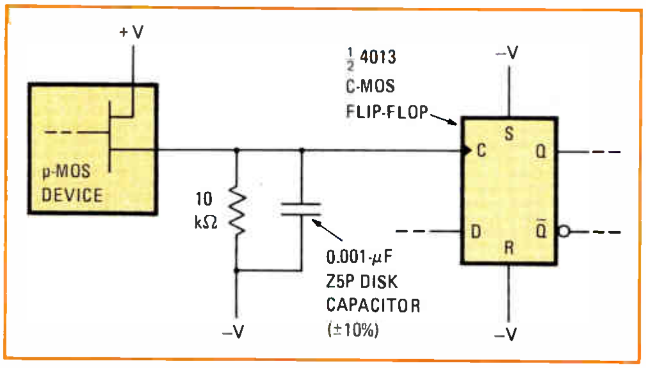
by Peter A. Goodwin
*Loblolly Associates, Wayland, Mass.*

Engineers who struggle to minimize noise pickup in equipment built with integrated circuitry know that there is no magic procedure for eliminating interference caused by lightning hits on power lines, chattering relays, motor-starting transients, electrical discharges to or near the equipment, radio-frequency fields, and the like. Instead, they fight noise by meticulous attention to details of bypassing, grounding, shielding, decoupling, and circuit layout—all used with understanding of the particular characteristics of the ICs involved.

TTL devices exhibit low-impedance, current-mode characteristics and are particularly susceptible to potential differences between devices caused principally by conducted interference.

MOS devices exhibit high-impedance, voltage-oriented characteristics and are therefore susceptible to radiated interference. A secondary susceptibility to conducted interference arises by induction from a neighboring conductor that is carrying the current of an electrical discharge.

Linear integrated circuits have high input impedances and low output impedances, and lack the guaranteed-true voltage regions that are characteristic of digital circuits. Noise spikes can enter a high-gain amplifier through the supply-voltage bus.




**Noise suppression.** Typical application of capacitor to bypass p-MOS output line that feeds edge-triggered C-MOS device. (Bypassing would be same for n-MOS device and pullup resistor, except that n-MOS would have V– supply and resistor would connect to V+.)

The following design practices will reduce the susceptibility of IC equipment to electromagnetic interference.

1. Bypass everything. An inexpensive general-purpose ceramic disk capacitor (0.01-microfarad) should be placed across the supply-voltage bus near each integrated circuit. TTL circuits are also improved by the presence of a 6.8-μF tantalum bypass capacitor for every 15 chips or so. Bypass MOS output lines that feed edge-triggered C-MOS devices, because only a passive device exists to provide the pullup or pulldown function. Use the minimum capacitance that gives acceptable rise time, and specify a temperature-stable 10% disk capacitor. See the figure for an illustration of typical components. No similar problem exists with C-MOS-driven devices, because C-MOS devices feature a totem-pole output structure.

2. *Allow sufficient printed-circuit conductor width.* Most interference is at radio frequencies, which travel on the surface of the conductors. Conductor width is particularly important in a TTL environment, where supply currents are substantial and the rate of change of current is on the order of $10^7$ amperes/second. Supply-conductor widths of 100 mils or more are not uncommon in this environment. Use a ground plane wherever possible; the ground plane should be connected to the power-supply return.

3. *Distinguish between "earth" and "common" (system ground or power-supply return).* The earth conductor should never be used to transfer power. "Earth" and "common" conductors should be brought into contact at only one point in the system; otherwise a ground loop can radiate noise into the circuit.

4. *Run a separate supply bus for high-current devices.* This practice keeps transients off the busses that supply power to the logic circuitry. Remember also that conductors carrying current spikes couple inductively to neighboring conductors and that those carrying voltage spikes couple capacitively to their neighbors. Therefore, be careful in laying out these conductors.

5. *Keep pulldown resistors as small as possible* unless power consumption or other considerations are overriding factors. This is particularly true in MOS circuits.

6. *Don't overdo the fast-rise signals,* even though they are great for TTL devices. The lower the rise time, the less interconductor coupling.

7. *Don't let unused inputs float.* In the TTL discipline, connect them to V– or pull them up to V+ through a 1-kilohm resistor, as appropriate. In the MOS discipline, pull to V– or V+ as appropriate—a floating input is a true "maybe" condition.

8. *In general, use 1% resistors and capacitors in linear-circuit feasibility models.* The exceptions are pulldown resistors and bypass capacitors, where 20% variations can obviously be tolerated. After the design is optimized, then investigate the effects of component tolerance variations.

9. *Remember that decoupling is particularly suited to the low-current requirements of MOS circuitry.* A 1-ohm series resistor inserted in the supply bus on the supply side of the input bypass capacitor provides good isolation from high-frequency power variations.

10. *Avoid one-shots if pulse-width is critical.* The trouble is, their manufacturing tolerances are loose. Instead of

using one-shots, arrange to derive pulses from the clock.

If all else fails, line filtering and unit shielding offer attractive although more expensive possibilities. Metal or conductively coated nonmetallic equipment enclosures provide marked attenuation to external interference. Windows over displays, dials, and meters can be covered with copper screening. Line filters offer resistance to power-line-conducted noise, but generally should be matched to the equipment by enlisting the aid of the filter manufacturer. □

# VOM with calibration circuit measures ignition dwell angle

by S.K. Wong
*Torrance, Calif.*

To extract the best gas mileage from an automobile engine equipped with the conventional Kettering ignition system, the distributor point gap or dwell angle must be set correctly from time to time. And, though the angle can be measured with a commercially available instrument known as a dwell meter, which has a scale calibrated in degrees, a cheap version may not be accurate, and an accurate one is expensive. The handy volt-ohm-milliammeter (VOM), however, can do the job just as well as the better dwell meters if a suitable calibration circuit is added to it.

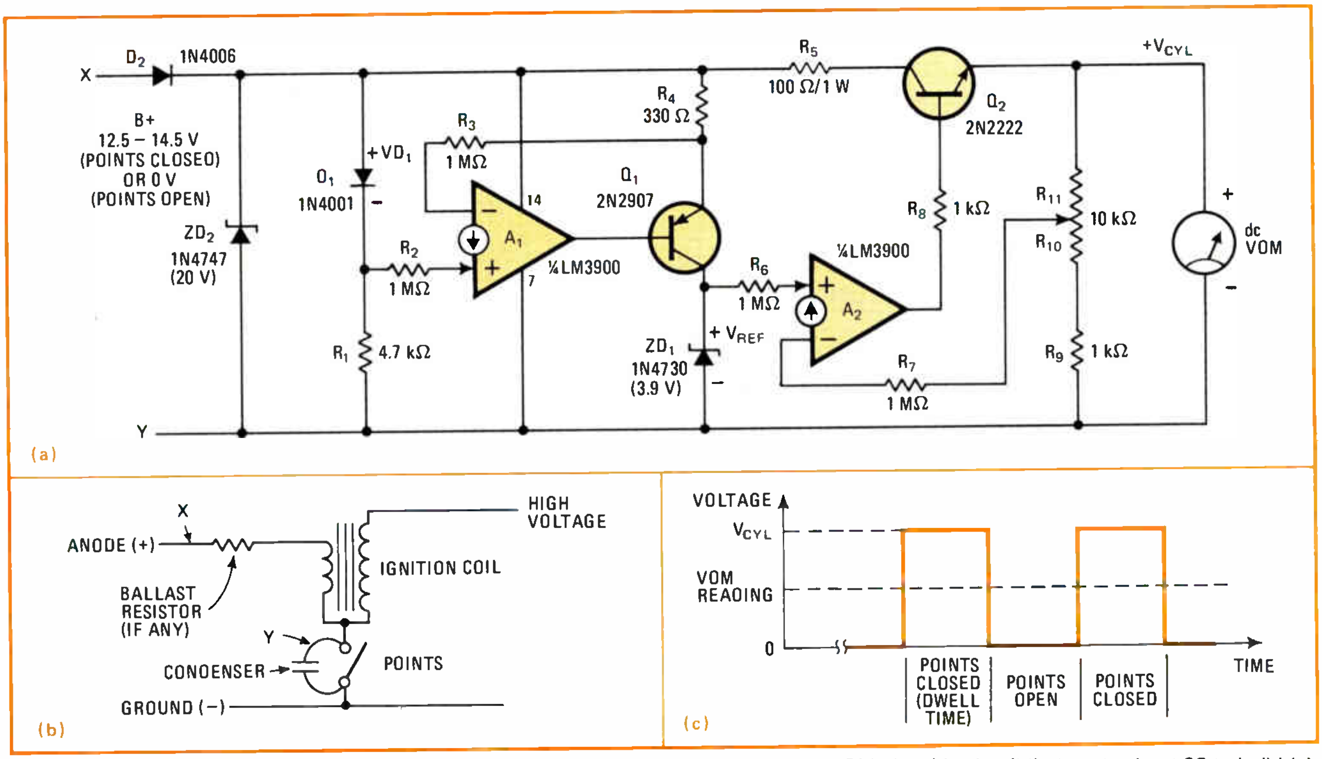
A circuit for this function that costs about $5 in parts is diagrammed below. It includes a constant-current source and a voltage regulator so that the normal voltage variation of the car cannot affect the dwell-angle readings. Thus the accuracy of the VOM dwell meter is limited only by the accuracy of the VOM itself.

The circuit uses two of the four Norton operational amplifiers in a low-cost LM3900N integrated circuit. Since these amplifiers can operate from a single voltage supply anywhere in the range from 4 to 32 volts, they are well suited to this application where they tap their power from the low-voltage side of the ignition system.

Amplifier $A_1$ and transistor $Q_1$ constitute a constant-current source that provides a current of $V_{D1}/R_4$ (about 2 milliamperes) into the zener diode $ZD_1$ whenever a B+ supply voltage higher than the zener breakdown voltage is applied at points X and Y. This steady flow of current, in turn, maintains across the zener diode a constant reference voltage, $V_{ref}$, which is fed to the noninverting input of feedback amplifier $A_2$. Transistor $Q_2$ functions as a series pass regulator whose output (emitter) voltage, $V_{cyl}$, is controlled by $A_2$. The value of this voltage is

$$V_{cyl} = V_{ref}(R_9 + R_{10} + R_{11})/(R_9 + R_{10})$$

which cannot be higher than the B+ voltage. Hence if




**Dwell idea.** Automobile distributor-point dwell angle can be measured with an ordinary VOM plus this circuit that costs about $5 to build (a). Peak voltage to meter is held constant by regulator; potentiometer is adjusted so that time-average voltage read on meter is easily converted to dwell angle in degrees. Circuit taps ignition system's primary voltage supply for power, so no other battery or power source is required. Protection against reversed connections and short circuits is built in. Calibration circuit is connected to ignition coil as in (b). For best gas mileage, dwell time is adjusted to give VOM reading that corresponds to the dwell angle prescribed by auto manufacturer (c).

the potentiometer ($R_{10}$ and $R_{11}$) is adjusted to set $V_{cyl}$ at a level substantially lower than the B+ voltage, variations of the latter have virtually no effect on the dwell-angle readings. Since the series pass voltage regulator ($Q_2$) has very low output impedance, operation is independent of the VOM input resistance.

For convenient and error-free dwell-angle readings on the VOM, a simple initial calibration is needed. This calibration is made by adjusting the potentiometer when the circuit is connected to the car at the X and Y points and the distributor points are closed. (An alternative method is to connect the X and Y leads of the circuit to the anode and cathode of the car battery, respectively, for calibration.) The voltage $V_{cyl}$ is then set to the appropriate value shown in the table.

With the leads properly connected to the primary side of the ignition coil, the system is ready for making measurements. When the distributor points close and open repetitively while the engine is running, a train of rectangular voltage pulses with an amplitude of $V_{cyl}$ is impressed upon the VOM. Because the VOM movement possesses mechanical inertia, the pointer cannot track the pulses, so only an averaged voltage is indicated. This average voltage is effectively the dwell voltage. For example, a voltage of 2.7 V indicates a dwell angle of 27°. Rotating the point assembly then adjusts the dwell angle to the value suggested in the service manual for the particular model of automobile.

Diode $D_2$ and zener diode $ZD_2$ protect the circuit from accidental reversal of lead connections at X and Y and from high-voltage transients when the points open. Current-limiting resistors $R_5$ and $R_8$ protect transistor $Q_2$ and amplifier $A_2$ from overloading if the VOM leads are accidentally short-circuited. □

**SETTING OF $V_{CYL}$ FOR VARIOUS AUTOMOBILE ENGINES**

| Number of cylinders in 4-stroke engine | Maximum dwell angle | $V_{CYL}$ |
|---|---|---|
| 8 | 45° | 4.5 V |
| 6 | 60° | 6.0 V |
| 4 | 90° | 9.0 V |

# Electronic timer circuit improves welder performance

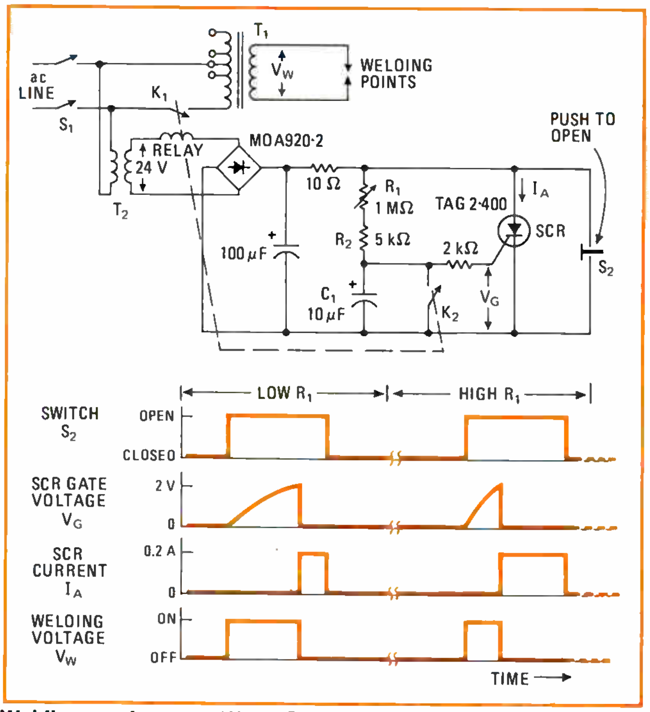
by Alex W. Sivan
*Orpak Ltd., Tel Aviv, Israel*

Point welders are widely used in industry, but many of them have no timers. Without an automatically controlled welding pulse, only skilled operators can weld thin metal parts that require a current-pulse duration of less than a second; if the equipment is automatically timed, however, almost anyone can weld such parts successfully. And even skilled personnel can probably perform repetitive production operations more quickly and efficiently with the aid of a timed current pulse.

A simple timing circuit that can be added to a welder is shown in the figure. When the ac line voltage is turned on and switch $S_2$ is closed, current through the relay coil holds $K_1$ open and $K_2$ closed. When the operator wants to weld, switch $S_2$ is opened, and the current through the relay coil thereupon decreases so much that $K_1$ closes and $K_2$ opens.

With $K_1$ closed, welding current flows in the secondary of $T_1$, and because $K_2$ is open, $C_1$ charges through $R_1$ and $R_2$. When the voltage across $C_1$ reaches the firing voltage of the silicon-controlled rectifier (about 2 volts), the SCR carries enough current to let the relay open $K_1$ and close $K_2$ again to stop welding and discharge $C_1$. The SCR continues to conduct until the operator lets $S_2$ close again. The welding current flows for a time returned by $(R_1 + R_2)C_1$ and the line voltage.

One of the most important features of this circuit is that the welding cycle is immune to noise from the relay spikes and transformer surges.




**Welding made easy.** When $S_2$ is pushed open, welding current flows and gate voltage starts to rise. Once gate voltage becomes high enough to let SCR conduct, welding current ceases. SCR continues to conduct until operator allows $S_2$ to close; thus, duration of welding pulse is determined only by charging time for $V_G$ to reach SCR firing voltage, not by how long $S_2$ is open.

The timing diagrams in the figure illustrate the operation of the circuit and indicate some typical values of current and voltage. □

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.

Data handling

# DEC fills out product lines

## Two print-only units, a video terminal, and an operating system bow at Wescon

Rounding out existing lines and services, the products and services being introduced at the Wescon show by Digital Equipment Corp. all come from the Components division. The big push is in printers, and DEC announced two: the LA-180 character printer and the LA-35 character printer. The latter is based on the LA-36 Decwriter, a keyboard-equipped terminal that prints at 30 characters per second.

The LA-180 is a peripheral, not a terminal, in that it has no keyboard. It prints 180 characters per second using a 7-by-7-dot matrix, forms a 132-character line, and operates at 1,200 baud. It has a parallel interface, positive tractor speed, movable right tractor, and movable part forms. A top-of-form function allows the user to advance the printer by the number of line feeds necessary. A variety of paper sizes and multipart paper are acceptable. The LA-180 will cost $1,975 each for 100 units and will be available for delivery in January.

At the other end of the printer line, DEC is introducing the LA-35, a read-only version of the LA-36. It has no keyboard and prints at 30 characters per second. It will be available in November at $1,310 each in hundreds.

DEC is also expanding its line of video terminals with the VT-52A, an enhancement of the VT-50. The screen on the 52A is double the size of the 50's and displays 24 lines of 80 characters each. Unlike the 50, it also has full cursor control, upper- and lower-case characters, and a numeric pad. Price will be approximately $1,340 each for 100 units, and it will be available in January.

The third announcement was the availability of an operating system for the LSI-11 microcomputer. A version of RT-11, which can also run on the PDP 11/03 minicomputer, it is available in Fortran IV or Multiuser Basic with a maximum of four users. DEC notes that the introduction of an operating system for the LSI-11 supports the contention that the device is fully compatible with the PDP-11 line of minicomputers and can rely on PDP-11 software. The Basic RT-11 operating system will be available in November and will sell for $750. Multiuser Basic and Fortran IV capability cost an additional $500 each.

Digital Equipment Corp., One Iron Way, Marlborough, Mass. [361]

## Floppy disk system works with Motorola EXORciser

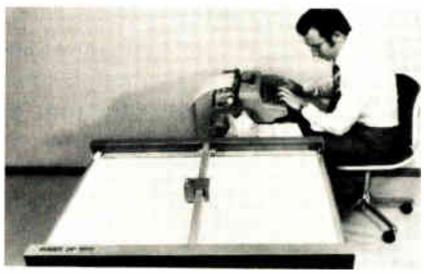
The iCOM FD360-68 is a low-cost floppy-disk system which plugs directly into Motorola's M6800 EXORciser and includes all hardware and software needed for immediate operation. According to iCOM, a typical edit/assembly sequence can

be performed in less than five minutes with the FD360-68 compared to three hours with a teletypewriter. Consisting of from one to four disk drives, an IBM-compatible formatter/controller, and a desktop cabinet with power supplies, cooling, and cabling, the disk system starts at $2,350 for a single-disk version in unit quantities. The unit price for a dual-disk system is $3,000. In small OEM quantities, the price of a single-disk system can drop as low as $1,840. Delivery time for all four versions is 30 days.

iCOM Inc., 6741 Variel Ave., Canoga Park, Calif. 91303. Telephone inquiries: (213) 348-1391, Terry Zimmerman [366]

## Large graphic output plotter is fast and accurate

Able to accommodate drawings up to 22 by 34 inches, the DP-1600 computer graphic output plotter can run at speeds up to 800 increments per second with a maximum error of 0.004 inch. A built-in microprocessor allows the device to plot a



straight line given only the line's end points, while a character symbol generator further reduces data-transmission and software requirements. The DP-1600 has a price of $14,000 and a delivery time of 60 to 90 days.

Glaser Data Co., 225 Forest Ave., Palo Alto, Calif. 94301. Telephone inquiries: (415) 321-1348, Jeff Ziman [363]

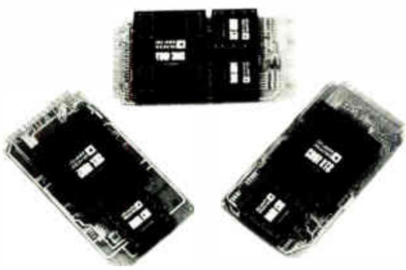
## Thermal printer has self-cleaning head

Designed to work with plastic-coated strip-chart paper as well as with chemically treated paper, an alphanumeric thermal printer from MFE Corp. has a special self-cleaning printing head that melts and vaporizes plastic that would smear and ruin other printing elements. Able to operate at rates up to 20 characters per second, the printer uses a 5-by-7-dot matrix to generate characters that measure 0.10 by 0.081 inch. The printer, which can be added as an option to MFE stand-alone recorders, contains its own power supply. Compatible with TTL circuitry, the device, which is being shown at Wescon, is expected to sell for about $300; deliveries will start at the end of the year.

MFE Corp., Keewaydin Dr., Salem, N. H. 03079 [364]

## Interface units connect converters with computers

A family of interfacing subsystems is intended to simplify the interconnections of such parallel-output devices as analog-to-digital converters with serial-input ASCII-compatible teletypewriters and computers. Mounted on printed-circuit boards, the subsystems are based on Analog Devices' Serdex (serial data exchange) modules which were introduced two and a half years ago. Three subsystems are offered: a transmitter subsystem at $395, a receiver subsystem also at $395, and a multiplexer at $450. All three are available from stock.



Analog Devices Inc., P. O. Box 280, Norwood, Mass. 02062. Telephone inquiries: (617) 329-4700, Ron Natale [365]

## Character printer writes 55 characters per second

Intended primarily for use in word-processing systems, the Sprint 55 is a character printer that can produce output copy at a speed of 55 characters per second. A companion unit, the Sprint 40, runs at 40 c/s. Both units use a daisy printwheel positioned by a pair of servo motors for high-quality printing. The Sprint printers can handle any paper size

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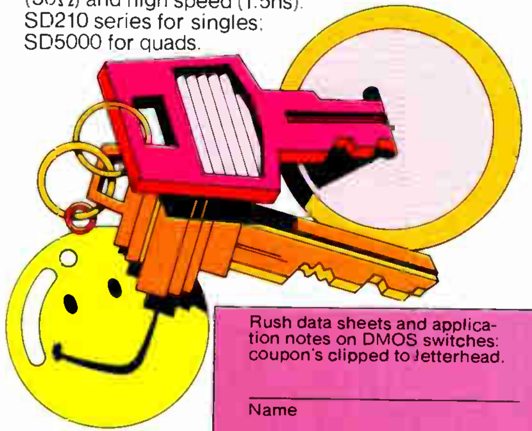

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up to 15 inches in width. Bidirectional paper feed and fast horizontal tabulation allow the use of any printing format in horizontal increments of 1/120 inch and vertical increments of 1/48 in.

Qume Corp., 2323 Industrial Parkway West, Hayward, Calif. 94545. Telephone inquiries: (415) 783-6100, Sol Zasloff [367]

## Cartridge disk drive can store 400 megabits

Possessing a formatted storage capacity of 400 megabits, the model 5017 cartridge disk drive uses a patented method to achieve a packing density of 500 tracks per inch on the disk. The fast-access unit zeroes in on its own data track, permitting it to find and lock onto the desired track regardless of temperature variations. Able to work properly in ambient temperatures from 50°F to 100°F, the model 5017 has an average head positioning time of 35 milliseconds. To ease the problem of evaluation by a potential user, the manufacturer can provide a controller to interface the 5017 with a Digital Equipment Corp. PDP-11 minicomputer.

Vermont Research Corp., Precision Park, North Springfield, Vt. 05150. Telephone inquiries: (802) 886-2256, Evered W. Hinkley [368]

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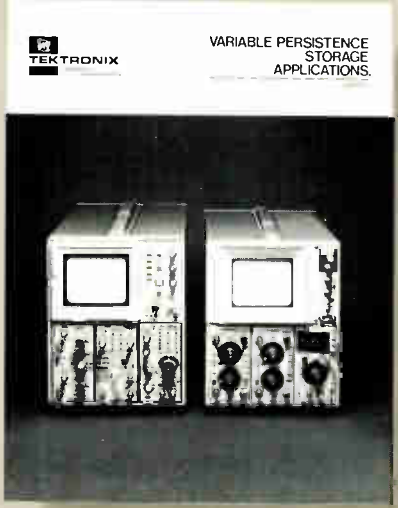


But there's a lot more to be said. Variable persistence storage has applications in spectrum analysis, mechanics, biophysics, and many other areas. Just fill out the coupon and we'll send you our guide, "Variable Persistence Storage Applications," or, if you prefer, arrange for a demonstration.

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- ☐ "Variable Persistence Storage Applications".
- ☐ "Bistable Storage Applications".
- ☐ "FAST and Multimode Storage Applications".

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   ☐ Please arrange for a storage-oscilloscope demonstration.

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  Model ____________

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Instruments

## Synthesizer has 7-digit resolution

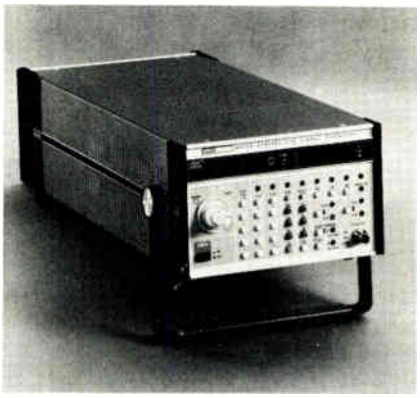
### Digital commands set both amplitude and frequency of microprocessor-based unit

The model 6011A synthesized-signal generator from John Fluke Mfg. Co. improves on microprocessor control, introduced in the firm's model 6010A synthesizer [*Electronics, April 3, p. 113*], by offering digital entry of output level as well as frequency.

Four-digit amplitude levels in volts, millivolts, or decibels along with seven-digit frequency values from 10 hertz to 11 megahertz can be entered via front-panel push buttons or a rear-panel ASCII interface connector. Interfaces compatible with IEEE STD 488-1975 or RS-232-C are optional and cost extra.

Priced at $3,995, the model 6011A can store nine sets of frequencies and amplitudes and recalls them individually when one of nine location buttons is pressed. Values can be changed by dual-concentric edit controls—one knob selects the decade to be changed, and the second varies the value.

The model 6011A can also store reference values for frequency and output level. Numbers then entered are added to these references. The amplitude reference can be set at a voltage, and new entries can be programed in decibels with respect to the stored reference.



An amplitude limit value can also be set, a feature especially useful in production-line testing. Amplitude modulation of the output is standard, frequency modulation an option that costs extra.

Frequency resolution is 0.1 Hz from 10 Hz to 110 kilohertz and 10 Hz from 10 Hz to 11 MHz. Drift is less than one part in $10^8$ per day.

Amplitude-setting resolution is 0.01 decibel, 1 millivolt, or 0.1 microvolt on the dB, V, and mV ranges, respectively. Voltages can be programed in peak-to-peak or root-mean-square values, either terminated or open circuit.

Frequency response is ±0.025 dB from 100 Hz to 5 MHz.

John Fluke Mfg. Co. Inc., P. O. Box 43210, Mountlake Terrace, Wash. 98043 [351]

### Tektronix logic analyzer fits TM-500 mainframe

The LA 501 logic analyzer, an addition to Tektronix' TM 500 instrument series, can display up to 16 channels of digital data in timing diagram format.

Priced at $3,250, the instrument is housed in a two-unit-wide plug-in that requires a TM 500-series mainframe for power. It is shown along with a DD 501 digital delay and an SC 502 oscilloscope in a $325 TM 515 mainframe.

Data sampling can be either synchronous or asynchronous, with four input channels of 1,024 bits sampled at up to 100 megahertz, eight channels of 512 bits at 50 MHz, or 16 channels of 256 bits at 20 MHz.

A choice of pre-trigger, center-trigger, or post-trigger modes lets a user select where the displayed block of data falls with respect to a trigger taken from a system. In the pre-trigger mode, 94% of the displayed data occurs before the trigger, in the center-trigger mode, 50%, and in the post-trigger mode, 6%.

A front-panel selector switch makes the LA 501 compatible with TTL or ECL levels, and a third position provides a variable threshold from -10 to +10 volts to accommodate other logic types.

The LA 501 can be used with any monitor or oscilloscope that has X-Y capability and at least 500 kHz of bandwidth. Any one channel of the display can be selected and moved vertically for comparison with any other channel by use of a position control on the LA 501.

Tektronix Inc., P. O. Box 500, Beaverton, Ore. 97077 [352]

## True-rms digital multimeter measures up to 6,000 counts

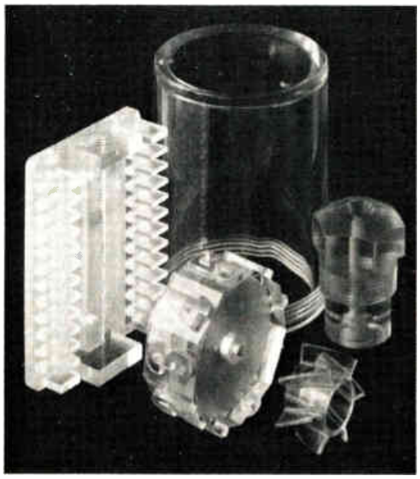
Although it's called a 3½-digit multimeter, Data Technology's model 31 is a 6,000-count instrument that measures dc voltage and current, true-rms ac voltage and current, and resistance. The meter can handle ac voltages from 100 microvolts to 1,000 volts with a maximum crest factor of five. Priced at $395, the model 31 can operate for 10 hours from rechargeable batteries. The price includes a battery charger and holder and automatic charging and shut-off circuitry. Options for the instrument, which is being shown at Wescon, include a universal test lead kit, high-voltage, rf, and demodulation probes, a carrying case, and a rack-mount kit.

Data Technology Corp., Data Instruments Div., 2700 S. Fairview Rd., Santa Ana, Calif. 92704 [353]

## Programable data and timing generator is interactive

By combining microprocessor control with digital word generation, the designers of the RS-432 microprocessor-controlled data and timing generator have come up with a

## New products/materials



**Clear epoxy casting resin** Stycast 1269A cures to such a crystal-clear transparency that it can be used to make windows, lenses, and other optical components. Since the parts can be cast to exact size and shape, expensive grinding is not needed. Red and green dyes are available for coloring the material, if desired, when it is used as an encapsulant for light-emitting diodes. Sold as a two-part system, Stycast 1269A cures in 16 hours at 190°F. It sells for $3.70 per pound in 18-pound lots; delivery is from stock.
Emerson & Cuming Inc., Canton, Mass. 02021, Telephone inquiries: (617) 828-3300 [476]

**Conductive compounds** for use in the solution of shielding problems and other applications are offered in a sample kit that contains six formulations: two epoxy adhesives, a silicone RTV adhesive, two caulking compounds, and a coating. Priced at just $25, the kit contains materials that would normally sell for $50 in large quantities.
Chomerics, 77 Dragon Court, Woburn, Mass. 01801, Telephone inquiries: (617) 935-4850 [477]

**A line of laminated cable tapes** is much less bulky than standard copper shielding. Consisting of two or more layers of plastic films and aluminum foil in various combinations, LAM-A-SHIELD provides both insulation and shielding in one material. The tapes are quite rugged: no problems occur during the

extrusion of cable jackets, for example, and the line includes tapes that will heat-seal to the jacket during extrusion.

Bee Chemical Co., Fairfield Div., 26 Daniel Rd., Fairfield, N. J. 07006, Telephone inquiries: (201) 863-8689 [478]

**Optical coating materials,** including SiO, PbTe, $Ta_2O_5$, ZrO, $MgF_2$, $PbF_2$, ThO, $Ti_2O_3$, and other rare-earth fluorides, plus the metals aluminum and chromium, are offered in a variety of shapes and purities for thin-film deposition. The nonmetallic materials are vacuum hot-pressed to densities in excess of 90%, yielding virtually gas-free evaporation or sputtering source material. Shapes include random chunks for evaporation, precise shapes and sizes to customer specifications, and sputtering targets. Purities range from 99.9% to 99.99%.

Materials Research Corp., Route 303, Orangeburg, N. Y. 10962, Telephone inquiries: (914) 359-4200 [479]

**Microwave substrate** material Epsilam-10 is a laminate with a dielectric constant of 10.3 ±0.5. Intended for both microstrip and stripline applications for frequencies up to and including X band, it is a copper-clad, ceramic-filled Teflon compound that combines the flexibility of plastic with the dielectric properties of alumina. Epsilam-10 is supplied in 9-by-9-inch sheets either 0.025 or 0.050 in. thick. It can be machined, drilled, routed, or cut with shears or knife.

3M Co., Dept. EP5-11, P. O. Box 33600, St. Paul, Minn. 55133 [480]

**Plating catalyst** Cataposit 44 is a highly concentrated tin-palladium material that permits high adsorption and provides excellent through-hole coverage because of its extremely small particle size. Intended for use in the fabrication of both multilayer and conventional printed-circuit boards, Cataposit 44 can be heated up to 120°F for better adsorption on hard-to-catalyze substrates.

Shipley Co. Inc., 2300 Washington St., Newton, Mass. [401]

## New literature

**Saving gold.** Manufacturers of electrical contacts, connectors, and lead frames who want to conserve gold may be interested in TMI 55 Bulletin No. 12 which describes TMI 55 gold alloy. This material contains 55% gold, the balance consisting of silver, cadmium, and indium. The result is a contact alloy that compares favorably with gold in most respects, yet costs only 63% as much. The bulletin is put out by Technical Materials Inc., 5 Wellington Rd., Lincoln, R. I. 02865. Circle reader service number 421.

**Ferrites.** Catalog sheets on a wide range of ferrite coil forms, sleeves, toroids, and beads are available from the Sales Manager, Krystinel Corp., Fox Island Rd., Port Chester, N. Y. 10573 [422]

**Decapsulation.** A 12-page brochure which tells about a decapsulation service called Access can be obtained from the Advertising Manager, Amphenol Cadre Div., 20 Valley St., Endicott, N. Y. 13760 or 600 Diagonal Highway, Longmont, Colo. 80501. The Access process is a proprietary method for removing potting, molding, and encapsulating materials from components or assemblies without the use of high temperatures, ultrasound, or abrasives. [423]

**Pre-etch plasma treatments.** The effectiveness of plasma-induced wettability of oxide surfaces and of plasma descumming are discussed in an application note from Tegal Corp., 860 Wharf St., Richmond, Calif. 94804 [424]

**Data collection equipment.** A 20-page reprint from the June supplement to Datapro 70 describes 45 specialized data collection devices and systems from 31 manufacturers. The report, which is called "All About Data Collection Equipment," can be ordered from Datapro Research Corp. at $10 per copy. The address is 1805 Underwood Blvd., Delran, N. J. 08075 [426]

**Video instruments.** A short-form

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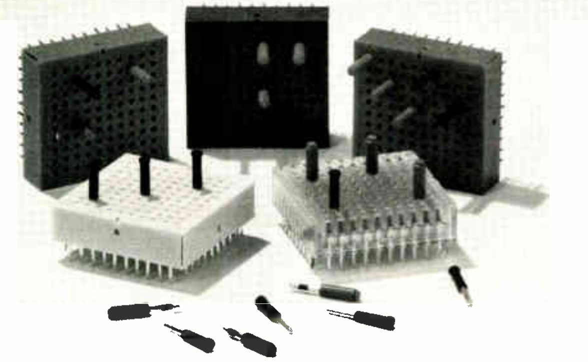

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There isn't another strip chart recorder on the market today that can match the Gould 110's performance, ruggedness, versatility and writing dependability.

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For complete information, write Gould Inc., Instrument Systems Division, 3631 Perkins Ave., Cleveland, Ohio 44114. Or Gould Allco S.A., 57 rue St. Sauveur, 91160 Ballainvilliers, France.

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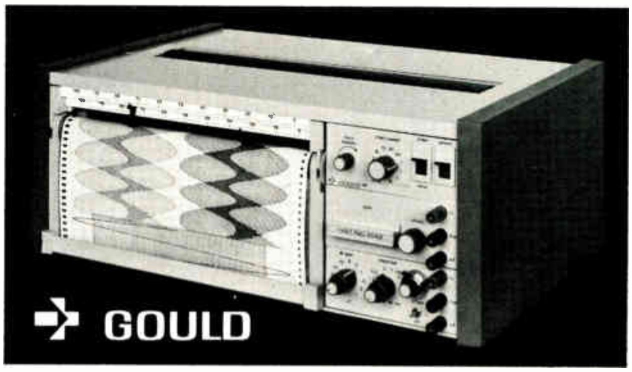


Circle 189 on reader service card

catalog from Colorado Video Inc., P. O. Box 928, Boulder, Colo. 80302, lists 35 video instruments including slow-scan equipment, video digitizers, quantizers, disk memories, and X-Y devices. [427]

**C-MOS circuits.** Two extensive lines of C-MOS logic circuits are covered in detail by a new catalog and applications manual offered by National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. The 246-page handbook includes information on the 54C/74C and CD4000 series. [428]

**Computer products.** A 26-page catalog includes photos and brief descriptions of nearly 100 OEM computer products made by HP. Entitled "OEM Computer Products," the catalog can be obtained from Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [429]

**Everything electronic.** The 228-page 1976 Allied Electronics Engineering Manual and Purchasing Guide (No. 760) contains catalog information on a variety of electronic equipment from wire and cable to test equipment and semiconductor devices. The guide can be ordered for $1 from Allied Electronics, Dept. 76, 401 East 8th St., Fort Worth, Texas 76102 [430]

**Twisted-pair ribbon cable.** A data sheet from Spectra-Strip Corp., 7100 Lampson Ave., Garden Grove, Calif. 92641, describes a twisted-pair ribbon cable that reduces crosstalk and is easy to terminate. [431]

**Automatic transfer switches.** Entitled "Withstand Current Ratings for Automatic Transfer Switches," a 20-page booklet from Asco is a primer on short-circuit characteristics. After giving details on short circuits, the booklet explains why their detailed characteristics must be considered in the selection of an automatic transfer switch. Listed as Asco publication 919, the booklet is published by Automatic Switch Co., Florham Park, N. J. 07932 [425]

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September 18, 1975

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**free wall chart!**

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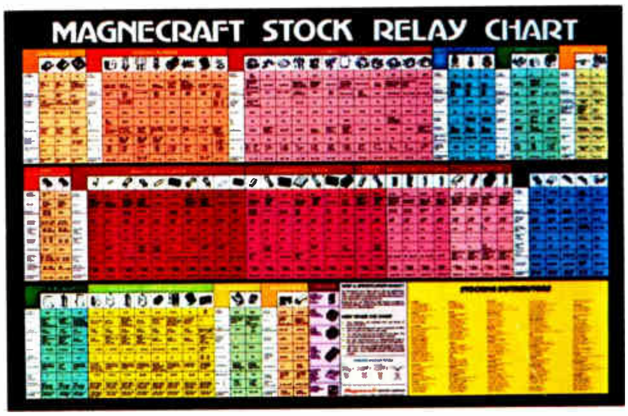


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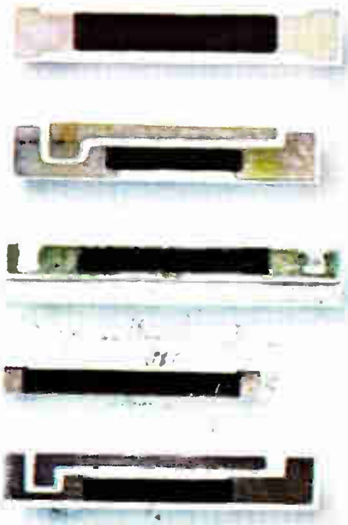


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