APRIL 29, 1976

ELECTRO76: NEW VITALITY AT A NEW SITE/106

Target for nonvolatile memories: hand-held calculators/75

A selection guide to computer-aided design programs/102

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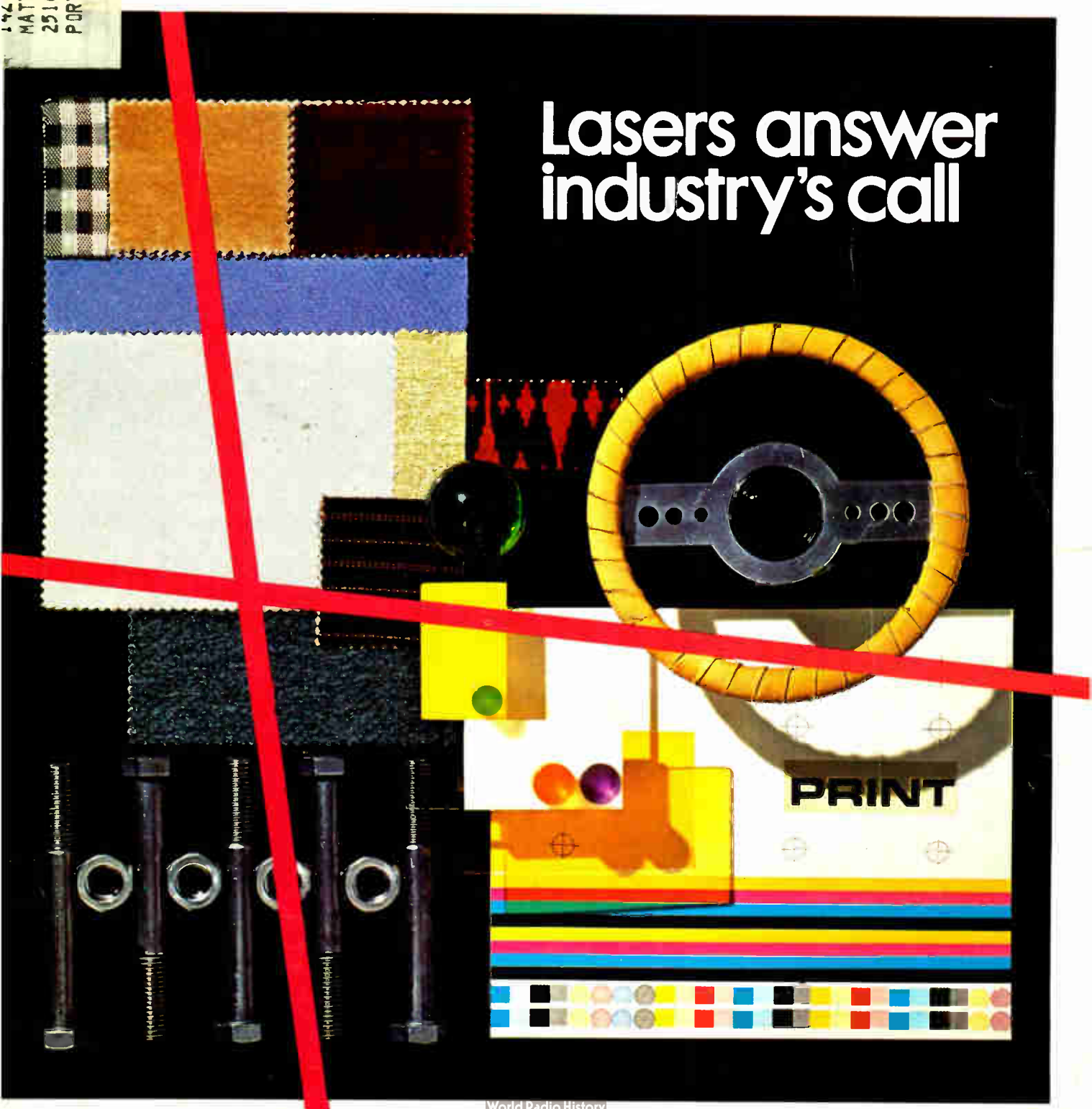
Electronics



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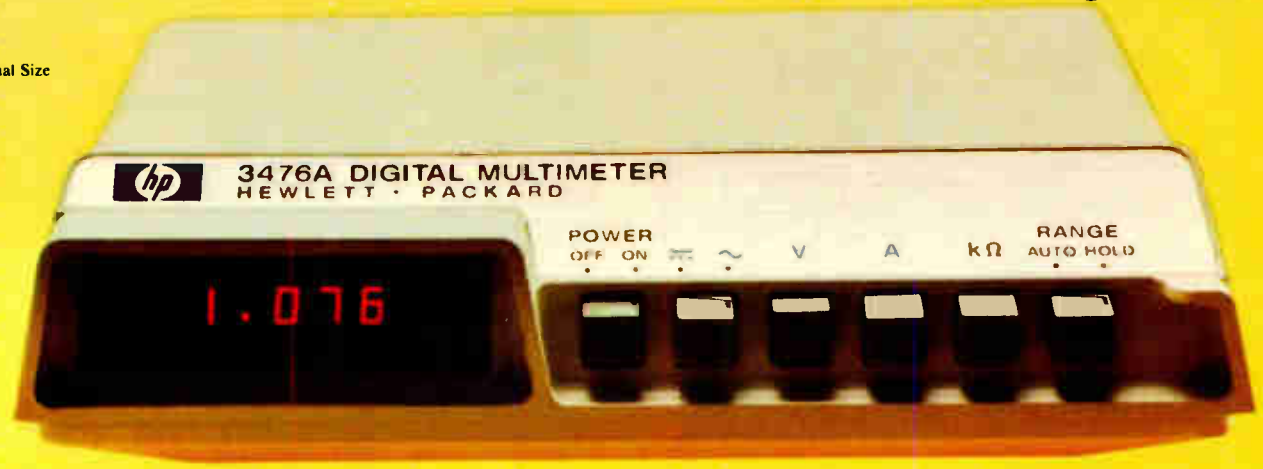
*Domestic U.S.A. prices only.

HP DVM's— the right decision

095/52

Actual Size



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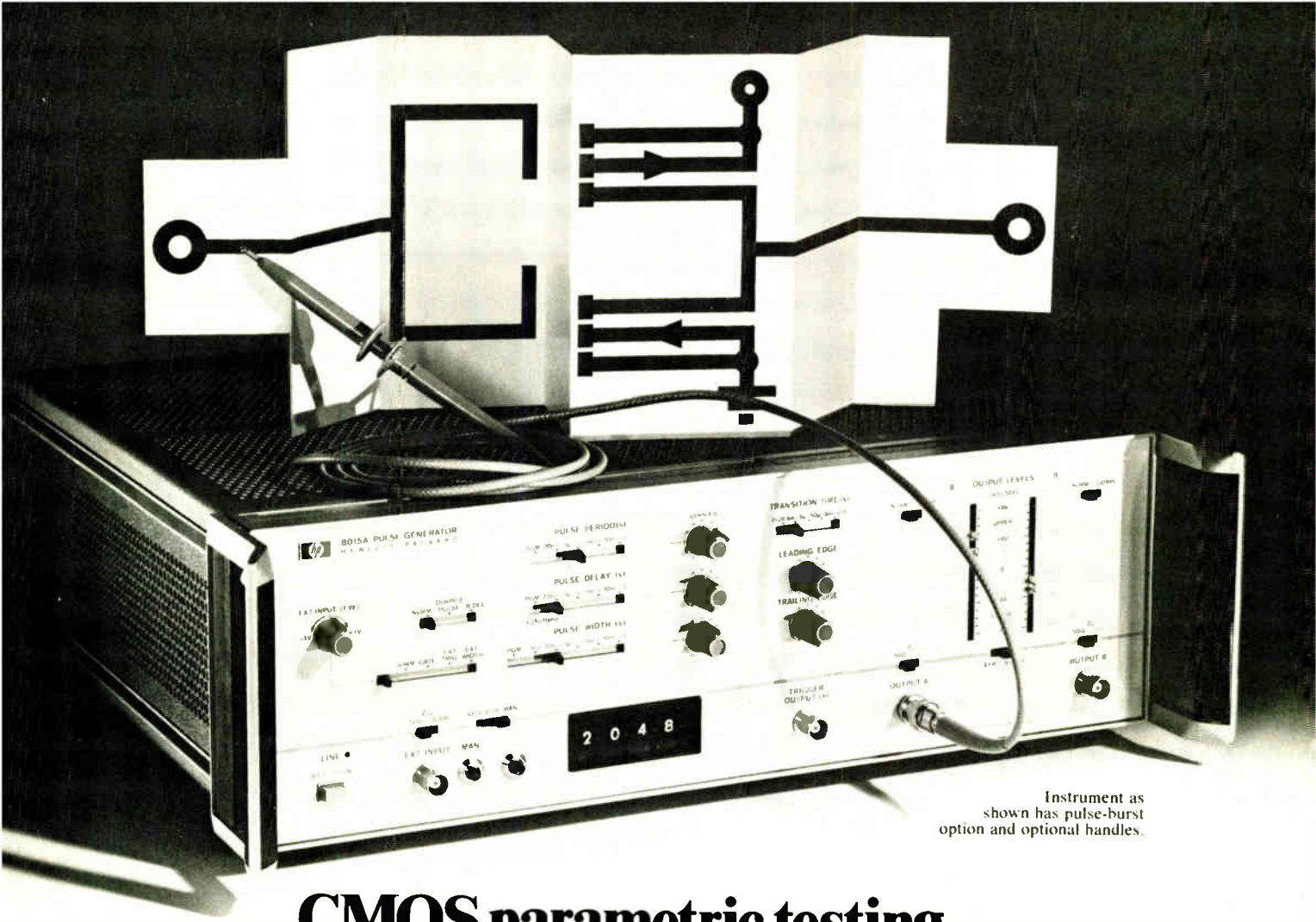

Instrument as shown has pulse-burst option and optional handles.

CMOS parametric testing makes special demands... Meet them with HP's 8015A Pulse Generator.

This pulse generator has standard features and options that make it ideal for MOS and CMOS parametric testing. For example:

You get dual-channel outputs, each variable to 16V. Or, they combine into a single 30V channel adjustable within a ± 16V window. That versatility makes the 8015A compatible with CMOS, and most MOS devices. You can delay channel B with respect to A for generating 2-phase nonoverlapping clocks. And combine the adjustible B delay with A + B to generate three-level signals.

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The 8015A options makes CMOS testing even easier. Pulse Burst (option 002) eliminates conventional gating problems. Just set the exact number of pulses you want (from 1 to 9,999) on thumbwheel switches. That's exactly the number you get...independent of pulse-rate settings.

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Direct Output Amplifier Access (option 004) lets you convert word generator outputs, or TTL signals, to MOS/CMOS levels, or amplify low-level analog control signals to MOS/CMOS levels.

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And TTL Output (option 005) gives you a separate TTL compatible, 50-ohm output that tracks channel A output with fixed TTL levels.

The 8015A, starting at $2,250*, gives you parametric testing flexibility and saves valuable setup time.

Or, if your need is for functional CMOS testing, consider HP's 8011A. Priced at just $525*, it gives you high amplitude (to 16V) pulses at rates from 0.1 Hz to 20 MHz, and offers the Pulse-Burst Option.

Contact your local HP field engineer for all the details. Or, write for the 8015A and 8011A data sheets and our Application Note 195—"Pulse Generator Techniques in CMOS Applications."

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086

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016/20

Electronics
The International Magazine of Electronics Technology
Vol. 49, No. 9 • April 29, 1976

Highlights

Cover: Lasers take hold in industry, 89
As the technology matures, lasers are flourishing in alignment and inspection tasks, metalworking jobs, and printing and information handling. Improvements in reliability and operating life, together with decreasing costs and the move toward standardization, could signify an upswing in both types and numbers of industrial applications.

Cover construction is by Bob Strimban.

Bubble memories are almost ready, 73
Manufacturers in the U.S. and Japan are satisfied that bubble memories will work, and so it looks as though some devices may be available within a year. Most likely market is mass memory, with enough products from different companies to add up to a wide range of applications.

IEEE show is full of promise, 106
Electro/76, in Boston, reflects happy days returning in the electronics industries and offers a technical program that emphasizes microprocessors. Our preview of the May 11–14 show includes a look at Boston's offerings for the Bicentennial visitor and a listing of some restaurants.

Electro/76 exhibits boast many new products, 121
There will be more unveilings this year than in recent IEEE Eastern shows. Emphasis, of course, will be on microprocessors and on intelligent instruments and terminals—but particularly on new applications of these technologies in the traditional jobs of measuring, controlling, and communicating.

And in the next issue . . .
A 16-k RAM that requires no advanced manufacturing process and offers prospects of high reliability . . . MOS technology takes on TV functions such as tuning and on-screen displays . . . a high-speed multiplier chip promises simplified digital-signal processing.

Electronics

Publisher's letter

This year it's called Electro/76, it is going to be held in Boston, and it is already generating a lot of excitement. The annual IEEE show, which has started its alternation between New York and Boston, has been through some rough years, but all the signs are pointing to a successful show this year.

Our preview of Electro/76, which should draw in excess of 25,000 attendees from May 11 to 14, starts on page 106. In the five pages that follow, we have packed in a lot of details on who will be exhibiting in Boston's Hynes Auditorium, as well as in-depth reports on the 34 technical sessions. Those sessions, to be held at the nearby Sheraton-Boston Hotel, include seven devoted to microprocessors.

There is also a summary of what Boston has to offer in the way of entertainment and in the way of dining out. For that, see pages 112 and 113. Then, on page 121, we take the wraps off a number of new products that will make their market debut at show time.

Lasers have been somewhat slow to achieve the bright future in industry that was predicted for them when they were first developed. Nonetheless, there are an increasing number of jobs that would be much more difficult, if not outright impossible, to do without the concentrated bundle of energy contained in the laser beam.

Starting on page 89, you'll find a detailed eight-page report on the industrial uses of the laser, which range from precision alignment and inspection applications to fine machining, from welding to precise hole cutting, from imaging systems to printing-plate production.

According to Margaret Maas, our industrial editor, who put together the report, "it is the unexpected development of the consumer laser market that has given the industrial laser its biggest recent boost. Mass production has already driven costs down from close to $1,000 only five years ago to $100 today. And if the video disk really takes off, it will quickly drop to the $10-20 range."

Computer-aided design programs can bring a lot of computational power to bear on just about the most crucial stage of a product's long journey from idea to marketplace. The actual design of the electronic circuitry takes a large number of man-hours, a good part of which are spent on manipulating mathematical formulas rather than on achieving creative results.

Yet computer-aided design approaches have their limits. On page 102, we are publishing a summary of a recent Air Force study of 16 major CAD programs. The study looked into advantages and drawbacks of the programs and the type of problems they can handle, as well as the speeds, flexibility, and special features of each. The tables that accompany our summary give a lot of details about third-generation programs and should help in clarifying how CAD can help you raise the creativity/drudgery ratio in circuit design.

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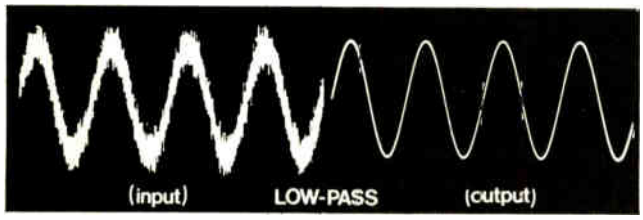

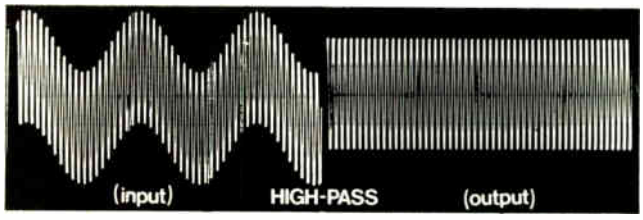

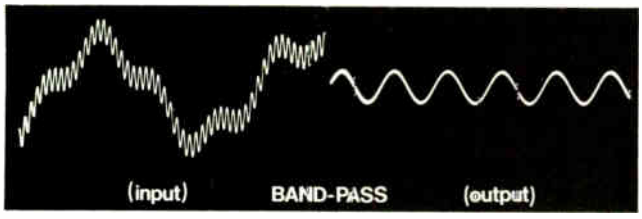

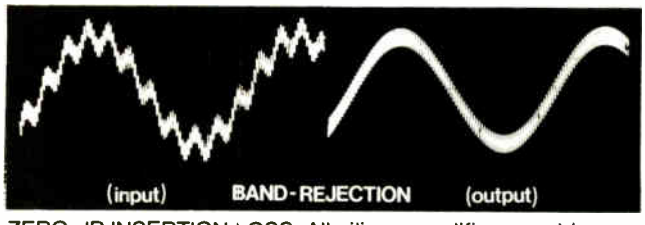

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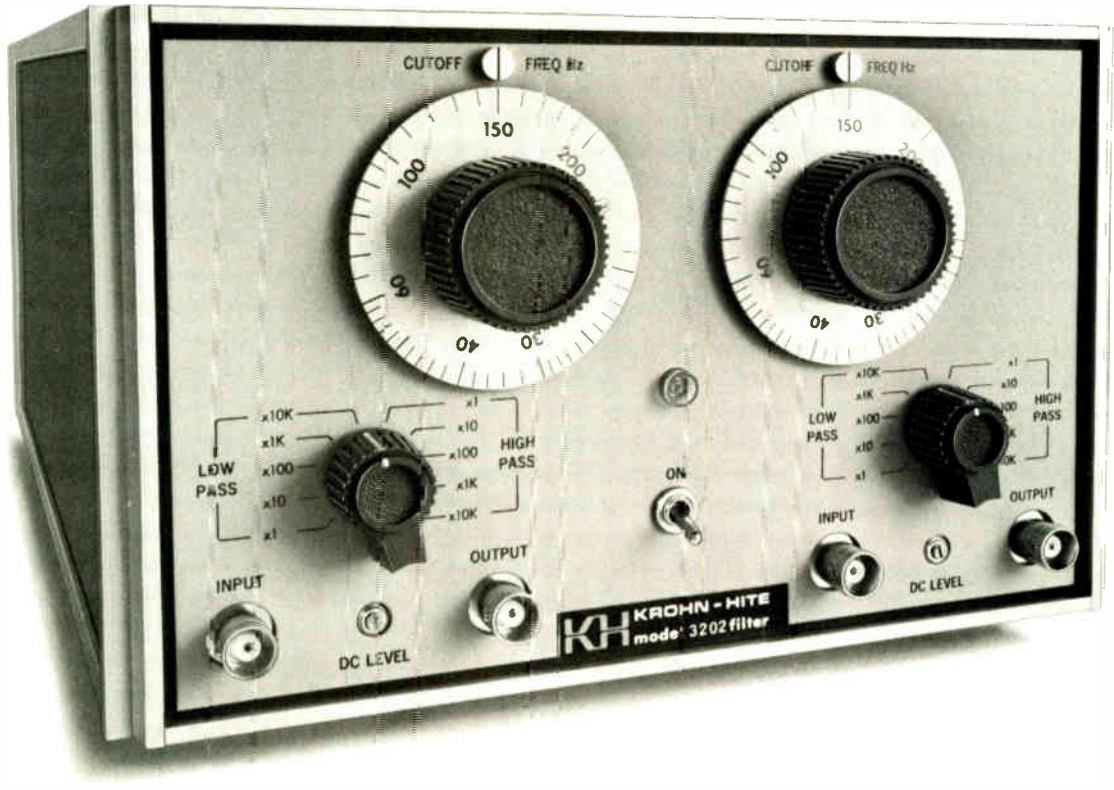

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Readers' comments

Why not store $a^{1/2}$?

To the Editor: In "ROM-stored sine functions yield square roots" [Nov. 13, 1975, p. 139], a sin α table stored in the read-only memory is addressed via a, not α, the relation between these being given by:

$$\sin \alpha = 2(a^{1/2})/(a+1)$$

The only solution I can see is that you would have to precalculate sin α for every possible value of a, so you might just as well store the value of $a^{1/2}$. Alternatively:

$$\cos \alpha = (a-1)/(a+1)$$

But to do these calculations as well would seem to be more trouble than it's worth. In either case, for only five significant figures, you would have to store approximately 10^7 decimal digits (100 addresses of 10^5 digits each).

Sidney V. Soanes
JVA Scientific Consultants Ltd.
Toronto, Ont., Canada

■ **The author replies:** *The use of a for the address gives ready access to the sine table in the ROM. Sin α would be calculated by a standard computer method and stored in the ROM. Some very interesting and surprisingly cyclic characteristics appear in sin α in the computer simulation of the circuitry—which could lead to further investigation for developing a function generator.*

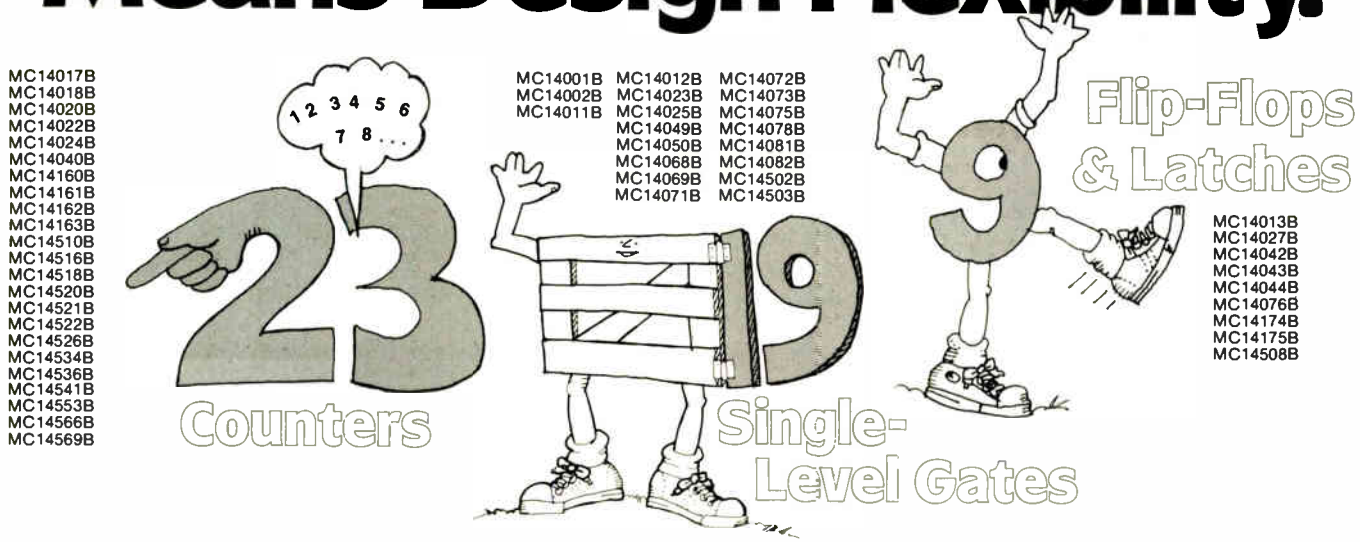
I needed a rapid way of calculating square roots with a reasonable degree of accuracy. The iterative method usually used is slow. I hope that my article will stimulate some investigation into the rapid calculation of square roots for unlimited numbers.

Editor's Note

Electronics has been advised that, although developed independently, the circuit described in "Counter inverts period to measure low frequency" [March 4, p. 100] is virtually identical to a circuit invented by Karl Ritzinger and published in U.S. Patent 3,859,512, dated Jan. 7, 1975. Readers may be interested in obtaining copies of this patent.

Also, in Fig. 2, the device type of the period counter A is incorrect; it is a CD4040.

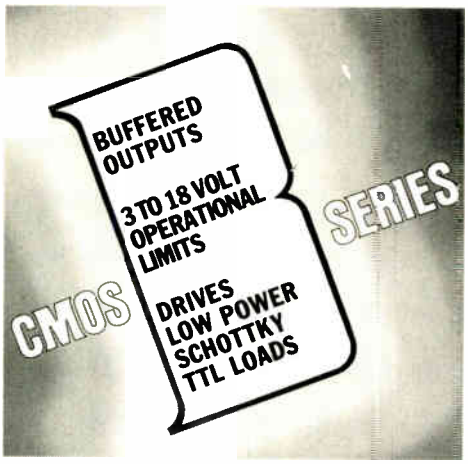
Motorola's B Series CMOS Means Design Flexibility.



It's a matter of numbers.

There are other good reasons for picking Motorola's B Series of CMOS logic functions for your systems, but the design flexibility derived from the industry's outstanding B Series device selection is probably the best.

It's a matter of numbers. A number like 23. That's 23 different B Series counters to choose from. Numbers like 19 and 9. That's 19 different single level B Series logic gates and 9 flip-flops and latches, for coverage in the simple function area. The number 11 means 11 arithmetic circuits, an indication of the total range of B Series options in complex functions. And, there's the number 92, representing the broadest line of B Series CMOS available right now in SSI, MSI, and LSI complexities.



As we said, it's in the numbers that you find the design flexibility of Motorola's B Series CMOS, but let's not overlook the other good reasons for going with McMOS*.

In these cost conscious days, our low prices are important, and the knowledge that what you design into your systems will be delivered on time is reassuring. Certainly, Motorola's CMOS reliability, in both plastic and ceramic is a confidence factor. Motorola's B Series CMOS is built for use now, priced for use now, available for use now.

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News update

■ A semi-insulating polysilicon technique developed by Sony Corp. for passivating semiconductors is being used by the Japanese manufacturer in a few devices for television sets and some for facsimile. At the same time, Sony is working to improve the process before putting it into large-scale production.

When Sony researchers announced their development [*Electronics*, May 15, 1975, p. 30], they said the approach would mean denser, faster, and more reliable devices than those passivated with conventional thermally grown silicon dioxide. C-MOS devices built with the new technique, said Sony, were 50% denser than conventional C-MOS circuits. The reason: space-wasting guard rings are eliminated. What's more, the company says that the process is inexpensive, versatile, easily mass-produced, and can be used with any silicon device. It also permits operation at extremely high voltage—the researchers report operating npn and pnp transistors at 10,000 volts.

■ A communications system for coal mines, developed by the U.S. Bureau of Mines and built by Collins Radio Group of Cedar Rapids, Iowa, is apparently enjoying some success. Collins has just completed installation of another of the computer-controlled monitoring and control systems, this one at Eastern Associated Coal's Federal No. 2 mine, which is near Miracle Run, W. Va.

Sold for about $200,000, the system features a console based on a Digital Equipment Corp. PDP-11/05. It monitors carbon monoxide, methane, and airflow in the mine. In addition, it provides a 100-station phone system, plus pocket pagers for individual miners.

The prototype of the system was installed in a coal mine near Uniontown, Pa., operated by United States Steel Corp. Such systems are now part of the standard product line for Collins [*Electronics*, May 15, 1975, p. 34], a subsidiary of Rockwell International Corp.

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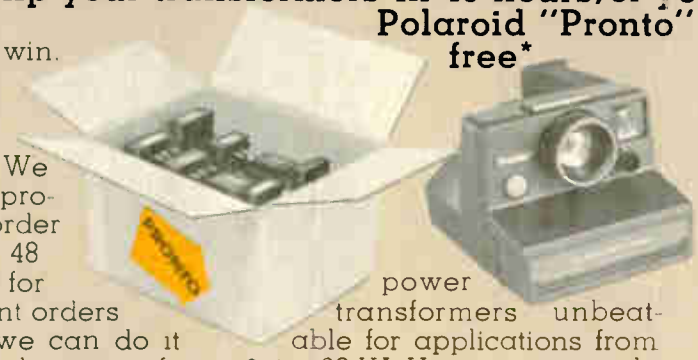

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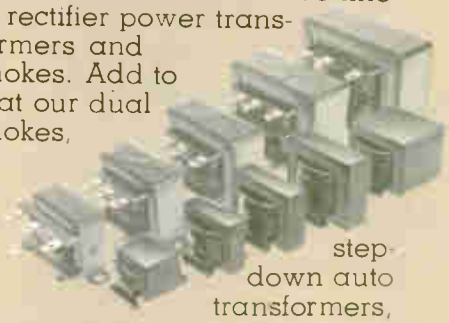

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Editorial

The engineer's duty to himself

In a series of articles and editorials, we have scrutinized and decried the injustice of age discrimination, an insidious and all too widespread a practice that appears to hit over-40 electronics engineers particularly hard.

Many solutions, with varying degrees of merit, have been proposed for this problem. They range from forming a tight guild in the American Medical Association mold to a strict quota system in engineering schools. Government, educators, industry managers, and IEEE leadership all must share responsibility for ending age discrimination.

As we have said often, age discrimination is not only illegal it is wasteful. We still believe that it ultimately will be eliminated because all the parties involved will find how wasteful it really is.

Meanwhile, the individual electronics engineer must cope with this problem realistically and intelligently. Despite our numerous calls for organized action, we remain convinced that the best protection for an EE's career can come from his own sense of striving for professional attainment.

That engineering degree, by itself, entitles him to nothing. The idea that government, or a union, could or should bear the individual's burdens for him now pervades too many sectors of society. No one can take an engineer's courses for him and no one can read technical magazines for him. No one except himself can keep up with the latest technology and thus stimulate, nurture, and expand his creativity.

In engineering, the best protection against obsolescence is proven value. And if an engineer has to prove his over and over again, that may be the necessary incentive to keep pace with technological advances. It may be tough, but it's also what makes this profession so challenging and so much fun.

When will there be real progress in citizens' band?

The sudden upsurge in interest in citizens' band radio caught the Federal Communications Commission off guard. The first four months of the year, for example, saw some 2,000,000 people apply for citizens' band licenses. The backlog of applications climbed so fast that some of those turned on to the prospect of convenient personal communication were being turned off by the long wait for approval to legally use their now not so newly bought equipment. The result, not unexpectedly, has been an upswing in illegal—that is, unlicensed—CB transmissions, and a climb in anonymous transmissions.

Thus, it is heartening that the FCC has cleared the way for purchasers of CB hardware to use their equipment as soon as they buy it. Now, after applying to the FCC for a license, as usual, the CB-set buyer can start transmitting by using a temporary set of call letters, which are based on his initials and his zip code.

This temporary "license" is a temporary expedient at best. The long-term goal must be a fundamental restructuring of the grossly overcrowded citizens' band allocations, so that more space can be given to the millions of CB-set owners. After all, the agency that, on the one hand, can regulate citizens' band through licensing requirements has, on the other hand, the responsibility to see that its licensees are fairly dealt with.

The recent delay in upping CB channel allocations from 23 to 50, a stopgap that many considered an interference-prone step backwards, may be a blessing in disguise if it hastens a meaningful expansion of citizens' band into frequency modulation and into higher frequencies. Unfortunately, given the FCC's slow track record in CB, it probably adds up to just one more delay.

Compare all two.

Before you pick a microprogram sequencer, be sure you're getting the most for your money.

It's easy. You only make one decision: The 28-pin Am2909. Or the stripped-down version, the 20-pin Am2911.

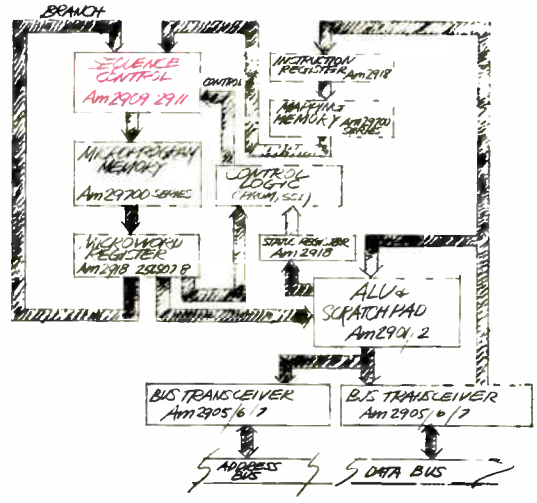
The Am2909. The world's only sequencer with a provision for n-way branching on one cycle and two branch address input ports.

The Am2911. The world's only sequencer that offers a space-saving package and a low 100-piece price of $7.77.

Both are expandable to generate any length address. Both have built-in microprogram counters. Both can branch immediately to any address.

There's more. Both can loop and store up to four nested subroutine addresses. Both have combinatorial logic between the control lines and the outputs, allowing high-speed, same-cycle branching.

Hello LSI.



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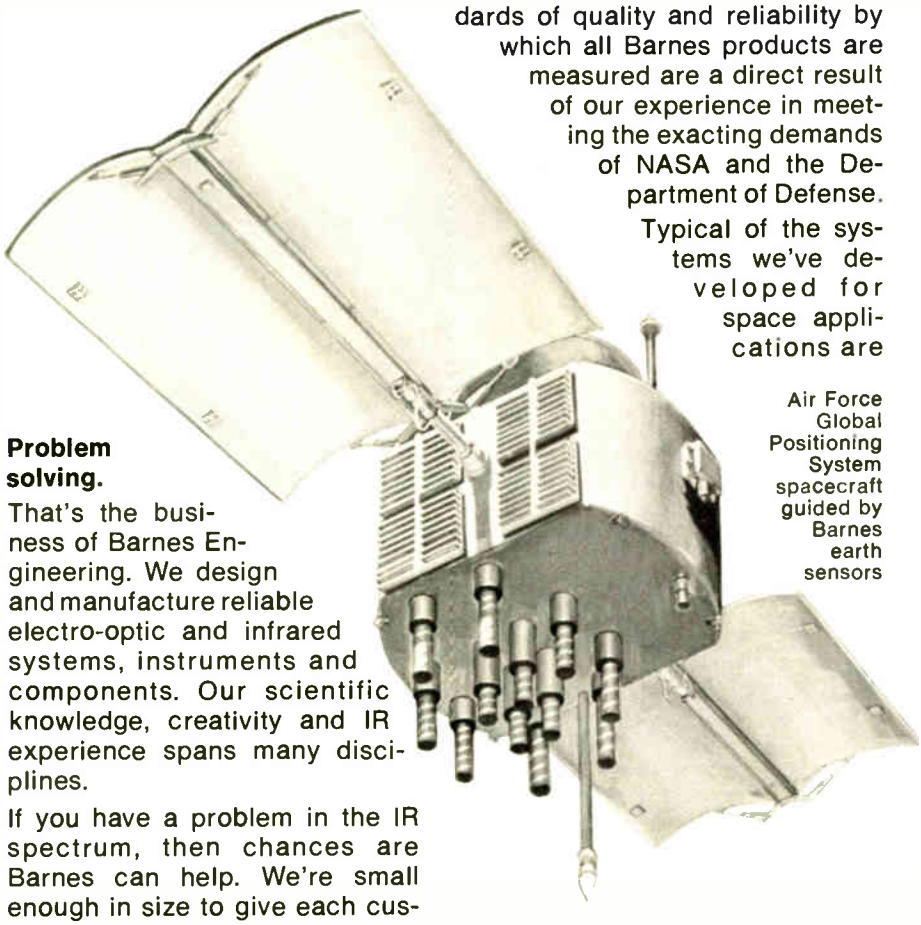

Air Force Global Positioning System spacecraft guided by Barnes earth sensors

Problem solving.

That's the business of Barnes Engineering. We design and manufacture reliable electro-optic and infrared systems, instruments and components. Our scientific knowledge, creativity and IR experience spans many disciplines.

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Barnes has solved thousands of difficult problems in infrared. Space vehicles carrying Barnes IR products have mapped the moon, helped forecast the weather, flown by Venus and Mars, and set up worldwide communications networks.

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A good deal of our electro-optical and infrared technical expertise comes from developing problem-solving hardware for space applications. In fact, the high standards of quality and reliability by which all Barnes products are measured are a direct result of our experience in meeting the exacting demands of NASA and the Department of Defense.

Typical of the systems we've developed for space applications are satellite infrared horizon sensors. Since 1956, Barnes has been building these instruments for use in spacecraft navigation and attitude control. It's no wonder we have a broad range of flight-proven satellite horizon sensors to meet all types of space missions. One of the newest members of the Barnes family of horizon sensors will soon be flying on the Air Force's Global Positioning System (GPS) spacecraft.

This is the most reliable horizon sensor ever developed—achieving its incredible 99.98% reliability over a five year period through advanced design techniques. The instrument has no moving parts. It has complete redundancy in design and operation.

Satelliteborne earth resources and meteorological instruments.

Besides horizon sensors, a family of multi-spectral satellite infrared radiometers has also been developed and produced by Barnes for various space missions.

One example is the Infrared Scanning Radiometer which was built for the Apollo Program. This spacecraft instrument was designed to make thermal maps of the moon's surface. Operating in lunar orbit from Apollo's Command Module, it scanned the moon's surface to make hundreds of discrete temperature measurements each second.

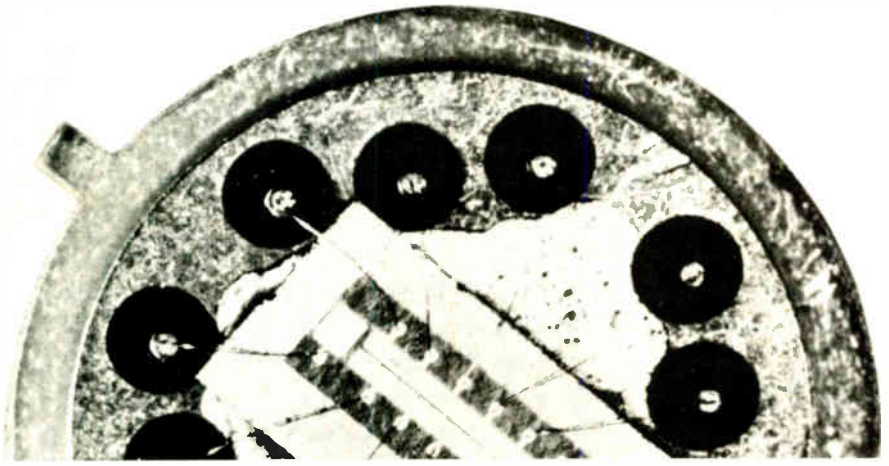
Another example is the Satellite Temperature Sounder. Built for the Defense Meteorological Satellite Program, its mission is to look down from orbit and make continuous temperature measurements of eight different layers of the earth's atmosphere. This multi-channel IR radiometer has an accuracy of 2° C and has over three years of continuous operation in space to its credit.

Spectral signature and atmospheric transmission instruments.

Other Barnes infrared radiometric instruments are helping scien-

Quality assurance engineers make the final inspection of an Infrared Scanning Radiometer used in the Apollo program

filters throughout the spectrum.



Microminiature array of 12 indium antimonide detectors. Each detector element is 0.002 inches wide and 0.012 inches long

tists and engineers all over the world solve problems in such areas as ground truth measurements, infrared signature and suppression studies, meteorology, atmospheric physics, agricultural studies, oceanography, non-contact temperature measurement and intrusion detection.

Our new Atmospheric Transmissometer, for example, is designed to meet the needs for standardized, direct-reading atmospheric transmission measurements in selected portions of the visible and infrared radiation spectrum. These measurements are especially useful in evaluating and calibrating the performance of military systems operating in the infrared that detect, track or analyze distant targets.

An instrument which has become a worldwide standard is the Barnes SpectralMaster Precision Research Radiometer.

This instrument, equipped with an appropriate infrared detector and up to eighteen discrete optical filters, can make extremely accurate sequential radiometric measurements in a wide selection of spectral regions.

In one of its more sophisticated forms, the SpectralMaster can be equipped with a motor-driven circular variable filter wheel and will provide continuous spectral measurements over a selected wavelength range. These measurements may be observed directly as real-time oscilloscope displays or processed for automatic computer reduction. Infrared spectral analysis of remote materials or phenomena can be produced at rates to two spectra per second.

Fully qualified IR detectors and optical filters and coatings.

Detectors and optical filters are the heart of Barnes electro-optic and infrared instruments. We have been successfully developing and producing these components for over 25 years. Selecting the right detector or filter for your application doesn't have to be a big problem . . . not when you come to Barnes for a solution.

In terms of spectral coverage, the Barnes family of problem-solving detectors is the broadest. From 0.02 microns in the ultraviolet to well beyond 30 microns in the far infrared. Thermal or photon, cooled or uncooled, we have them all, including space qualified pyroelectrics.

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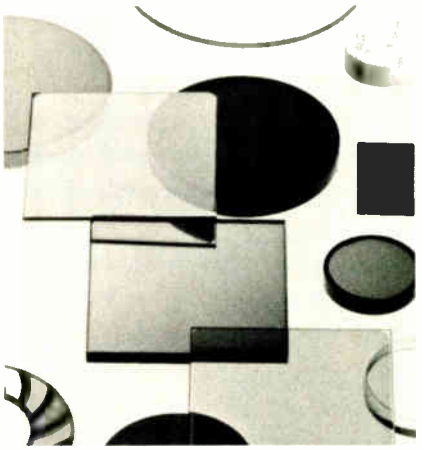
Problem solving throughout the IR spectrum.

Remember, Barnes means Infrared. We have a wide range of instrumentation, detectors and filters throughout the spectrum. Let us apply our know-how and ingenuity to give you the solution your problem needs.



A wide variety of optical filters and coatings are available from Barnes

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People

Pennings: Tempress pushes semiconductor processing

Look for the newly reorganized Tempress Microelectronics division of Sola Basic Industries to become a much more aggressive supplier of production and assembly equipment for semiconductors. This warning comes from the president of the division in Los Gatos, Calif., 44-year-old Matheus D. Pennings, a soft-spoken but determined executive who knows where he wants his organization to go.

"No other supplier of semiconductor production and assembly equipment has a line so broad," Pennings says. "And we plan to make it broader."

All in one. From a division that has specialized basically in the production of wire bonders, wafer scribers, saws, and dicers, Tempress now includes all semiconductor-related operations previously split up among divisions of Sola Basic, a Milwaukee-based manufacturer of component parts and equipment for semiconductor processing and the electric-power industry. Sola Basic had close to $169 million in sales in fiscal year 1975. Its semiconductor products include chemical-vapor deposition reactors, diffusion furnaces, laminar-flow work stations, gas systems, process-control systems, and tools used in wafer separation and bonding.

"What this reorganization does is magnify our leverage in the marketplace," says Pennings, a veteran of 18 years in the semiconductor industry who had been president of the original Tempress organization. He joined Sola Basic in 1969.

"From half a dozen or so separate operations scattered throughout Sola Basic, each with 2% or 3% of their particular market, we're now a combined operation with a hefty 15% to 20% share of the total market."

With this leverage, Pennings plans to increase market share by expanding, both through acquisition and by the internal development of new products.

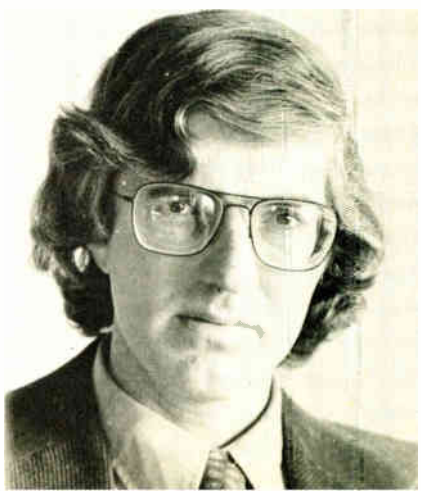
Growing. The product line at Tempress will get broader, says Matheus D. Pennings.

In wafer bonding, for example, Pennings says Tempress will be introducing a microprocessor-controlled system at the up-coming Semicon/West '76 meeting in May in San Mateo, Calif. And a move into thermal compression to go with the company's ultrasonic wire bonders may be made through acquisition. Other likely areas of expansion include equipment for photoresist coating and spinning, mask alignment and exposure, he says.

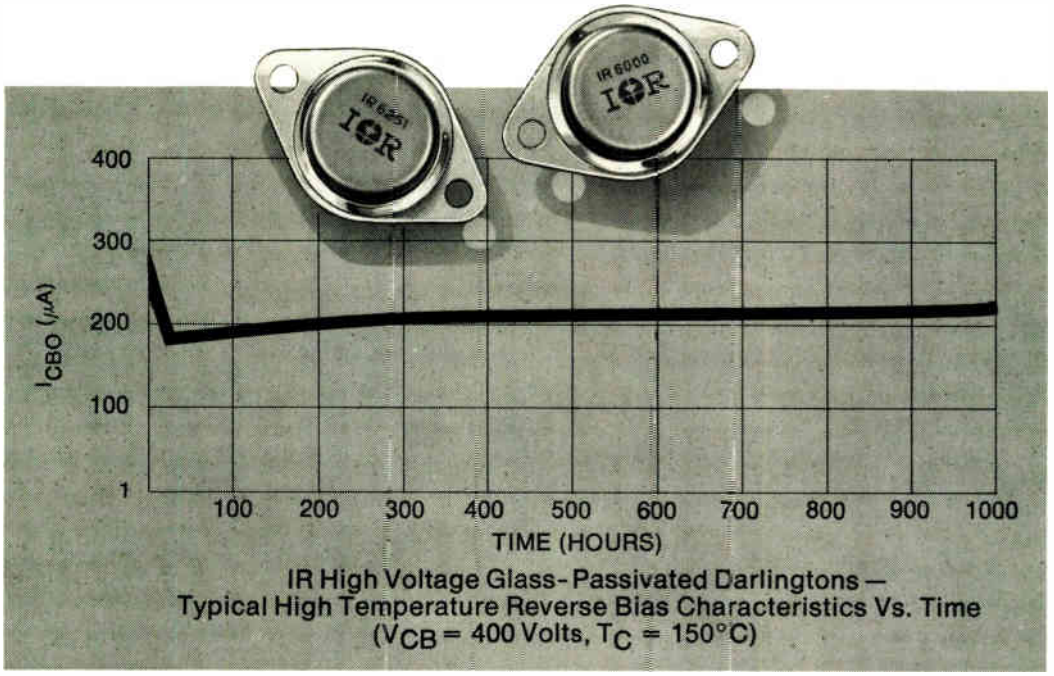
Newton expects boom in telecommunications

The telecommunications industry is growing at a tremendous rate, says consultant Harry Newton, but "a better product at a lower price isn't necessarily going to make it in the marketplace. There are just too many other unique factors involved in the business—like the regulatory environment and the dominance of the industry by vertical suppliers such as the five major U.S. telecom-

Design plus. Success, says Harry Newton, will take more than a great, new product.



Darlingtons that last.



IR High Voltage Glass-Passivated Darlingtons — Typical High Temperature Reverse Bias Characteristics Vs. Time (V_{CB} = 400 Volts, T_C = 150°C)

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3 New Series for 20KHz Switchers.

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While you're getting data, ask about our new super-voltage, 500 to 900 Volt $V_{CEO(SUS)}$ devices, and our many other high gain high-voltage series for 5KHz applications.

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munications companies that effectively control 95% of market."

Newton, 33, is helping the market researchers, Frost & Sullivan Inc., put together a seminar in May in New York on "Marketing Strategies for Selling to the Communications Industry." He explains, "People used until now to selling in high-technology industries like solid-state electronics and computing don't realize these things."

Big dollars. The growth rate for the various segments of the telecommunications market is between 10% and 15% annually, but certain ones, like computerized telephone-answering systems, electronic PABXs (private automatic branch exchanges), and sub-minute facsimile machines, will grow at 100% rates, says Newton. He predicts that total sales will reach a giant $18 billion by 1985.

The dollars are certainly out there. Interconnect companies are already selling $500 million worth of PABXs and key-telephone sets annually to end users, Newton points out. And the FCC decision that interface devices for most telephone products no longer must be approved by the telephone company should boost sales of such things as automatic dialers, answering equipment, cordless telephones, and resident-protection devices even further, he says.

Newton, based in New York, estimates there's $1.5 billion annually outside of the U.S. for telecommunications equipment, ranging from complete central offices to domestic-satellite systems, to telephone-subscriber handsets.

And telephone companies are going to buy more from outside suppliers, he says. "One of the big reasons is the competitive threat from the specialized common carriers and other new suppliers of telecommunications equipment like the minicomputer companies. Also, some major Japanese consumer-electronics firms are eyeing the market. And on top of this are the antitrust implications if Bell System companies continue to buy from in-house Western Electric Co.," he explains.

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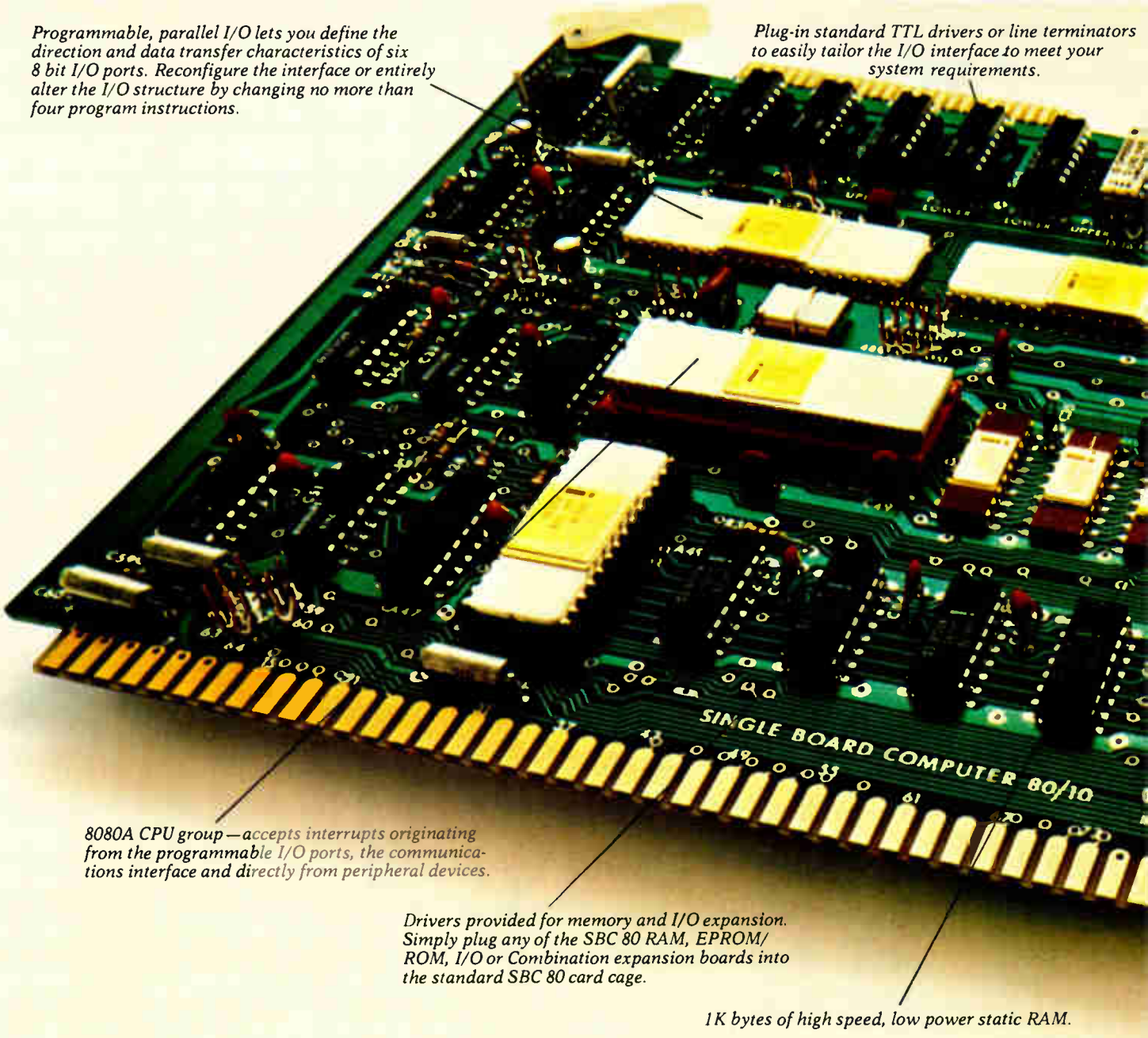

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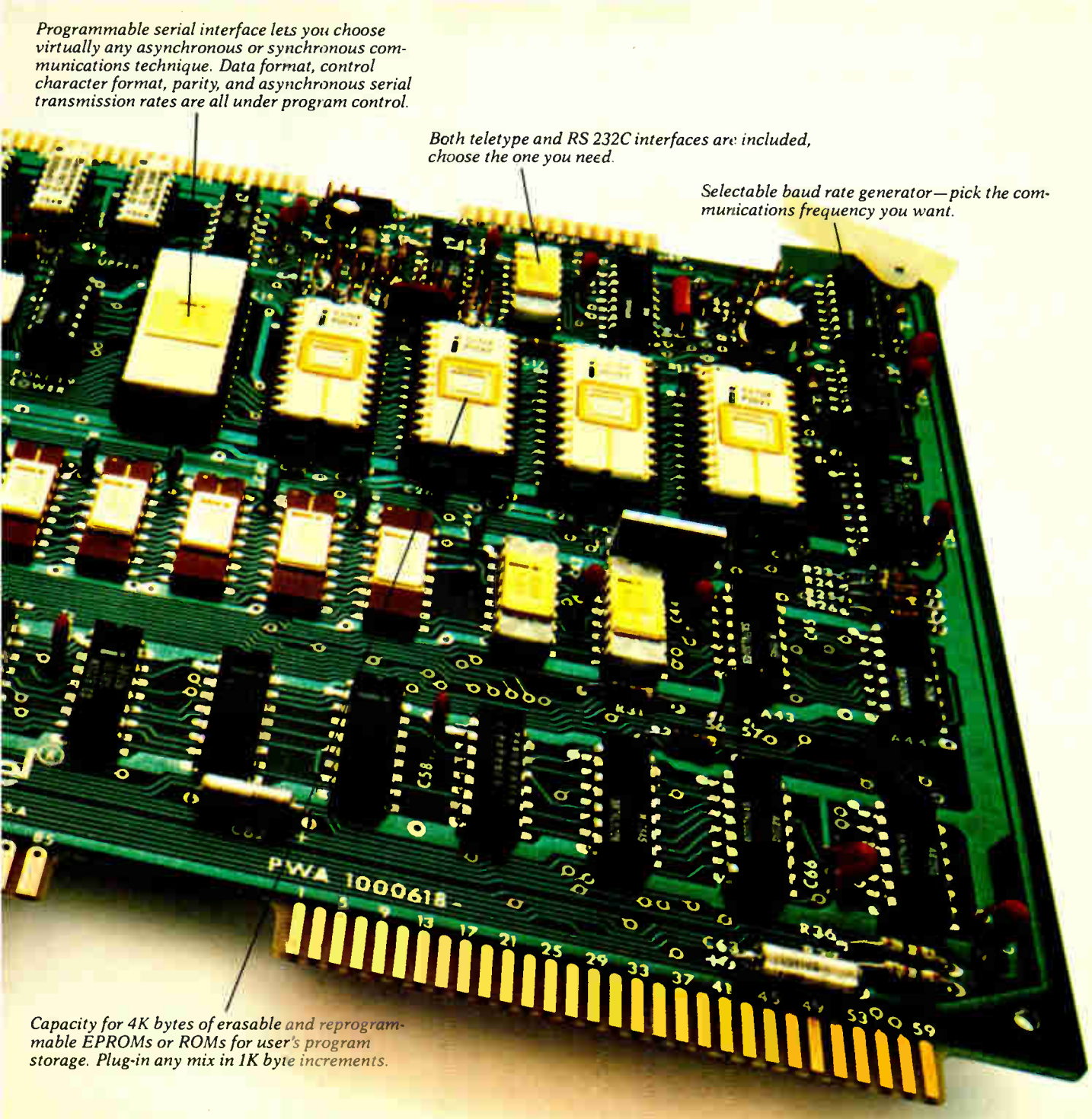

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Meetings

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National Workshop on Low-cost Polycrystalline Silicon Solar Cells, National Science Foundation and Energy Research & Development Administration, Southern Methodist University, Dallas, May 18–19.

Naecon Aerospace and Electronics Conference, IEEE, Dayton Convention Center, Dayton, Ohio, May 18–20.

Conference on Lasers and Electro-Optical Systems, IEEE, Town and Country Hotel, San Diego, May 25–26.

Semicon West '76, Semiconductor Equipment & Materials Institute (c/o Golden Gate Enterprises, Santa Clara, Calif.), San Mateo County Fairgrounds, Calif., May 25–27.

International Symposium on Multivalued Logic, IEEE, Utah State University, Logan, Utah, May 25–28.

Trends and Applications in Micro and Mini Systems, IEEE, National Bureau of Standards, Gaithersburg, Md., May 27.

National Computer Conference, IEEE et al., New York Hilton, Americana Hotel, and New York Coliseum, June 7–10.

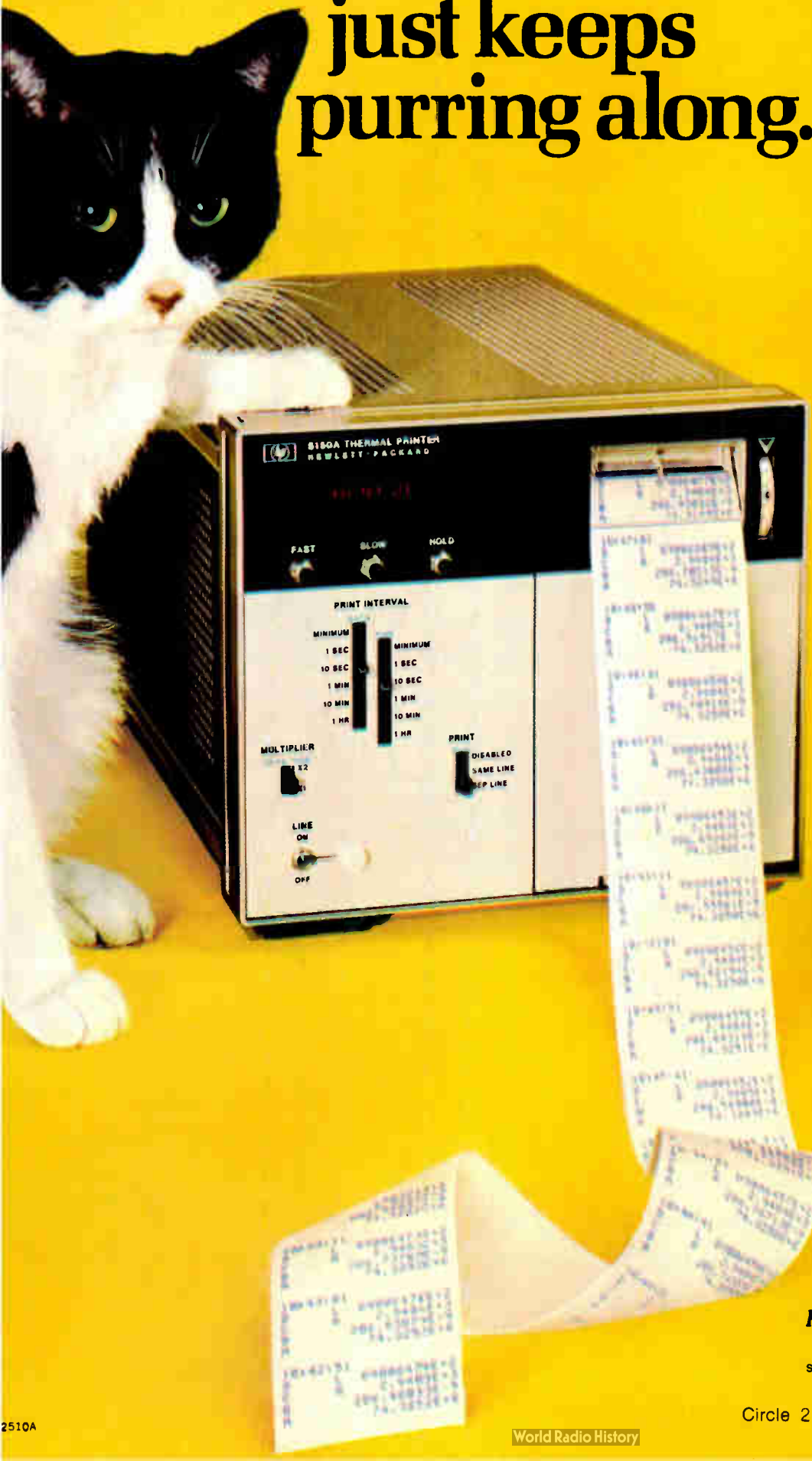
Hybrid Microcircuits Symposium, U.S. Army Electronics Command, Fort Monmouth, N.J., June 8–9.

Power Electronics Specialists Conference, IEEE, NASA Lewis Research Center, Cleveland, Ohio, June 8–10.

Electrical Insulation International Symposium, IEEE, Queen Elizabeth Hotel, Montreal, Que., June 14-16.

ICC '76 International Conference on Communications IEEE, Marriott Motor Hotel, Philadelphia, June 14–16.

HP's new thermal printer just keeps purring along.



Say goodby to the clank and rattle of mechanical printers and say hello to quiet, reliable operation. With its thermal printing technique, the new HP 5150A Thermal Printer needs only two moving parts — those that transport the tape.

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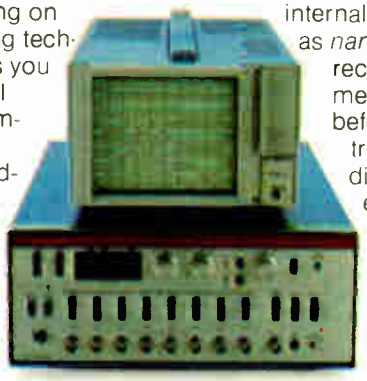

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Data Precision built the 5740 to be exceptionally versatile. It measures frequency, period, period average, elapsed time and total events with the kind of accuracy, sensitivity, and upper frequency capability generally found only in higher priced units.

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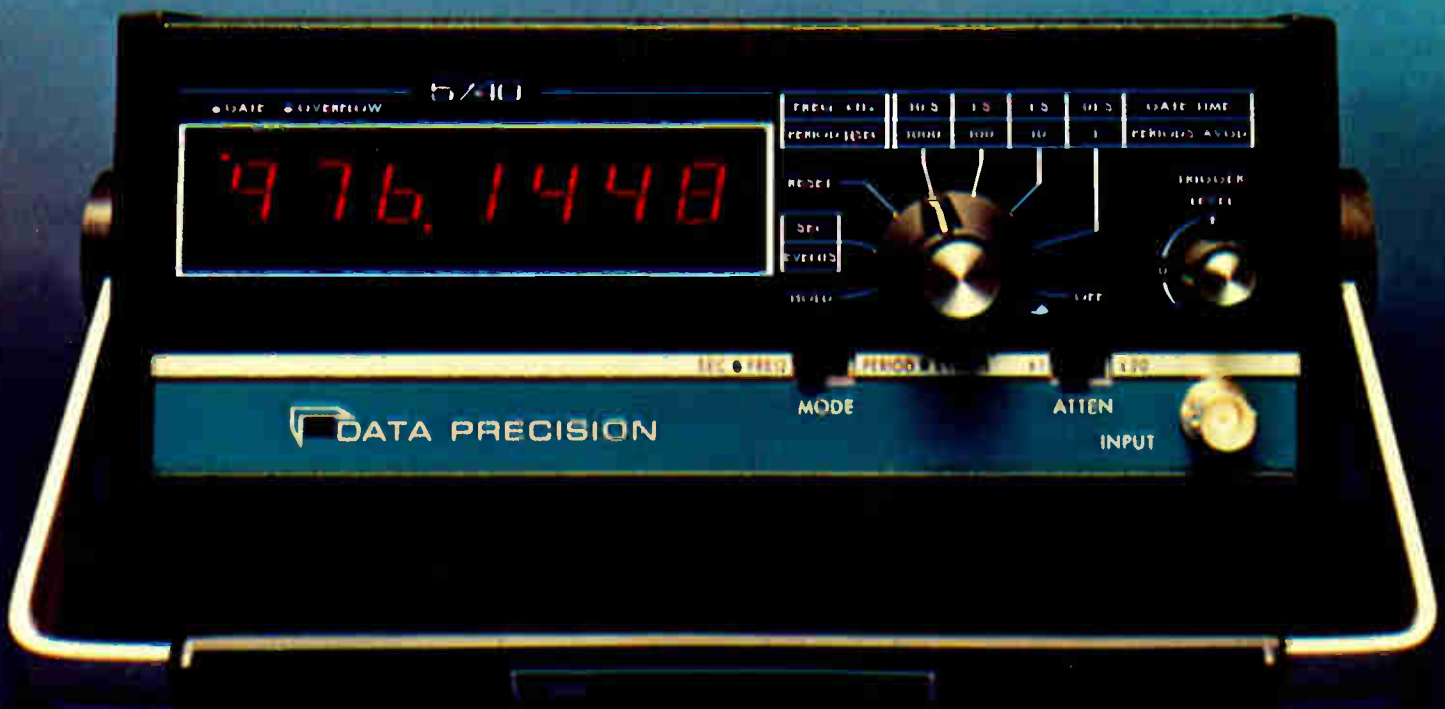

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Electronics newsletter

'Good-sized' orders predicted for Army fire control

Nine firms are going after the contract for the Army's battery computer system that controls firepower at the battery level. **A decision is expected in early summer, and two bidders are to be picked for a 14–18 month fixed-price shootout.** One prime requirement is that the system must operate with the army's Tac-fire system, the next higher level of automated battlefield control. Tac-fire is being built by Litton Industries' Data Systems division, Van Nuys, Calif.

Present plans call for the Army to buy a minimum of 350 battery computer systems, and up to 1,000 at a unit price not to exceed $65,000. Bidders are Litton, Computer Devices of Canada, Burroughs, Magnavox, Raytheon, the Librascope division of Singer Corp., Teledyne-Brown division of Teledyne, Norden division of United Technologies, and Rolm.

DEC becomes own second source to Western Digital

Digital Equipment Corp.'s investment in a semiconductor facility in Worcester, Mass., is beginning to pay off. Andrew Knowles, vice president and manager of the components group in Marlboro, Mass., says the facility has provided DEC with its own second source to Western Digital Corp. for the LSI-11 MOS microcomputer chip set. The Worcester facility has been delivering chips cut from 3-inch wafers for a few months.

Zinc-chlorine storage batteries get ERDA nod

The Energy Research and Development Administration has awarded Energy Development Associates of Madison Heights, Mich., the contract to develop experimental zinc-chlorine batteries to store electric power for electric utilities and, eventually, electric vehicles. **The two-year program calls for delivery of two batteries with power outputs of 5 to 10 kilowatts to the National Battery Test Facility in Argonne, Ill.**

Kurt W. Klunder, program manager for batteries at ERDA's Conservation, Research and Technology division, says the batteries would be used by utilities for load leveling—to be charged at night and discharged during periods of peak daytime demand. Until now, batteries have not been used for such load-leveling. But Klunder believes zinc-chlorine batteries offer great potential because of the low cost and long life of the materials.

Award for battlefield sensor now between four

The Army Electronics Command at Fort Monmouth, N.J., has narrowed the field to four companies for the development of the Army's new remotely monitored battlefield-sensor system (Rembass). Some 70 electronics firms had requested the original bid package. The four are Honeywell, GTE Sylvania, American Electronics Laboratories, and RCA Corp. **Two of these companies will be awarded first-phase design contracts in June, but only one of the two will pick up the production contract** for Rembass expected to be awarded in June, 1977.

The system will be the Army's initial family of unattended ground sensors and associated data-communications equipment capable of operating in all climatic conditions.

British scope comes to U.S.

Gould Inc.'s Instrument Systems division, Cleveland, plans to market a 10-megahertz oscilloscope with 200-kilohertz digital storage made by Gould Advance Ltd., the firm's subsidiary in England. With an introduction slated for the IEEE's Electro/76 meeting in Boston, the OS4000 scope marks the return of the Advance line to the United States

market. Once handled by Marconi Instruments, Northvale, N.J., Advance's sole penetration of the U.S. market in recent years has been through Ballantine Laboratories, Inc., Boonton, N.J., which builds some Advance scopes under license and sells them under the Ballantine trade name.

FCC meeting set on PBX, key system connector standards . . .

Plug and connector makers are preparing for a new series of Federal Communications Commission meetings at its Washington headquarters on May 3-4 and May 13-14 to develop connector standards for PBX and key telephone systems. At meetings in February and March, communications equipment makers developed consensus views on plug and jack standards for main telephones and extensions. The FCC is asking for comments by May 3 and replies by May 13 on a proposed standard to adopt connectors now used by the Bell System and other telephone companies. **The standard would include Bell's plan to license anyone to make its plugs and jacks at a standard royalty, and to sell Western Electric Co. plugs and jacks to terminal equipment suppliers** at the same prices charged Bell System companies.

. . . but data modem makers are unhappy with plan to modify connectors

Opposition is developing among data modem makers to a telephone connector proposal that "certain data configurations of the eight-pin plug and 50-pin connector contain convex keying to prevent the inadvertent insertion of a data plug into a jack intended for voice." The opposition stems from the 6-9-month delay before the modified plugs and connectors would be available from telephone companies.

System services printed-circuit boards in field

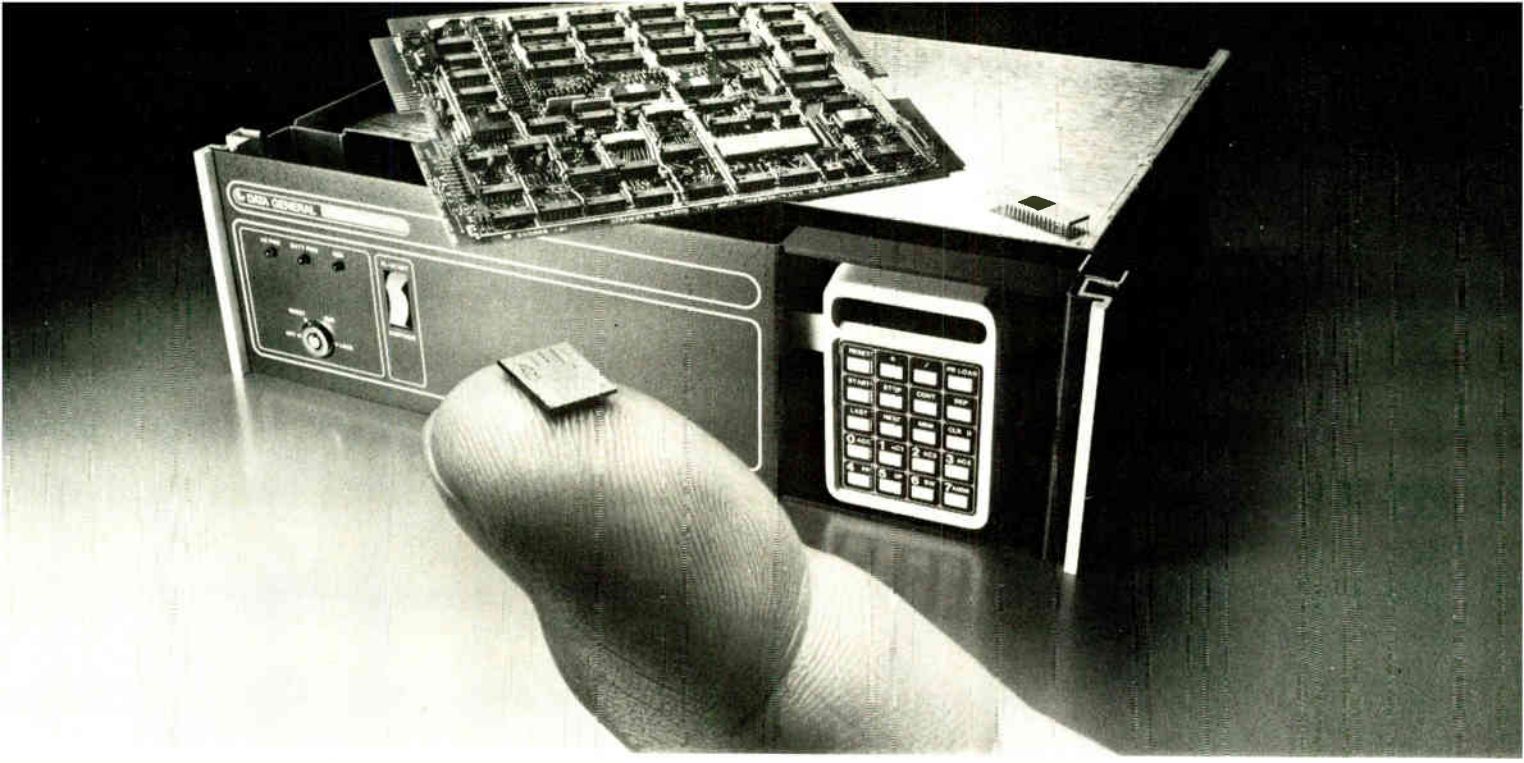
Testline Instruments Inc., Titusville, Fla., is introducing a portable system that **solves one of the most vexing problems facing high-volume microprocessor users—field service of printed-circuit boards.** The model 1000, which weighs 20 pounds and is housed in a package the size of an attache case, performs full functional tests at a bit rate of 675 kHz and analyzes the output-voltage thresholds on each integrated circuit mounted on a board.

The instrument can unambiguously isolate faults to the errant chip—not just the failing circuit path. Built around a Motorola 6800 microprocessor, the model 1000, which costs $4,500, uses a 16- or 24-pin clip to interface with ICs on the unit under test, and can test at a rate of 20 ICs per minute. **Test programs are stored on cassettes, a single cassette for each board with up to 200 ICs.**

Microprocessor controls data input/output printer

The most sophisticated in a new line of printers introduced last week by Centronics Data Computer Corp. is the model 761, **a microprocessor-controlled serial teleprinter aimed at computer input/output and remote-terminal application.** Two versions of the 761—a receive-only unit and a keyboard send-and-receive model—both print on-line at 300 bauds bidirectionally to boost throughput by eliminating carriage return.

An Intel 8080 acts as an interface controller in the printers, and also controls the print and paper feed mechanisms. Centronics officials say that at a price of $1,275 in quantities of 100 for the model 761 send/receive version, the unit will compete with Digital Equipment Corp. LA-36 printer, which does not include a microprocessor.



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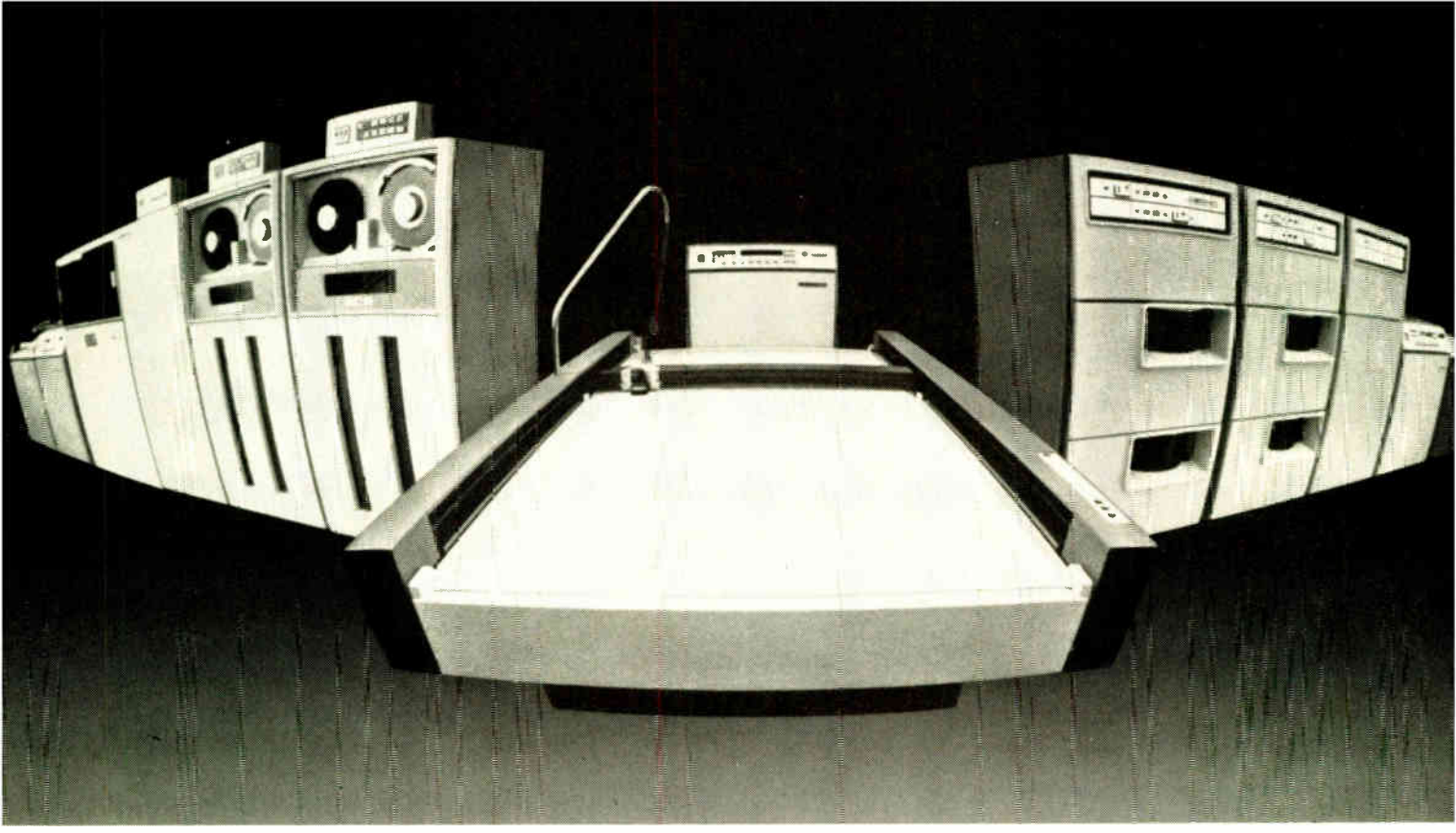

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Thin-film delay lines aim at ECL

Japanese researchers' LC plug-in units are compatible with high-speed logic of large-scale computers

The latest twist in thin-film techniques is a plug-in delay line that is compatible with the high-speed logic used in large-scale computer systems.

As reported at this week's Electronic Components Conference in San Francisco, engineers at the Susumu Industrial Co. Research Laboratory, Kyoto, Japan, have turned to a distributed network of inductors and capacitors for their new delay line. The thin-film devices will respond to the nanosecond switching speeds of the waveforms encountered with, for example, the fast emitter-coupled logic that is used in big computers. Conventional delay lines employing discrete inductors and capacitors just won't respond quickly enough. The Susumu delay lines are actually the first inductive-capacitive devices to be compatible with ECL.

Plug-in candidate. Until now, delays have been introduced by using special-geometry conductors or extra logic devices. But now Susumu engineers appear to be building plug-in delay elements for high-speed digital circuits that are similar in concept to those used with lower-speed transistor-transistor logic.

The Japanese claim that their delay lines have been responding to a 1-nanosecond pulse with a rise time of only 1.5 ns. This rise time means the line introduces only 10% distortion in the signal waveform—small enough so that the LC networks show promise as plug-in devices.

Its developers say the process offers good repeatability, yielding devices with uniform characteristics. However, to build delay lines for sub-nanosecond pulses, further development work is needed, they point out. More research is likely to concentrate on refining the inductor-capacitor designs.

To fabricate the devices, the inductors are formed by photoetching a copper foil, which is then fastened to a ceramic substrate with polymer resin. Next, the capacitors are made right on top of the etched-foil inductors by depositing, through plasma polymerization, an organic thin-film dielectric and then vacuum-evaporating aluminum electrodes onto the dielectric film.

After the connections to the films have been made with reflow-soldered ribbon leads, the finished devices are encapsulated with molded epoxy resin. Up to 10 ns of delay time can be squeezed into a 16-pin dual in-line package, or about 2 ns in a four-pin DIP. □

Microprocessors

National kit includes debugging

Following up on its entry into the minimum-chip microprocessor system market with the SC/MP microprocessor, National Semiconductor Corp. will soon be offering users a low-cost development kit that enables an engineer to "talk" to his microcomputer to help write and debug its programs.

National, based in Santa Clara, Calif., will start selling its LCDS (low-cost development system) in June for less than $500. Including a keyboard, light-emitting-diode display, and built-in debugging software, the company's development kit provides the design engineer with communications in real time.

The first kit will be built around National's new 8-bit p-channel metal-oxide-semiconductor 2-microsecond SC/MP microcomputer system. But Phil Roybal, National's microprocessor marketing manager, says that development systems built around other microprocessors from

Check. Technician Mike Badzik, watched by SC/MP designer Jack Morris, types microprocessor program on built-in keyboard from National's SC/MP development kit.

National will soon follow.

In its hexadecimal-based kit for machine-language input, National provides a keyboard, six-digit display, and control switches, plus 2 kilobytes of read-only-memory firmware with the programs for debugging and operating the display and keyboard.

All this equipment plugs into an 8-by-12-by-3-inch motherboard frame that also accepts the usual parts found in such a kit: the SC/MP central processing unit, 256 bytes of random-access memory, 512 bytes of ROM, and the logic necessary to support the processor. The motherboard also contains extra slots for expanded memory, including an optional 2,048-by-8-bit ROM or programable ROM card, and user-developed interface cards.

No extras. The total kit allows "the same breadboard sort of approach many an engineer has taken to talk to his microcomputer and avoids the extra expense of a teletypewriter or ROM programer," says Roybal. "But buying the same parts individually costs at least twice as much as the kit itself. Then there is the cost in time to develop the debugging software, even before he knows how the microprocessor works."

National, of course, has economies of scale in its favor, as far as component costs are concerned, he explains. And the debugging software, while expensive to develop, is an outgrowth of programs for earlier, more sophisticated systems and is already partially amortized.

At about $400 to $500, Roybal says, the profit margin on the kit is much closer to the threshold than in other product lines. "But LCDS is basically a way of selling parts," he says, "and we've tried to make it as easy for the engineer as possible."

Roybal cites a relay controller as a design example. The engineer would start with a blank 4.5-inch-square card, install the relay, with one transistor to drive it and a couple of resistors, then plug it into the motherboard. All of the data, address, and control lines in the system would be daisy-chained from the chip on the CPU card, Roybal says, "so it's a relatively simple matter to develop an interface card."

Developing a program, or debugging one, is relatively simple also. "In the case of the relay controller, the engineer can start by simply writing a two-word program into the keyboard," he says. "If it works, he goes on to a more complex series of instructions, feeding them into the RAM." The program steps are run through the system, and if the program doesn't work, debugging software allows the engineer to stop, start, and change the program until it does. Once it works, the engineer can write it down, he says, or transfer it into a cassette, paper tape, or printer. □

Automotive

Light beam adjusts ignition timing

The ordinary car driver probably won't be aware of it, but optoelectronic devices could eventually be operating in vehicle ignition systems. Cutting down on maintenance costs is the reason, according to West Germany's Siemens AG, which is developing a light-emitting-diode and phototransistor combination to replace the distributor's mechanical breaker points, which time the firing of the spark plugs.

Siemens' system could possibly be ready for market in as little as two years with low-cost, mass-produced devices, says Guenther Hatzinger, product manager for optoelectronic semiconductor devices at the Components division in Munich.

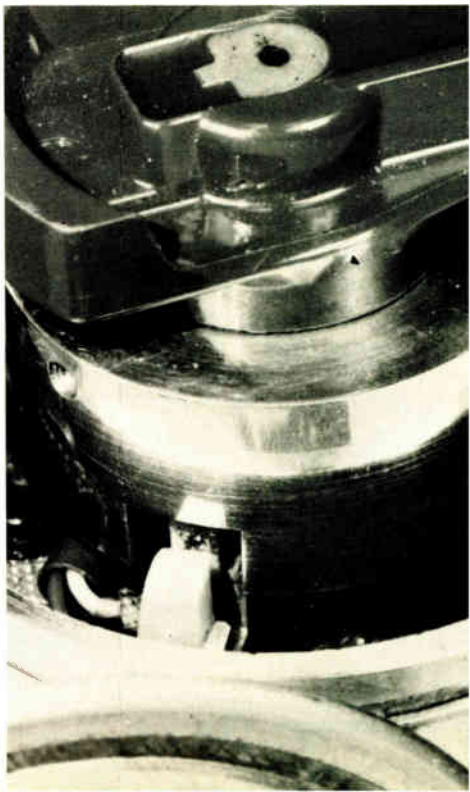
Plastic devices. What Hatzinger has in mind are inexpensive, plastic-encapsulated components tough enough to survive inside an auto engine. Siemens is therefore gearing its effort to modifying available components that are neither cheap enough nor rugged enough.

The components need to withstand ambient temperatures as high as 135°C. Metal-encapsulated versions can operate at 125°C, but are too expensive. However, most plastic-encased devices can tolerate no more than 80°C. So the firm is investigating high-temperature plastic materials that can be easily worked and won't impair semiconductor mechanisms.

In addition, Siemens engineers are looking at ways of making a light-emitting diode that can operate in such heat. This could be even harder to reach than developing a plastic package, Hatzinger says.

Solid-state ignition. The optoelectronic approach would be used with transistorized ignition systems, which are already standard on many U.S. cars and are slowly being introduced in Europe. In a Siemens developmental model, an electric-eye system, consisting of an infrared LED and phototransistor receiver, is mounted in the distributor, as shown in the photo below. Rotating with the distributor shaft and crossing the infrared beam is a round cap. Cut out of this cap are rectangular slots, one per engine cylinder. As each slot comes around, the diode beam is unblocked and trav-

Zap, you're fired. In Siemens-developed optoelectronic distributor, rectangular slot in rotating round cap permits infrared light emitted from diode to strike phototransistor, which initiates firing of auto spark plug.



els some 3 millimeters to hit the phototransistor whenever a spark plug is to be fired.

The width of the slot determines the time that the ignition system's primary circuit is closed, and, hence, the duration of the spark. The current produced by the phototransistor is amplified and applied directly to the ignition transistor whose emitter-collector circuit is connected to the primary of the ignition coil. □

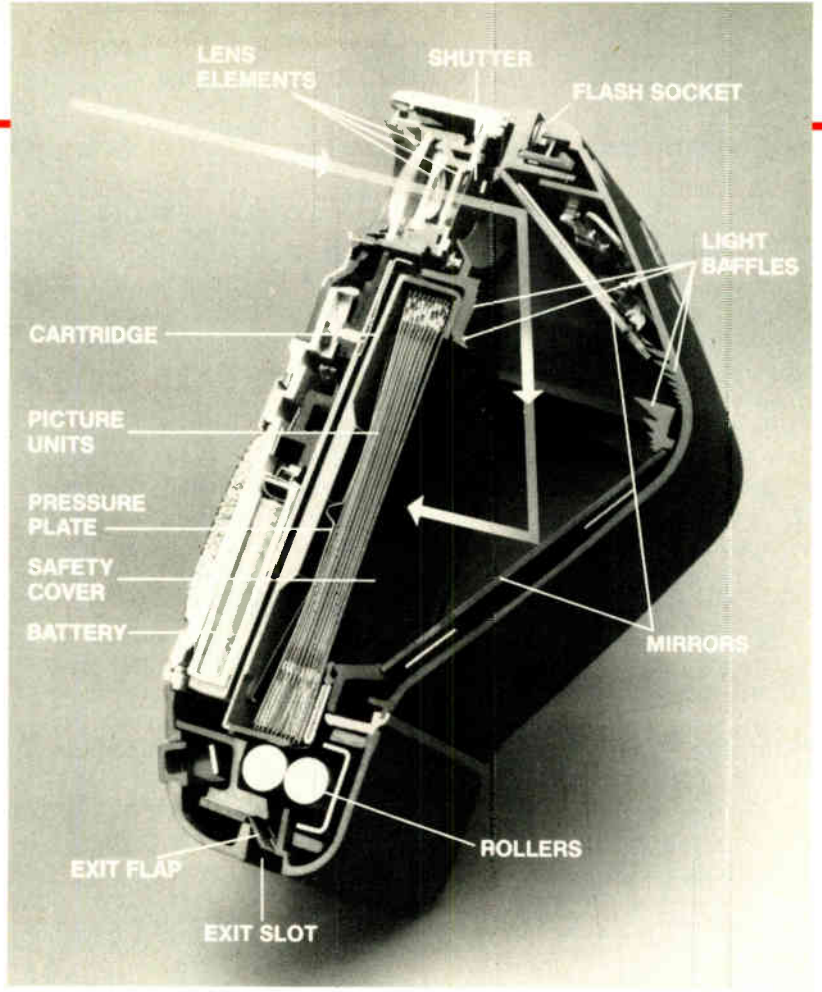
Communications

I^2L, Schottky sets carrier frequencies

For years semiconductor manufacturers have been trying to convince the telecommunications industry of the advantages of large-scale-integrated-circuit technology. But, except for the use of the standard logic families in switching networks and carrier equipment, telephone companies have stuck with discrete components to build the oscillator/dividers, pulse generators, and synthesizers in the so-called "common equipment." This is the gear that generates multiplex signals and contains the bulky passive filters used to maintain spectral purity and low signal jitter.

120 mils on a side. But a $5-to-$6 programable 10-megahertz digital-frequency synthesizer developed by Signetics Corp. using integrated-injection logic, low-power Schottky technology and phase-locked-loop techniques may change all that. According to Gary J. Summers, telecommunications product manager at the Sunnyvale, Calif.-based company, the 120-by-120-mil LSI circuit could allow telephone companies to replace the filters and much of the common equipment, resulting in one third the system size and one tenth the cost.

At any station in a telephone network, common equipment generates the basic carrier signals—typically bipolar 4-kilohertz pulse trains. Passive filters clean up these signals and pick off harmonics, which are then



Kodak fast-development cameras rely on bipolar chip from National

Two cameras that develop film in eight minutes have been introduced by Kodak Co. several years after the company revealed that it was generating products to compete with Polaroid Corp. The EK6 (below, right), will sell for $69.50 and the EK4 for $53.50. A film cartridge for 10 pictures, which is loaded from the bottom, is priced at $7.45.

Three U.S. sources produce the single custom linear bipolar integrated circuit used for shutter control in both models. Because of the sales volume expected, Kodak will not attempt to produce more than a fraction of the chips at its own IC-manufacturing facility. Although the camera company is not saying, the prime supplier of the control chip is understood to be National Semiconductor Corp., supported by two small custom-IC houses. The camera, to become available in Canada May 3, and in the U.S. and Puerto Rico June 28, produces a picture 6.7 centimeters by 9 cm on a mounting 9.7 by 10.2 cm. The only difference between the EK4 and the EK6 is that the latter has a motor-driven film ejector and requires two J-size batteries. The EK4 has a hand crank to eject the picture and needs one J-size battery to power the electronic shutter. A third camera, the EK8, a deluxe folding model, will be produced later in Germany and sell for $140. Kodak says that the German unit will also use the American-made IC.

used by channel-bank modems to multiplex voice signals onto carriers in groups of 60, 600, 1,200, or 1,800 channels. "The advantage of this approach has been that it gives the telephone companies the signals they want at a very low cost," Summers says. "Typically, each channel's 9-by-9-inch passive filter can be made for about $15."

PLL approach. A more direct approach, he says, would be to generate the specific channel frequencies in the channel-bank modems, thereby eliminating the external common equipment and filters.

"There would still be the problem of getting spectrally pure signals without jitter," Summers says. "But a programable frequency synthesizer implemented with phase-lock-loop techniques to provide frequency tuning and filtering is ideal."

Indeed, several semiconductor technologies have been used in the past to come up with a frequency synthesizer that achieves the right balance of cost, power, frequency range and component count, Summers points out. But while they have met standards for low cost ($7 to $12) and low power, systems of complementary-metal-oxide-semiconductors require 6 to 8 medium-scale-integrated devices.

However, the frequency range is limited to about 2 to 3 MHz, or about 60 to 600 channels. Standard transistor-transistor or emitter-coupled logic reduced components count to two or three chips and allowed frequencies up to 200 MHz, but the power required—several watts—is prohibitive, he says.

Using a process combining Schottky and high-density, low-power I²L, Signetics engineers have built a chip for frequencies up to 10 MHz and programable to any one of almost 1,200 channel frequencies. In volume, he says, the chip will cost about $5 to $6 with power consumption down in the 300-to-400-milliwatt range. I²L circuit rules are used to fabricate three 4-bit binary-coded-decimal counters used in programing the chip, as well as in portions of the phase comparator.

Because I²L is not TTL-compatible, low-power Schottky was used for the input portion of the phase comparator—an exclusive -OR gate—and for the output portion of the 10-MHz voltage-controlled oscillator. A stable reference voltage for the on-chip oscillator is obtained from standard 60-, 64-, or 308-kHz receiver/transmitter synchronization signals present on the phone line. □

Two-way watch

Zenith Time SA the Swiss watchmaking subsidiary of Zenith Radio Corp., has introduced an electronic watch with a combination electronic/digital display in Switzerland. Charles J. Sindeler, Zenith Time's president and general manager, says the watch, priced initially from $195 to $325, will be marketed in July in the U.S. by Zenith-Movado-Time Corp., New York City. The analog dials read hours and minutes, and upon command a light-emitting-diode display shows the date, seconds, and a.m./p.m.

The watch models, the first in the U.S. to carry the Zenith brand name, are reset electronically. "You push one button to advance the hands by means of a stepping motor," says Sindelar. "You hold and push another button to turn time back. While the hands are automatically resetting themselves, a memory circuit counts seconds, so you do not lose an instant."

Data nets get pinpoint tester

One of the big headaches for companies with on-line distributed data networks is having the network "crash" because of a faulty dedicated phone line, a failed modem, or a glitch in a terminal. But Intertel Inc. aims to relieve that headache with its NCS4000 network control system, which, unlike earlier systems, can diagnose flaws in seconds.

The Burlington, Mass., company unveiled its system last week, disclosing that five big companies including an oil company, a bank and an airline had already bought it.

Unskilled user. Intertel officials say that, while sophisticated test equipment exists for engineers to test and troubleshoot data networks, they know of no other system that allows an unskilled operator at a central site to test for and isolate faults automatically, without operator assistance at remote sites.

A typical test system probably would include the operator's diagnostic console with light-emitting-diode displays for indicating network status, rack-mounted modems to generate test signals, bridges that provide the dial backup and monitoring of signal levels in 2-decibel increments, voice-frequency patch panels, and a line-monitor speaker. The bridges link a single private line to eight dial lines, essentially making them look like one to the network's central computer.

The new system does not hinder normal data flow in the network. Test signals are generated and sent out by a frequency-shift-keyed modem on a 75-baud frequency-division-multiplexed side channel near the edge of the data band.

Intertel president Jerry Holsinger notes that about half the problems in distributed data networks are outages of dedicated phone links. The new system will isolate the link that is out, even noting in which direction a full-duplex line is flawed.

The system can also detect failed modems and terminals in the net, and provide modem backup if the network is equipped with a "hot spare" that can be activated on command. If the problem is in a terminal device, the system can quickly isolate which terminal is faulty, disable it and alert the network oper-

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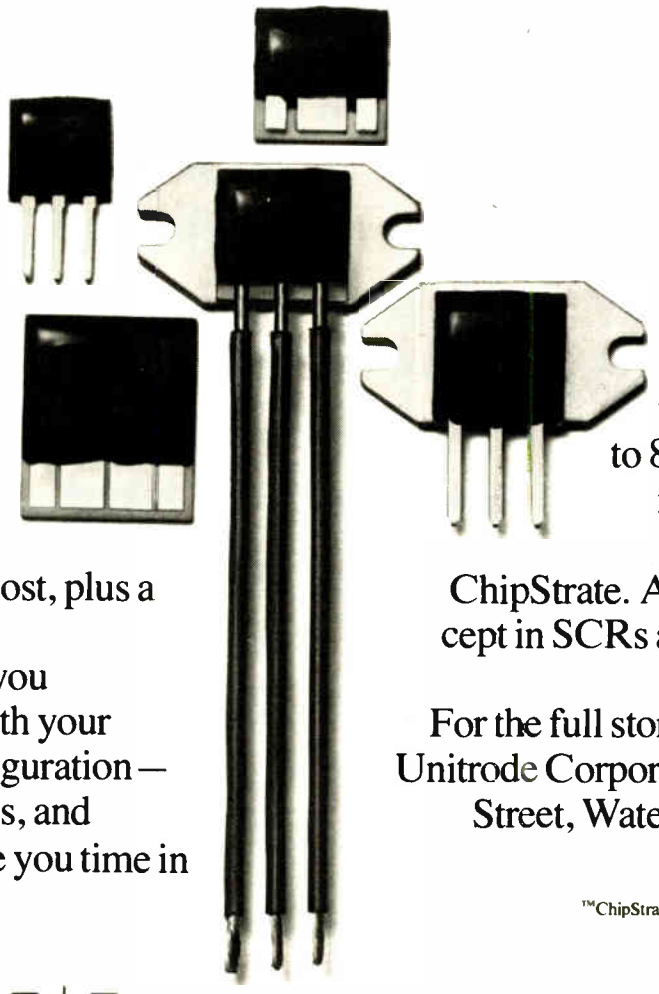

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ator to have it repaired.

A common problem in a terminal is streaming, a condition that causes it to continue sending even after its polling period is over, unduly tying up the line. This condition formerly took several phone calls to identify and turn off the faulty terminal. The new system, Holsinger says, can isolate the streaming terminal and have it disabled.

Speed independent. The Intertel control system will work with any network configuration and at any speed—from 1,200 baud up to 9,600 bits per second—or it will work with combinations of speeds and configurations. It can handle any number of lines, with up to 40 drops (remote sites) on a single multipoint line and up to 400 drops on a concentrated or multiplexed line.

LED displays and English phrases show results of the system's diagnoses. The system will sell for from $50,000 to $100,000, depending on complexity. □

Plato power. Complicated processes and operations can be displayed in drawings together with text, symbols, and numbers on the flat-panel display of Plato, Control Data's computer-based education system for government and industrial markets.

Computer instruction

CDC puts Plato on nationwide hookup

Control Data Corp. has announced what may be the most ambitious computer-based education and training system in the nation. Some 13 years in the making, CDC chairman William C. Norris says, the Plato system is aimed at the high end of the $20 billion U. S. and Canadian training market represented by federal and state government agencies, businesses, and segments of higher education.

Originated in 1963 as part of a cooperative effort with the University of Illinois and the National Science Foundation, the system is powered by CDC Cyber 170-, 70-, or 6000-series computers, with extended core storage, disk storage, plasma display terminals, communications interfaces, Control Data's time-sharing operating system, and supporting instructional software programs.

In concept, at least, Plato apparently outguns IBM Corp.'s Coursewriter system which has the most computer-based courses in the U.S. However, it is available to but a relatively few 360- and 370-computer users. Smaller computer-based education and training systems have been developed and are marketed by Digital Equipment Corp. and Mitre Corp. Both are aimed primarily at university and college markets.

Three-way service. Robert E. Morris, vice president of CDC's computer-based education systems and services department, says the company will offer its system in three ways: through a subscription service, through a chain of learning centers in major metropolitan areas for business and industry training needs, and through privately installed computer systems.

Control Data recently opened learning centers in Baltimore and Towson, Md. Others are operating in Bloomington and Arden Hills, Minn., and will be opened shortly in Cleveland, Philadelphia, New York, Washington, D. C., and Dallas.

Morris says the company expects to have more than 500 terminals operating at the centers and at customer facilities by the end of this year, and between 1,500 and 2,000 by the end of 1977. The systems are priced in the $5-million-to-$6-million range, depending on the number of terminals in the network. More than 500 users can gain simultaneous access to different materials in a single Plato system.

Commercial Credit Corp., Control Data's financial services subsidiary, will develop and operate the learning centers and market the Plato system. In addition to existing lesson programs ("courseware," CDC calls it), Commercial Credit plans to help local businesses and industries develop their own training materials for the system.

For the time being, all Plato terminals will be produced by Magnavox Co. The plasma display screen with an 8.5-inch-square viewing area consists of a 512-by-512 matrix of addressable points. Illumination of groups of these points initiates a display presentation with up to 32 lines of 65 characters per line. The panel is also translucent, permitting rear projection of color images from a microfiche slide capable of storing 256 frames, randomly accessed in 0.3 seconds. Access to the computer is by keyboard or by touching a special viewing panel.

The touch-panel feature is optional. It consists of a grid of eight vertical and eight horizontal infrared beams. By interrupting the beams at any of 256 intersections, students can, for example, respond to multiple choice questions or enter other data into the computer. □

Companies

Bowmar survives and shows profit

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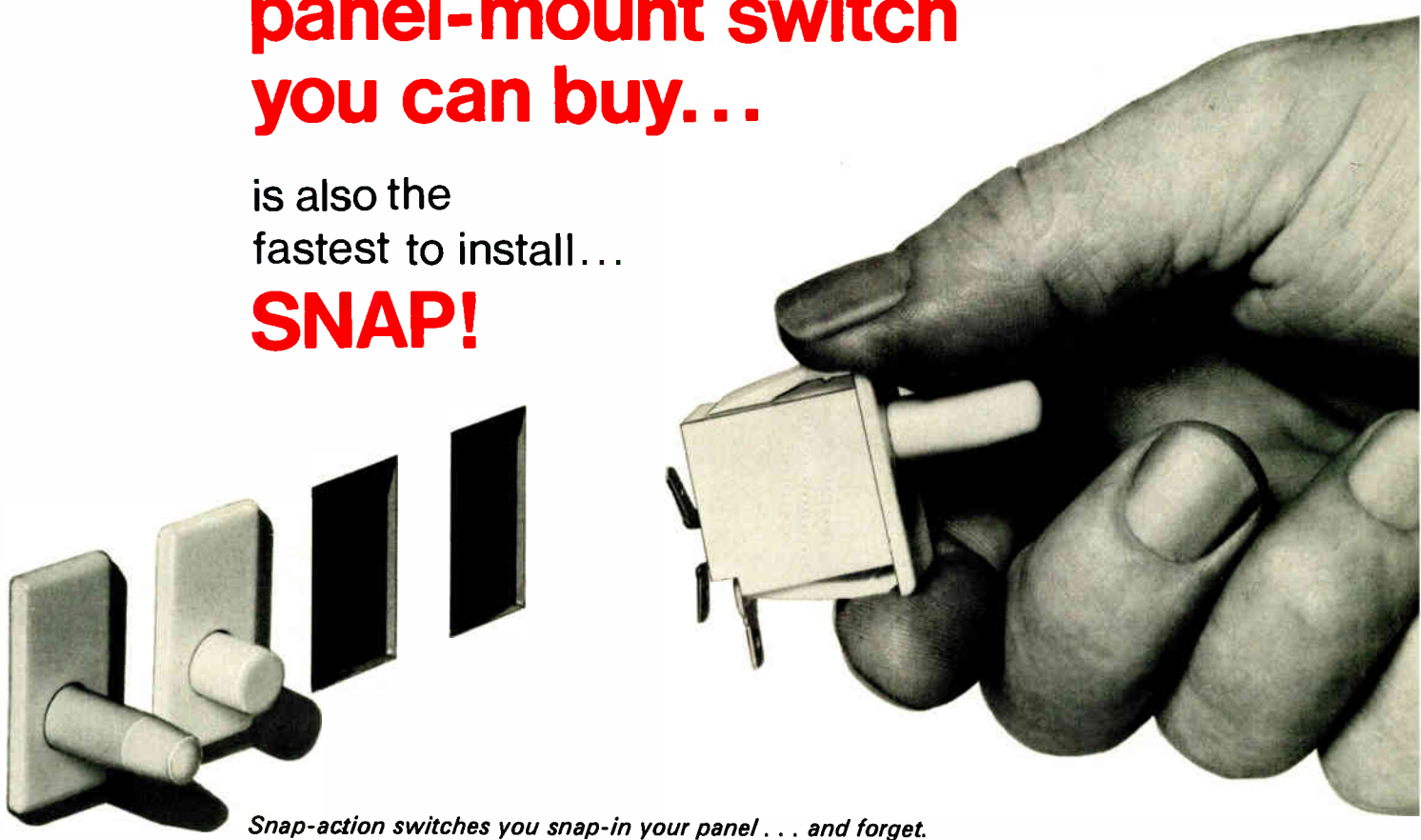

Snap-action switches you snap-in your panel . . . and forget.
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Circle No. 183
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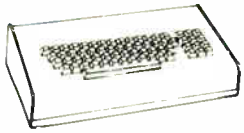
Circle No. 184
for Free Sample



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PLASMA-LUX GAS DISCHARGE DIGITAL DISPLAYS

Phoenix from the ashes of Chapter XI proceedings any day now. And therein lies a tale of a hairbreadth business-salvage job that has put the 25-year-old calculator pioneer back squarely to its previous status—a manufacturer of electronic components such as light-emitting diodes, keyboards, and potentiometers.

Although low-key in his approach, president William M. Crilly projects an intensity that underscores his measured words. "If the company were only in one time zone, we wouldn't have made it," he admits. "Our No. 1 problem was to meet the payroll, and with no cash on hand, we literally collected in one time zone and then paid in another."

Brought in at the February 1975, board meeting when directors voted to file for the protection of voluntary bankruptcy [*Electronics*, Feb. 20, 1975, p. 36], the 51-year-old Crilly is credited with saving Bowmar, the company that in September 1971 introduced the first handheld calculator, then priced at $240.

Competition. Bowmar kept first place until Christmas 1973 when major competitors, principally Texas Instruments, cut prices drastically. Adjusted results for fiscal 1974 and 1975 show net losses of more than $25 million each year. Sales plunged from $78 million in 1974, including about $52 million from calculators and watches, to $27.2 million in 1975. But during this time, non-calculator operations remained profitable, and Bowmar's first 1976 quarter, ending Dec. 31, had a $505,000 profit on $7.4 million sales.

Actually, Crilly had been through it before. As planning vice president, he was a key man in another noted business turnaround at Eastern Airlines in the early 1960s.

In addition to the time-zone caper, what enabled him to turn Bowmar around was the underlying strength of the non-calculator products, Crilly says.

Recalling the days after his takeover, Crilly describes some grim prospects for any manager: creditors at the door, payrolls waiting to be met, and a cash drain of $500,000 a week from calculator losses. "Overexpansion was the basic problem," he explains. "Bowmar got too big too fast and wasn't manned to handle it."

It also lacked, Crilly soon discovered, any semblance of cost controls for its calculator production. "We literally didn't know what it cost to build them," he marvels. Crilly and his helpers spent about a month "finding out if there was a viable future for Bowmar in the calculator business." Because $8 million more would have been required to stay in, Bowmar called it quits in May 1975. This move stopped the company from "leaking blood," and cash flow turned positive that June. After that, Crilly focused on restructuring the company, and cut costs ruthlessly. Total employment was pared from 3,000 to 850.

Continuity. One thing Crilly did differently from most management doctors brought in to heal a company was to keep many of the executives in the non-calculator sectors. Crilly says, "They were doing a

News briefs

Razor-maker Gillette orders watch modules

Integrated Display Systems Inc., a Montgomeryville, Pa., joint venture of General Electric Co. and Solid State Scientific Inc., has received a multimillion dollar sole-source order from the Gillette Co. for digital-watch modules. The order covers initial production of two types of modules and is the first phase of a three-year supply agreement between the two companies. Tom Saldi, IDSI president, says the digital watches will be marketed in 14 styles in the mid-price range by September. They'll use light-emitting-diode displays.

RCA to build Air Force weather satellites

RCA Corp. has received two contracts worth $29.9 million to design and build three new spacecraft for the Air Force Defense Meteorological Satellite Program, directed by the U.S. Air Force Space and Missile Systems Organization. The satellites are intended to provide timely high-quality meteorological data to support tri-service users throughout the world.

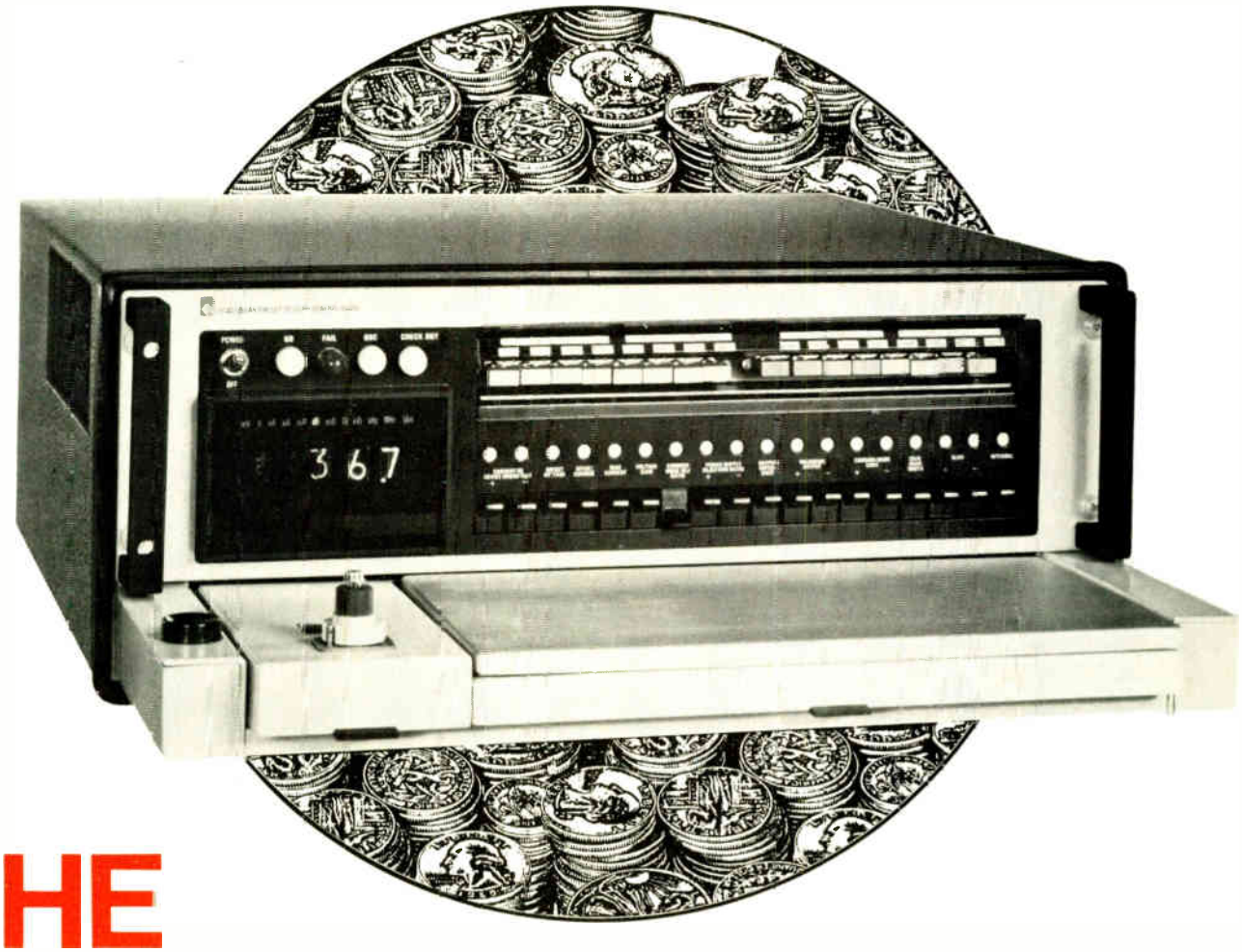
Raytheon wins award for missile-warning radar

Raytheon Co.'s Equipment division, Wayland, Mass., has won out over teams headed by General Electric Co. and Westinghouse Electric Co. to build the Pave Paws phased-array radar intended to detect sea-launched ballistic missiles aimed at the Eastern U.S. The initial award is for $46.5 million, but the value could grow to some $100 million [*Electronics*, Aug. 7, 1975, p. 43] because Raytheon now has the inside track for the planned Western U.S. site. The Eastern site is at Otis Air Force Base, Mass., and the Western location will be at Beale AFB, Calif. A source at the Air Force Electronic Systems division, Hanscom AFB, Mass., which administers Pave Paws, says the Beale award could come within weeks.

Do-it-yourself CB licensing

Still swamped by an unprecedented deluge of applications for citizens' band licenses [*Electronics*, March 4, p. 91], the Federal Communications Commission has begun a new system that allows prospective operators to license themselves—temporarily. An applicant simply fills out form 555B, which is brand new and available from CB retailers. This self-executing license is valid for 60 days from the date the application for a permanent class D license is dropped in the mail.

The applicant takes care of the call letters too. First comes the letter K, followed by the applicant's initials and zip code. There will be some duplications, but not many, the FCC figures. And the agency hopes that within 60 days it can replace the temporary call sign with a permanent one.



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New products

good job, mostly, so why change?"

In the second quarter of fiscal 1976, Bowmar made slightly less than in the first quarter, reflecting "the worries our customers had about us last year," Crilly says. But the situation should improve the rest of the year. Somewhat ironically, Bowmar's major product line, light-emitting diodes for calculator and watch displays, serve the consumer business that almost proved fatal. LED sales to watchmakers alone bring in about $1.5 million a quarter.

The agreement with the creditors chiefly provides for cash payments and the distribution of 2 million common shares of stock, or 49.9% of the total. After that, Bowmar will owe its creditors about $7 million, compared with peak debts of $55 million, Crilly says.

Now sitting at the helm of a stable company and with $5.6 million in the bank, Crilly is enjoying more tranquillity in his business life as the company headquarters is being moved from New York City to Stamford, Conn. He also hopes to use the available $45 million tax-loss carry-forward to shelter future growth and profits. But for now, he says, "while I like turnarounds, I hope this is the last one for me." □

Computers

Emulator goes after SPC-16 computers

Emulation—making one computer behave like a different one—may be an interesting exercise, but is it a solid marketing strategy? This question is being posed in Anaheim, Calif., where a small peripheral-controller manufacturer plans to market its emulation of a major minicomputer line.

Datum Inc. is introducing hardware packages that allow its Enhancer 1 microprogramable computer to emulate the SPC-16 minicomputer from General Automation Inc. That company has produced its minicomputer since 1969.

"As far as I know, we're the only company pursuing this kind of emulation-marketing plan," says Allan Devault, director of marketing for Datum's Computer Products division. He projects a fast-growing potential for second-sourcing minicomputers, probably a total of $12 million to $15 million a year. "This is because many end users and sizable OEMs have big investments in applications software based on hardware and operating systems no longer actively supported by the original manufacturers."

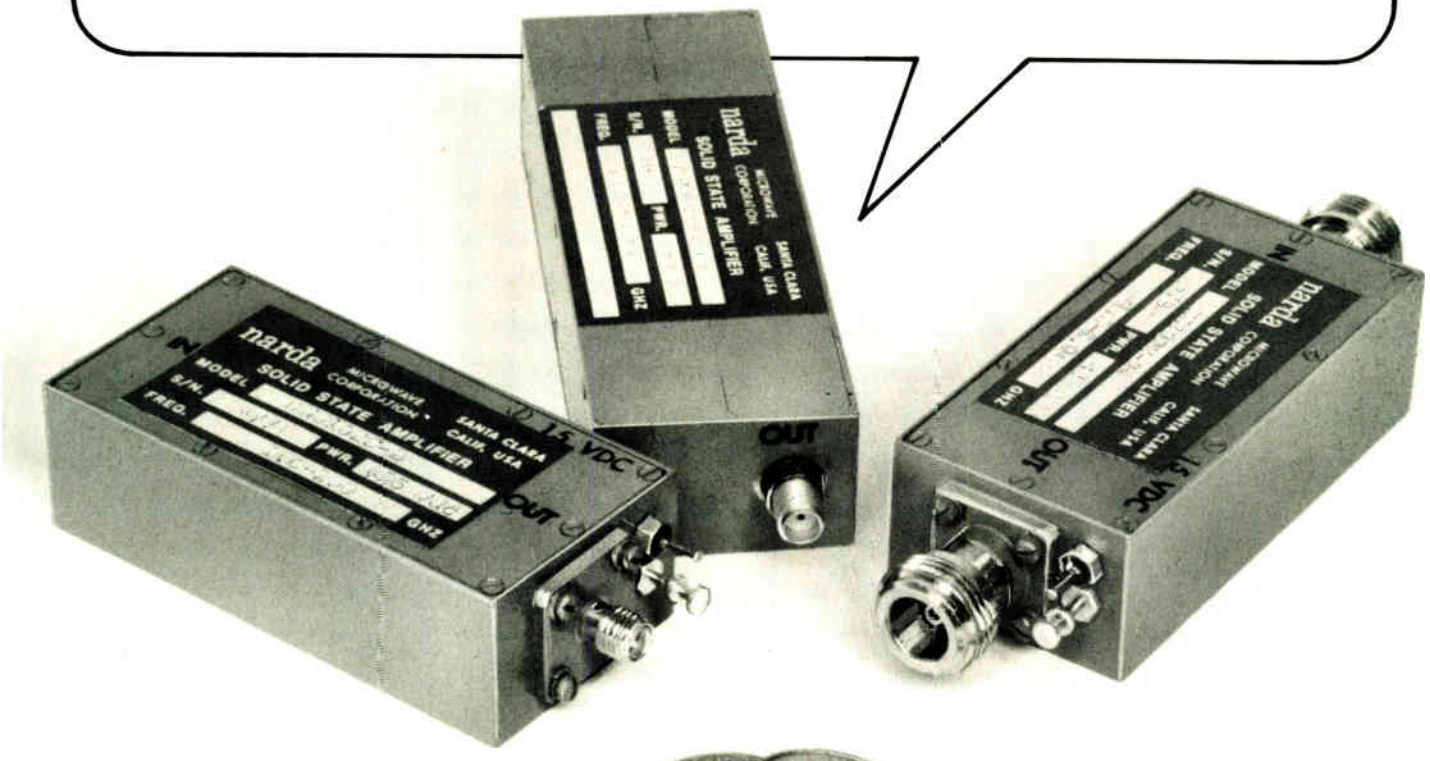
Puzzling. General Automation, however, is puzzled over why it was picked as Datum's first target. "That stuff about no longer actively supporting a line in no way applies to us," remarks Samuel Lane, marketing manager for standard products. In fact, the SPC-16, to be produced for at least another year, is even software compatible with GA's new Solution-series machines, he notes.

"Because we are so close (both companies are in Anaheim), they picked up a lot of our people who knew our big OEM customers and thought they knew our problem areas," Lane says. (Devault himself came over from General Automation in 1975.)

"My feeling is they will find it impossible to compete with us," Lane declares. He reasons that, not only are the models in GA's Solution series compatible, but through improvements, they offer more performance per dollar than the SPC-16. However, the biggest barrier to Datum, he says, is the software, which is licensed to customers. "They would have to pay us, or they couldn't use it, and then, where's the saving?" he asks.

Lower cost. But Devault says the Datum emulation packages will sell on a hard-headed dollars-and-cents basis. "Our processor and controller are located in the same package, so the user already saves the controller cost, compared with the SPC-16," he says. On a function-by-function comparison, Devault claims that his package offers a 20% saving for the simplest minicomputer and up to

can we amplify your story...



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8.0 to 12.0	7.5	+ 7 dBm	33
8.0 to 12.0	7.5	+ 7 dBm	24
5.2 to 10.4	7.0	+ 7 dBm	40
4.0 to 8.0	6.0	+10 dBm	40
4.0 to 8.0	6.0	+10 dBm	25

For Communications

Narda's communication amplifiers have been specially tuned with particular care given to the reduction of intermodulation products, gain slope, group delay, AM to FM conversion and VSWR's. You'll get a better idea how we can help you when you compare these specifications.

Freq. Range (GHz)	Noise Figure dB	Power Output 1 dB Comp. Pt.	SSG dB
3.7 to 4.2	2.6	+10 dBm	50
4.4 to 5.0	5.0	+10 dBm	25
5.9 to 6.4	6.0	+12 dBm	25
7.25 to 7.75	5.7	+10 dBm	32
7.9 to 8.4	7.0	+10 dBm	33

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5.4 to 5.9	4.5	+10 dBm	25
8.5 to 9.6	5.5	+ 7 dBm	20
9.0 to 10.0	6.5	+ 7 dBm	20

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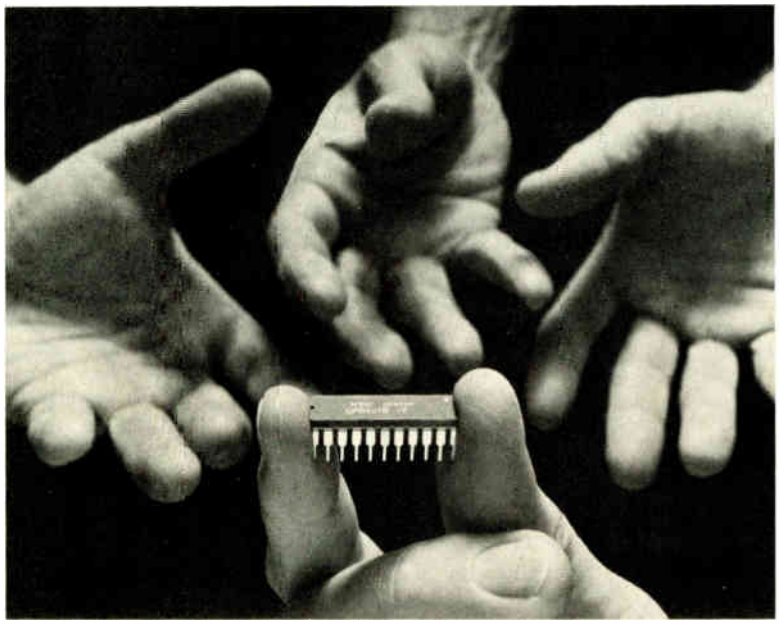

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New products

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Datum's 16-bit Enhancer 1 provides four system configurations, with a peripheral-controller board in the same enclosure. In terms of system speed, Devault claims that the 800-nanosecond cycle time allows it to execute instructions at rates equivalent to the SPC-16/85's 960-nanosecond cycle time.

The minimum Enhancer 1 package, priced at $13,950, has 32 kilobits of core memory, a controller for up to four IBM 2315-type cartridge disks, and serial input/output for teletypewriter and cathode-ray tube. The top of the line, priced at $24,750, offers 48 kilobits of core and controllers for disks, line printer, and other peripherals.

Xerox? Although Datum might be expected to make some inroads against the SPC-16, industry sources believe a prime target is the orphaned user of the Xerox computer.

Devault acknowledges that Datum is already operating a prototype processor that emulates the Xerox Sigma 5. Serious bargaining with the Xerox-user group can't start, however, until the terms of Honeywell Inc.'s service responsibilities to the users are specified, and that could be months away, sources say. Devault won't talk about plans for emulating other computers, but claims that Datum needs "only four months to design an emulation package from scratch." □

IEEE

Board's candidates announce platform

Promising to work to reduce the imbalance between the supply and demand for engineers, to change customs surrounding patent rights, and to press for "truly portable pensions," the candidates nominated by its board of directors to lead the Institute of Electrical and Electronics Engineers in 1977 outlined a broad 19-point platform last week.

Robert M. Saunders, professor of electrical engineering at the University of California in Irvine, and Robert D. Briskman, assistant vice president for fixed systems at Comsat General Corp. in Washington, the candidates for president and executive vice president respectively, are basing their appeal on a wide range of topics including technical and educational affairs and publications. However, five points devoted to professional affairs may come under closest scrutiny. Besides the three above, the platform includes establishing standards for engineering practice and improving the EE's status in society.

Competition. There will be a three-way race for president if Robert Rivers, president of Aircom Inc., and Irwin Feerst, engineering consultant, get on the ballot by petition. In addition, Carleton Bayless of Pacific Telephone and Telegraph Co. is collecting petition signatures to challenge Briskman. All three of the prospective petition candidates have stressed professional issues as their reasons for running. □

Displays

Magnetic particles form flat display

To produce a rugged display that operates in bright ambient light, researchers at Magnavox Corp. have put together a flat display of 2 by 3 centimeters that reflects light from magnetic particles suspended in a transparent panel. The nonvolatile display consumes minimal power, says Lawrence L. Lee, the engineer who developed the matrix-addressable unit for Magnavox Government and Industrial Electronics Co., Fort Wayne, Ind.

Lee, who will describe the device at next month's Society for Information Display symposium in Beverly Hills, Calif., emphasizes that it is still experimental. But he expects military funding for development because of its usefulness on portable equipment and in aircraft cockpits. The magnetic device would be less

sensitive to extremes of temperature and pressure than a liquid-crystal display, for example.

Magnetic spheres. Lee's display relies on tiny black spherical magnetic particles coated on one side with reflective materials and suspended in silicone oil between two transparent panels. These particles rotate toward their bright side in proportion to the strength of an external magnetic field. This field is generated for matrix addressing by a grid of wires on a ferrite magnetic memory sheet behind the display.

Magnavox has also built a simple experimental seven-segment display of roughly 1 by 5 cm. Groups of particles form the segments, and small coil-wrapped magnets behind the segments reverse the polarity of the magnetic field, turning the display on and off.

"Absolutely no power is required to maintain the image," Lee says. By careful design of the matrix-addressing system and the right choice of the memory material, Lee hopes to get a display that can be sequentially addressed to provide a variable gray scale that registers brightness in proportion to the amount of video scanning current applied to the wire grid.

So far, so good. Lee is pleased with his design. "It creates images, and it's matrix-addressable," he says. The particles now being used yield a contrast ratio of 15:1, and image spots are 1 millimeter apart. "We haven't worked on resolution and contrast at all," he adds. "Our current research is to show that every aspect of the technology required to manufacture the display is feasible." Theoretical estimates of resolution are between 100 and 200 micrometers, limited, not by particle size, but by the spacing between conductors of the address grid.

The particles are ferrite powder in a binder of wax or plastic. "We've been able to make them as small as 20 μm in diameter, and we've made large quantities in the 100-μm range," he says. As many as 10 million can be made in an hour—enough to display 100,000 characters, each a centimeter on a side. □

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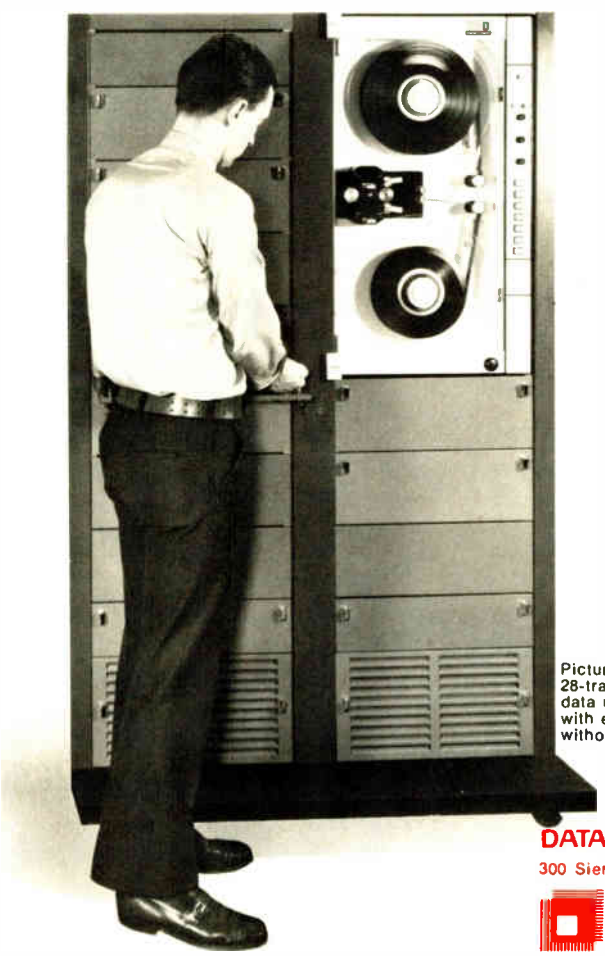

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BELL & HOWELL

Washington newsletter

ERDA sets 1977 to identify uses for solar photovoltaics . . .

A goal of Sept. 30, 1977, has been set by the Energy Research and Development Administration for identification of "attractive applications that will advance the widespread use of solar-photovoltaic conversion systems." The date is part of the agency's mid-April report to the Congress, laying out a national plan for energy research, development and demonstration. **But the new ERDA plan, updating its first report of a year ago, does not foresee heavy use of direct energy conversion using photovoltaics before the year 2000.**

After beginning a series of experiments on multikilowatt photovoltaic conversion this year, ERDA hopes to bring the price of concentrated photovoltaic systems down to "less than $2,000 per peak kilowatt" by fiscal 1979 through research, development and demonstration programs on materials and fabrication techniques. It expects to achieve a similar price goal for planar solar cell arrays by 1982. The total ERDA solar R&D program for fiscal 1977 will be $116 million, up 35% from this year.

. . . reports 100-kilojoule CO_2 laser for fusion underway

The military application division of the Energy Research and Development Administration is designing a 100-kilojoule carbon-dioxide laser for possible use as an energy source in fusion reactors for power generation, says Robert L. Hirsch, acting chief for solar, geothermal, and advanced energy systems. The military division at Los Alamos Scientific Laboratory, N.M., controls the program to build the world's largest known laser, Hirsch says, "because laser-fusion has potential military, as well as potential civilian applications."

A 10-kilojoule neodymium-glass laser for possible fusion reactor use, being built at Lawrence Livermore Laboratory in California, is expected to be operational next year, Hirsch says. The scientific break-even point for laser fusion reactions, at which the energy output equals that of the incident laser light, is expected in 1981-1982, Hirsch says, leading to net energy gain in the mid-1980s and a demonstration plant a decade later.

Federal role in EFT opposed by OTP's Eger

A new dispute over electronic funds-transfer systems has surfaced, with the White House's Office of Telecommunications Policy charging that a proposed Federal Reserve System regulation change is "both inappropriate and unwise" because it would place the Federal Reserve "in an operational role at the heart of a nationwide EFT system." **The change, which concerns Regulation J, would allow the Federal Reserve to act as a national clearing house for EFT transactions via its telecommunications network and computer center, Culpepper, Va.** John Eger, acting OTP director, opposes the change on grounds that it "would stifle innovation in the use of computerized telecommunications" and discourage private-sector competition in "a vibrant private-sector marketplace that has already evidenced its willingness and capability to operate such systems."

Citing Federal Communications Commission filings by Graphnet Systems Inc., Telenet Communications Corp., and Packet Communications Inc., Eger said "new entrants in the telecommunications and data-processing industries are providing specialized electronic-switching services that are easily adaptable to an electronic payments-system, and several have received FCC authority to provide services quite similar to those which the Federal Reserve appears to be contemplating."

Eger also opposed Government operation of an EFT system "because

this data will be a comprehensive source of information on the habits and finances of the public, there are obvious questions concerning the wisdom of allowing a Governmental agency unfettered access to such sensitive and private information. Federal Reserve chairman Arthur Burns told Eger he considers the EFT system issue "unsettled." **He referred the matter to the National Commission of Electronic Funds Transfer, which began to study the problems in February.**

Army readies study for cross-banding microwave landing system

The Army Electronics Command, Ft. Monmouth, wants quotations on a six-month study of cross-banding the National Microwave Landing System and the secondary surveillance radar display processor of the Air Traffic Control Radar Beacon System. The program's goals includes achievement of a high-resolution terminal air-traffic control capability by integrating the L-band interrogator function of the secondary surveillance radar with both air and ground NMLS equipment to get L-band beacon replies from an airborne ATC transponder. The **Army also wants conceptual designs for presenting aircraft altitude, range, angle, and identity on a ground-based display-processor.**

TV sales gain continues in March; radios up sharply

The economic upturn in consumer electronics continues as March shipments of television receivers to dealers rose 6.3% from a year earlier, to 1,049,940 sets—boosting figures for the first three months to 2,762,774, up 14.2% from 1975. **The more expensive color receivers rose 7.8% in March to 592,876, putting them 18.6% ahead for the first three months,** while monochrome TV rose only 4.5% in the month to 457,064, for a January–March increase of 8.5% over 1975.

Total radio sales climbed 43.9% in March to 3,501,516, pushing the three months total to 8,067,992, or 38.2% ahead of 1975. Major increases were recorded for fm or am/fm combinations, according to the Electronic Industries Association figures, which show a 64.3% jump in March and 48.4% for the first three months. Auto radio sales were also up sharply, climbing 43.9% in March and 57.3% for the first three months.

Addenda

Cockpit controls and displays for the Digital Avionics Information System will be developed by Hughes Aircraft Co., Culver City, Calif., under a $1.99 million award from the Air Force Avionics Laboratory, Dayton. **Hughes, which defeated Boeing Co., Seattle, in the competition,** will provide a cockpit configured to resemble the Vought A-7D close-support attack aircraft, plus five electronic displays for symbolic video data presentation including all aircraft subsystems—communications, navigation, and stores. . . . **First U.S. contract for K-band satellite ground stations with simultaneous two-way video, voice and data communications** has been awarded to Fairchild Space & Electronics Co., Germantown, Md., by the National Library of Medicine. The $1 million award covers six ground stations with 10-foot dish antennas and 1.5-KW transmitters. They will be used to exchange medical TV programs between health centers in the U.S. via the Communications Technology Satellite, a joint U.S.-Canadian project launched earlier this year.

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Case Size Range (D. x L.)	.326″ x .505″ to 1.000″ x 1.625″	.750″ x 1.625″ to 1.000″ x 3.625″	1.375″ x 2.125″ to 1.375″ x 5.625″	1.375″ x 2.125″ to 3.000″ x 5.625″
Operating Temperature Range	−55°C to +105°C	−55°C to +105°C	−55°C to +85°C	−40°C to +85°C
WVDC Range	6.3 to 100	5 to 200	5 to 55	6 to 50
Capacitance (Range (μF)	4.7 to 6800	50 to 16,000	2,800 to 67,000	470 to 100,000
Capacitance Tolerance	−10, +100%	thru 50 V: −10, +75% over 50 V: −10, +50%	±20%	−0, +100%
Max. Inductance (@ 1 MHz & within .125″ of capacitor)	20 nH	2 nH	20 nH	2 nH
Max. ESR (@ 25°C and 120 Hz)	1200 μF @ 6.3 WVDC: .11 ohm	16,000 μF @ 5 WVDC: .022 ohm	67,000 μF @ 5 WVDC: .004 ohm	100,000 μF @ 6 WVDC: .0015 ohm
RMS Ripple Current (@ 85°C)	2.61 A @ 100 kHz	7.00 A @ 10 kHz	19.5 A @ 120 kHz	54.6 A @ 1 kHz
Max. Impedance (@ 25°C)	.06Ω @ 100 kHz	.017Ω @ 10 kHz	.010Ω @ 10-40 kHz	.001 Ω @ 10 kHz
Engineering Bulletin	3452	3458A	3459	3443A
	Check 258 on Reader Service Card	**Check 259 on Reader Service Card**	**Check 260 on Reader Service Card**	**Check 261 on Reader Service Card**

For complete technical data, write for Engineering Bulletin(s) (see table for bulletin numbers) on the capacitor(s) in which you are interested to: Technical Literature Service, Sprague Electric Company, 35 Marshall St., North Adams, Mass. 01247.

4SE-6102

SPRAGUE
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THE BROAD-LINE PRODUCER OF ELECTRONIC PARTS

The ITT Semi

Published Monthly by ITT Semiconductors, Commerce Way, Woburn, MA 01801 SECOND

86 Interface ICs at

SUPERIOR NOISE IMMUNITY, CURRENT AND POWER HANDLING WITH ITT INDUSTRIAL INTERFACES

Drawing on its experience with the military market, ITT Semiconductors now offers a line of commercial interface circuits that are inherently hi-rel. While the line is pin-to-pin compatible with competitive devices, ITT has improved circuit performance in noise rejection, superior current/power handling capabilities, and excellent reliability.

Superior noise immunity makes the interface circuits less susceptible to noise spikes which often trigger these circuits prematurely. Superior power dissipation and current handling capability improve reliability. And for speed, products such as the sense amplifiers are typically 3-5 nanoseconds faster than the competition.

Use of the latest interface IC technology allows different process technologies to communicate, such as MOS and core memories to TTL. Interface circuits come in both plastic and ceramic packages. And with all these advantages, ITT interface circuits cost no more.

The 86 circuits in the line are designed for applications in: sense amplifiers, line drivers, line receivers, MOS clock drivers, peripheral drivers, core memory drivers, high-current impact-printer drivers, gas-discharge display drivers, LED display drivers.

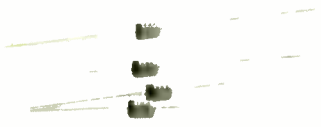
High reliability and high performance are achieved through innovative design. High-current driver circuits gain better power dissipation and current handling through oversized device geometries, metalization structures, and substrates. Each output can handle up to 500 milliamperes and drive 3 outputs simultaneously, instead of just one.

Outputs of other ITT drivers can handle from 100 to over 600 milliamperes without increased size.

ITT applications engineers can help designers find the right interface for circuit designs and specify parameters to meet the application. Many interface circuits are now available from stock.

Circle #2 for more information.
(Or reader service #269)

1 AMP GLASS RECTIFIERS OFFER HIGH PERFORMANCE



ITT Semiconductors 1 amp glass rectifiers are equal to the best in the industry. All devices offer excellent reverse power surge capability and high temperature stability.

There are two series with a 30 amp surge rating which offer peak inverse voltages ranging from 50 to 800 volts. The other two series with a 50 amp surge rating have peak inverse voltages ranging from 50 to 1000 volts.

Devices are available with glass passivation and have a low voltage gradient across the junction for greater reliability. And they incorporate grown-junctions technology to create a more predictable device. All are hermetically sealed. Easy to read and easy to handle for fabrication.

They are sturdy, too, with 18 lb. lead pull – especially useful for cut and bend operations.

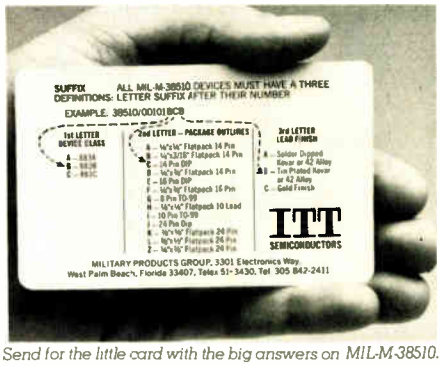
Circle #1 for more information.
(Or reader service #268)

An ITT Salesman is more than an order taker

An ITT sales representative can provide customers with hundreds of products off-the-shelf, but that's not his only function.

He is thoroughly knowledgeable about electronics and prepared to offer on-the-spot technical/design advice himself, or call upon the expertise of ITT regional applications engineers. The ITT salesman's close relationship with distributors in developing the best possible methods for processing and expediting client orders is another plus that makes him specially qualified to provide professional service to his accounts.

Circle #3 for more information.
(Or reader service #270)



Send for the little card with the big answers on MIL-M-38510.

ITT offers broad line of MIL devices

With ITT Semiconductors card in hand an engineer has a guide to all of the MIL-M-38510 JAN microcircuits it makes. The list encompasses one of the broadest lines of hi-rel digital bipolar ICs in the industry.

A total of 41 devices are fully qualified with Part I approval. These devices, plus a series of JAN TXV and JAN TX transistors and diodes that meet MIL-S-19500, include everything needed to build hi-rel, MIL-approved circuits and systems.

Screening ranges from regular military temperature specifications up to life support space craft levels.

All products are available in chip or wafer form at competitive prices and are ready for immediate delivery. Weekly open order status reports sent to customers keep shipments on track.

Circle #4 for more information.
(Or reader service #271)

ITT SEMICONDUCTORS, "SECOND TO NONE"

Every ITT Semiconductor advertisement signs off with the slogan "Second To None". It is not merely a catch phrase, but a statement of business philosophy. Jim Ambrose, General Manager, ITT Semiconductors indicates that slogan is the "outgrowth of a conscious effort by ITT to continue its leadership and to be the ultimate second source for semiconductor products in the industry". The effort Ambrose further adds, "is backed by quality manufacturing, wide breadth of line, competitive pricing and prompt delivery".

Circle #5 for more information.
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conductor News

TO NONE

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low cost from ITT

TTL ICS— PRICE PERFORMANCE COMPATIBILITY

When thinking of second sources for TTL ICs, think of ITT Semiconductors. Over 160 different devices, in plastic or ceramic packages, are available off-the-shelf. All are pin-to-pin compatible with competitive devices, at competitive quality and prices.

With the wide variety of circuit functions available, both SSI and MSI, and with four different product categories, the designer can find the right device for his application.

The 107 devices in the ceramic/plastic-packaged 5400/7400 series are intended for high-speed, general purpose digital applications. The series advantages include a typical propagation delay of 13 nanoseconds, a noise margin typically 1 volt or more, and output impedance of less than 100 ohms.

Higher speed applications call for one of the 37 ceramic/plastic-packaged devices in the 54H00/74H00. These have a typical propagation delay of 6 nanoseconds and a typical dc noise margin of 1 volt.

The 9000 series includes 15 different devices supplied in hermetically sealed ceramic packages. They offer a typical propagation delay of 10 nanoseconds, a typical noise margin of 1 volt.

There are 10 devices in the complex function devices 9300 series MSI.

Circle #6 for more information.

(Or reader service #273)

We've got your number (800) 225-1153

ITT Semiconductor has established a phone number its customers can dial to talk with a marketing manager on product information. The new direct line is another step by ITT to make doing business with the Semiconductor Division as simple and efficient as possible. Products may also be ordered over the phone, or by contacting one of ITT Semiconductor's many distributors—such as Hamilton-Avnet and Cramer.

Circle #7 for more information.

(Or reader service #274)

ITT Semiconductors makes 2000 products to commercial or military specs.

An example of the anodized silicon isolation process as used in the new generation of I²L devices.

ITT TAKES LEAD IN I²L TECHNOLOGY

Integrated injection logic, fast, dense, and simple to build, is emerging as among the most important bipolar LSI processes. And ITT Semiconductors is leading the way in I²L development by extending its capabilities through anodized silicon isolation.

The anodized silicon process, unique to ITT, promises even faster, simpler and denser devices and lowers the cost of production. Its use should extend I²L performance to compete with TTL. ITT is now matching its technology to product needs.

Silicon anodization is a low-temperature process that produces the dielectric to isolate the active elements on a chip in one step. This eliminates the usual, and more costly, two or three step high-temperature device-isolation process.

Performance is improved by lowered capacitance between elements and increased transistor gain and speed. Typically I²L devices with anodized silicon will be significantly faster than n-channel devices.

Anodized silicon I²L devices will have important applications in memories, microprocessors, and many other areas of digital equipment, signal processing, and combined linear and digital applications. Conventional I²L is already being used in products with low current and low voltage applications such as watch circuits with integrated segment and digit drivers.

An I²L design kit for low current applications is now available from ITT. It includes a booklet and a 15 building block product set.

Circle #8 for more information.

(Or reader service #275)

ITT Semiconductors
74 Commerce Way, Woburn, Massachusetts 01801

We'd be delighted to provide you with additional information on any of the stories or products appearing in the ITT Semiconductor News. Simply circle the appropriate number.

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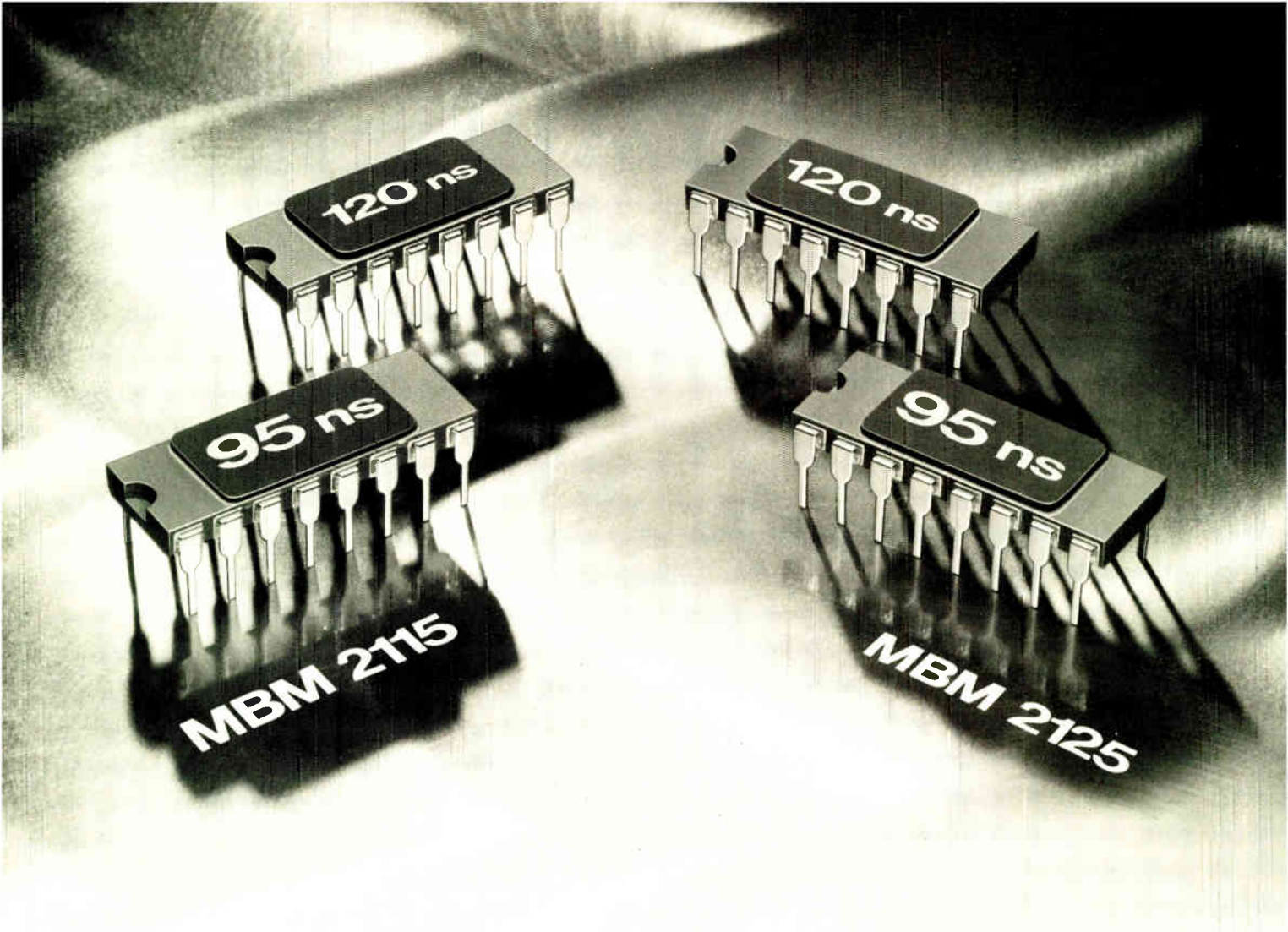


FUJITSU SEMICONDUCTORS

MOS MEMORY
1K Static RAMs
MBM 2115/25

When it comes to semiconductor memories, everyone's looking for a better way. And when it comes to 1024-bit RAMs, the better way is the new MBM 2115/25 family of static NMOS RAMs from Fujitsu. Pin compatible with the industry-standard 2115/25 family, as well as the bipolar 93415/25, these new Fujitsu RAMs offer you the same high speed, and with greater savings on power consumption, too.

Fast access time
Fujitsu static MOS 1K RAMs provide you with the high access time you're accustomed to with bipolar devices, and there is no internal refresh required, because these memories are static! With the MBM 2115E/25E, you get a maximum access time of 95ns and a typical of only 70ns; the MBM 2115N/25N has a maximum access of 120ns, and typical of 90ns. Yes, whichever you choose, you're ahead.

Power savings, too
One more benefit of Fujitsu 1K static MOS RAMs is the substantial reduction in power consumption. The MBM 2115/25 family dissipates typically only 200mW/chip (315mW/chip max.) for a speed-power product that can't be beat. Of course, extra savings on power consumption add up to extra savings in other ways, too. Like reduction of power supply costs, decreased cooling requirements, and higher reliability. In fact, no matter how you look at it, Fujitsu 1K static MOS RAMs are the "dollars and sense" choice for all your high speed requirements.

Proven reliability and available now
The MBM 2115/25 family of 1K static MOS RAMs is built by Fujitsu, a maker with proven reliability in the field of semiconductors and semiconductor memories. Stringent production standards, proven in-field performance, the most advanced processes, the capability to meet your requirements, and a price that's fully competitive—these and more add up to Fujitsu quality and Fujitsu service.
So, contact Fujitsu now for the MBM 2115/25 family, or any of your MOS memory requirements. Availability is NOW! Write or call for more information to Fujitsu California, Inc., Laboratory Division, 1280 East Arques Ave., Sunnyvale, California 94086,
phone: 408-735-0735 telex: 346393.

FUJITSU LIMITED
Communications and Electronics
Marunouchi, Tokyo, Japan

Circle 50 on reader service card

Electronics international

Significant developments in technology and business

Visitors reassured by technology and exhibits at Paris components show

For many show-goers at this year's early-April Salon des Composants Electroniques, a swing around the 1,000-odd stands at Paris' Porte de Versailles fairgrounds gave a fix on how business might turn out for the rest of the year. The readings were generally reassuring.

Technology buffs, too, left the show satisfied. Although Europe's major components makers have been through tough times in the past 18 months or so, they have kept their product-development teams hard at work. The first "European" microprocessors were on display, for example. And there was ample evidence that European producers are striding ahead nicely in leading-edge solid-state devices and tubes.

Microprocessors. Although Intel Corp. and its U.S. competitors still dominate European microprocessor markets, the native companies have started to move. So far, Siemens AG has mounted the strongest effort. The West German giant has a second-source pact with Intel and has developed a family of its own, the SAB 4080 line, intended mainly for uses like industrial control, terminals, and cash registers.

The family consists of several n-channel silicon-gate circuits. The microprocessor central processing unit is a 4-bit type with a set of 120 instructions and an instruction-cycle time of 1.5 microseconds. The firm is also offering a programing station intended to help users develop SAB 4080 software.

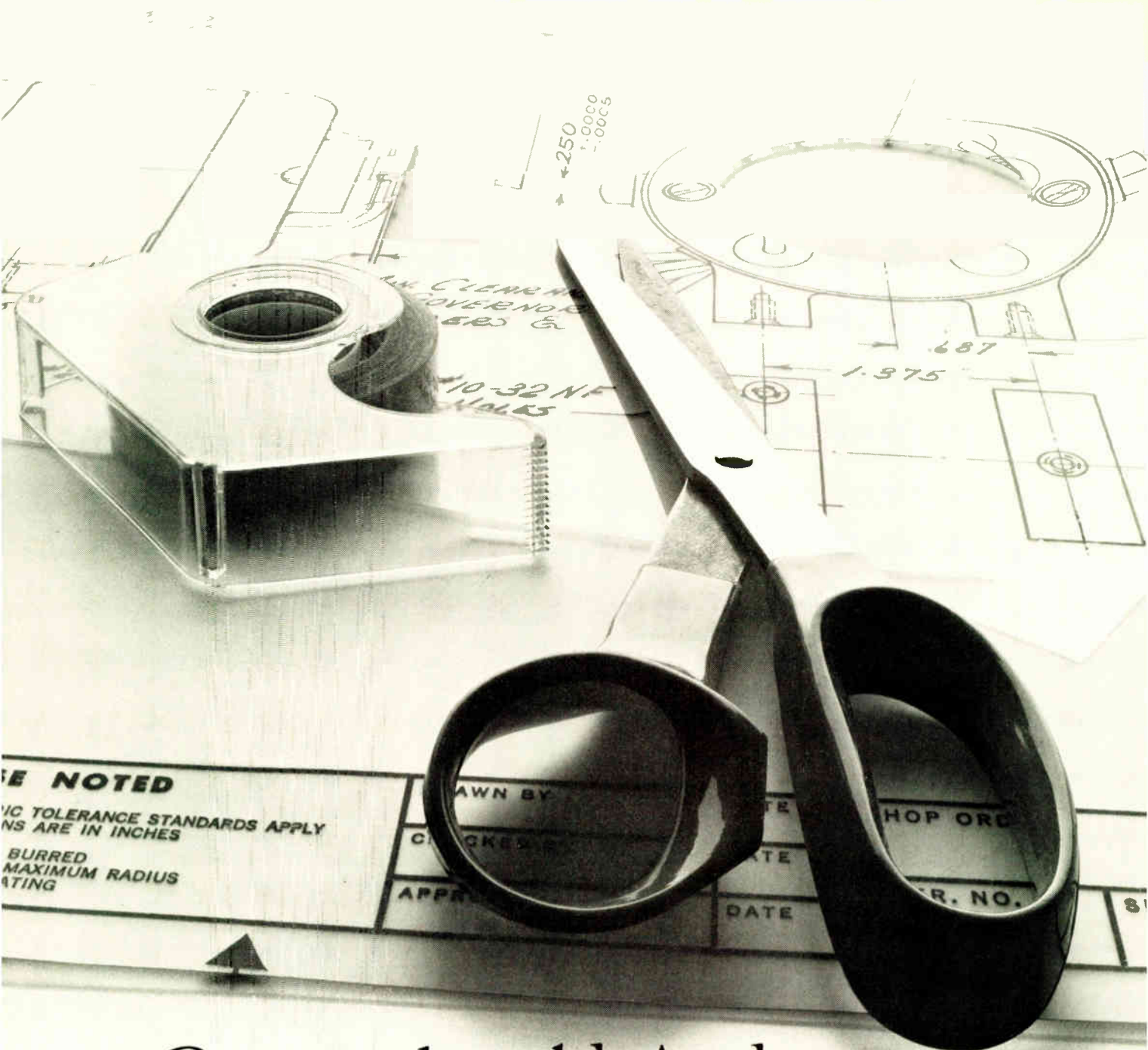
Siemens is not the sole European manufacturer peddling its own microprocessor. Germany's AEG-Telefunken, the Italian company SGS-ATES, and the British subsidiary of General Instrument all have gone to market with an 8-bit microprocessor originally developed for Olympia Werke, AEG's business-machine subsidiary. Its cycle time is 5 μs, and it has 48 instructions. Nixdorf, the German business-computer firm, is selling an 8-bit microprocessor it developed but has turned over to the McDonnell Douglas subsidiary Nitron for production.

Sescosem division of Thomson-CSF so far has gone into the microprocessor market only with American designs—second-source versions of Advanced Micro Devices 2900 family—but the French firm turned up at the salon with an original monolithic circuit aimed at making life easier for designers working with microprocessors. The circuit, designated the ESM 364, is the key package of a 13-circuit kit that converts ASCII inputs into a display for a standard 625-line television set. The basic format is 16 lines of 64 characters, but hard-copy outputs and light-pen inputs can be added.

Cramming in digits. Philips Gloeilampenfabrieken, largest of the European electrical/electronics groups, is counting on its American affiliate, Signetics Corp., for microprocessor designs. But for fast logic, the group's effort is paced by RTC-la Radiotechnique-Compélec. RTC's GXB 10000 family is now 60 members strong. The latest memory package to go into production is the GXB 10194, a 1,024-bit programable read-only memory with typical access time of 15 nanoseconds. The firm has squeezed this PROM onto a chip of only 7.7 square millimeters—about half the size of the prototype the company showed last year.

To complement the speedy logic, the company has developed prototype memory printed-circuit boards with a capacity of 2,000 18-bit words and a cycle time shorter than 58 ns. The board has seven layers, one of which is earmarked for line-matching and biasing resistances. That's the key to the tight packing, say engineers—199 packages in 9 square decimeters.

What's more, RTC has even faster families in the works. Its Caen semi-



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Versatility in reprographics

Circle 52 on reader service card

conductor facility has worked out a local-oxidation process that isolates logic cells on the bottom as well as around the sides.

Subnanosecond logic—the propagation time runs around 0.7 ns—based on the technology will be available in samples later this year. An even faster second generation is being readied at Laboratoires d'Electronique et de Physique Appliquée, a Philips-group research outfit in France. LEP has integrated experimental field-effect-transistor gates on gallium-arsenide substrates to provide propagation times of 110 picoseconds. Production versions, though, are at least five years away.

Cramming in color. European semiconductor makers traditionally have had an edge on their U.S. counterparts when it comes to linear circuits for TV sets, and they seem determined to increase it. SGS-ATES and AEG-Telefunken maintain that they have gone as far in color-TV integration as anyone yet with their three-chip PAL decoder. One chip, the TDA 2140, takes care of the regeneration and processing of subcarrier-reference signals. A second chip, the TDA 2150, amplifies the luminance and chrominance signals. The third chip, the TDA 2160, demodulates and matrixes the chroma signals for red-green-blue cathode drive of the picture tube.

Out front in sound-channel integration at the show was the ITT Semiconductor group's Intermetall GmbH. Its TDA 1935 circuit is a complete TV-sound channel, from tuner to output amplifier. The output is 4 watts, and there's full protection for thermal overload. In addition to the regular TV-tuner input, the demodulator accepts signals from video recorders or infrared modulators; the output amplifier can be driven by outside signal sources such as a tape deck.

Power packed. All kinds of new applications are popping up for power transistors—so many, in fact, that Sescosem has stepped up its market research to make sure its line of high-current devices matches user's needs. Yves Sautereau, in charge of marketing power transistors for Sescosem, figures that they will replace transformers in TV-set power supplies in a year or two. Like its competitors, Sescosem is ready with its BUX 47, which has voltage ratings of 400 or 800 volts and current ratings to 15 amperes.

Still another product from Sescosem's power effort is the ESM 1000, rated at 100 V and 200 A. Aimed at applications where thyristors are traditional, the ESM 1000 has a stud package. At the salon, Sescosem had one of these transistors wired as a circuit breaker; it broke 100-A shorts in about 41 microseconds.

Sescosem is not alone, of course. Alsthom, a unit in the Compagnie Générale d'Electricité group, introduced an 800-W (at 25°C) transistor at the show. The firm uses an interdigitated base-emitter layout with contacts on both the top and bottom surfaces to achieve power-handling to a 200-A peak with a switching time faster than 15 μs

Glowing success. New light-emitting diodes and cathode-ray tubes added brightness. RTC last year had a large seven-segment LED display—some 20 millimeters high on a single GaAs crystal. This year, the company turned up with a nine-segment LED—the CQY 298—19.6-mm high. The extra two segments form a 1, which makes the display particularly useful as a channel indicator for TV sets. Like the seven-segment version, the nine-segment LED glows red. But a yellow/orange version won't be far behind, suggests a company R&D executive. And, working with LEP, RTC has achieved blue emission from discrete gallium-nitride diodes at highly respectable efficiencies.

Several new cathode-ray tubes brightened the offerings of Thomson-CSF's tube division. Color displays so bright they can be read in full sunlight at high altitudes are the image of the THX 613. For projection of red, green, or white images on screens as large as about one square meter, there's the TH 8406. The TH 8502 has a screen 55 centimeters in diameter, which qualifies it for air-traffic-control displays. Writing speed is 10 mm per second; the trace is a mere 0.6 mm, but it is bright—500 candelas per square meter. □

Around the world

Swedish laser system exposes fine IC masks

Guided by a computerized control system, a laser is being used to expose high-resolution masks for large-scale integrated circuits in a fraction of the time and at lower cost than standard photographic or electron-beam processes. Although the electron-beam process can provide twice as much resolution as the new Laserscan system, Gerhard Westerberg, its developer, says his system gives three times better resolution than the conventional step-and-repeat photographic method. What's more, a future development could produce even higher resolution by avoiding the contact-copying step to process the circuits directly on the chip.

Westerberg, head of Micronic AB, Stockholm, has developed prototype and production models that are turning out LSI masks with lines as narrow as 0.5 micrometer for Swedish research institutes. He was aided by a $100,000 grant from the Swedish Technical Development Board.

Laserscan, priced at about $100,000, cuts the time for making the most complex masks to an hour at the most, compared with as long as 20 hours for the photographic method. Working on a 1:1 scale, the system can produce a mask 2.5 inches square in a half hour to an hour. Even after the mask is etched, the Laserscan can detect errors. The mask is put back into the machine and scanned again. This time, however, a detector under the mask picks up the beams, which are compared to signals from the original design tape. If an error is found, the circuit or entire plate can be discarded. To make the mask, the laser beam is directed by mirrors to a focusing lens, which is moved horizontally by a small minicomputer-controlled motor. The glass photo plate is moved vertically by a stepping motor.

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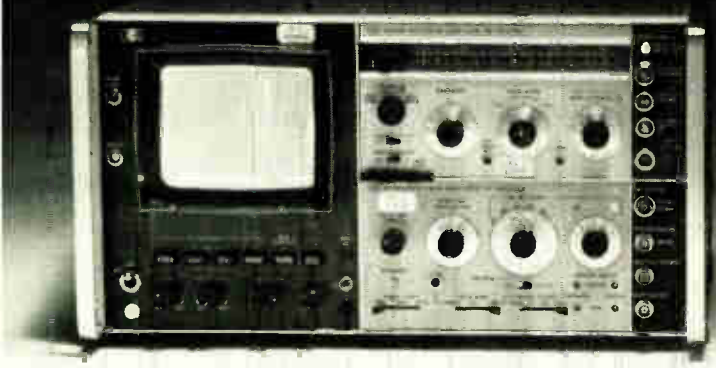

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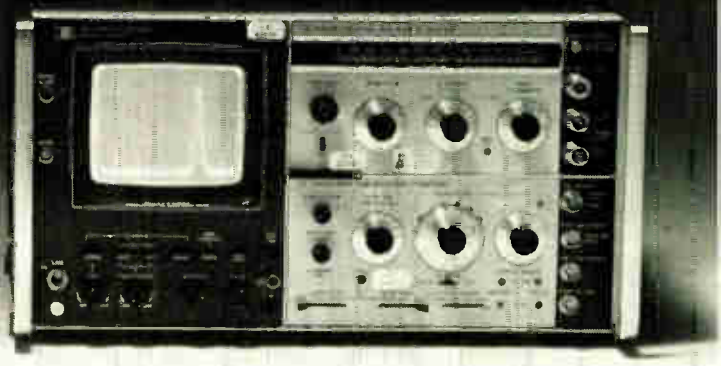

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Circle 54 on reader service card

International newsletter

Summer shortages with price hikes expected in Europe

Some electronics shortages are expected to hit in Europe by summer. **Consumer, industrial, and professional-electronics products will be affected in that order,** predict some suppliers, who are forecasting resulting 5% to 10% price hikes after currency adjustments. One marketing executive says short-term orders are already increasing, and lead times are lengthening. Depleted inventories and surging demand for consumer goods are also putting pressure on such products as capacitors, transistor-transistor-logic circuits, and memories.

Although the pattern sounds painfully familiar, suppliers this time will be wary of cranking up to meet the demand. "Profit will be the objective, not penetration," observes one. Opinion divides on how extensive shortages will be, but one executive comments, "He who pays the most, gets the most, but don't quote me." However, a distributor cautions that such talks may be "semiconductor manufacturers trying to scare people into buying more."

ITT swaps French subsidiary for phone-switch pact

To pave the way for participation in a multibillion-dollar reorganization of France's telecommunications network, ITT recently decided to allow Frenchification of one of its two subsidiaries there. Thomson-Brandt, the French electrical group, will purchase and obtain domestic control of either LMT or CGCT. The chosen company will manufacture the Metaconta electronic exchange system to help computerize France's telephone system. LMT is likely to be the government's choice, say sources connected with the state-run post office and ITT. The decision is expected this month.

France's program to renovate its telephone system calls for an increase by 1982 to 20 million subscribers from only 7 million today.

Nippon matches Intel components for microcomputers

In an attempt to win 40% to 50% of Japan's microcomputer market this year, Nippon Electric Co. plans by September to completely match the 8-bit microcomputer line of the American Intel Corp. **NEC will market 19 new components for its μcom 80 series, and 15 of these will be fully compatible with their Intel counterparts.**

Among the compatible parts are two microprocessors that operate at 2.5 and 3 megahertz, respectively, two types of interface for central processors, three types of input/output interfaces, five peripheral controls, two types of read-only memories, two types of programable ROMSs and four types of random-access memories.

Calculator boom to keep momentum in West Germany

Despite a sales increase of nearly 300% last year, the West German market for table-top and pocket calculators is far from saturation. That's the gist of a market assessment from Guenter Woithe, product manager at the Triumph-Adler Group, a leading German calculator producer affiliated with Litton Industries of the U.S.

Continuing sales increases during the first months of this year, coupled with the growing popularity of calculators in classrooms and the widening spectrum of special-purpose machines, has led Woithe to predict another considerable upswing in the calculator market for 1976. Last year's market climbed to 6.75 million units sold from 1.7 million in 1974.

International newsletter

Italian firm to send work to Singapore

Cutting assembly costs is the key tactic in the drive by Italy's SGS-ATES to double its annual sales by the end of 1978. They totaled $75 million last year. For starters, the company will shift most of its assembly operations to Singapore, and the few assembly lines retained in Europe will be highly automated. As for diffusion facilities, there'll be a shift to 3-inch wafers generally at SGS plants in Italy, France, and Scotland. Some $25 million has been earmarked for modernizing plants and strengthening the sales network, says Aldo Toscano, marketing manager.

UK firm develops tunable magnetron by adding cavity

An electronically tunable magnetron that minimizes clutter and identifies targets more precisely than mechanically tuned radar magnetrons has been developed by the English Electric Valve Co. **Funded by a Ministry of Defence contract, the new device is tuned by adding an auxiliary resonant cavity to the main magnetron anode. It changes frequency quickly to surmount interference.**

To optimize performance, the transmitter frequency is easily tuned to track the receiver frequency. An rf voltage is applied between the electrodes of the auxiliary cavity to cause a controlled electron multipactor discharge. This discharge creates a resonance shift, which changes the magnetron's frequency.

The development model electronically tunes over 100 megahertz in the X band at 50 kilowatts and 30 MHz in the S band at 200 kW of power output. A control voltage of 1 to 3 kilovolts tunes the device in a few nanoseconds. To add even more frequencies, several cavities can be added with little sacrifice in weight.

French airborne computer warns of crash danger

To warn commercial aircraft of imminent danger of crashes, the APS 500 airborne computer has been developed by Télécommunications Radioélectriques et Téléphoniques in Paris. Heart of the ground-proximity analyzer is the PACE—a 16-bit, single-chip microprocessor from National Semiconductor Corp. in the U.S. The first PACE was delivered last July, and within three months, a prototype analyzer was being tested aboard aircraft. **The 2.6-kilogram system warns the pilot when it senses an excessive rate of descent, a negative climb rate after takeoff, or a missed landing.**

To constantly monitor the relationship between the aircraft's attitude and the ground, analog signals denoting such parameters as altitude, barometric reading, glide-slope deviation, and position of the aircraft's flaps are fed through an analog-to-digital converter to the microprocessor. **Each APS 500 contains a half-dozen 4,096-bit programable read-only memories.**

Radio telemetry monitors fetal heart condition

Because some doctors fear that popular ultrasonic techniques for monitoring fetal heartbeat of about-to-be-born children may be harmful, Philips is updating a 10-year-old radio-telemetry development. This technology also allows the mother to move about without encumbering wires. An earlier special development by Philips Medical Systems Ltd. used a passive stomach microphone containing a moving-armature transducer, frequency-discriminating phase-locked loop with a filter centered around 70 hertz, and a modified radio transmitter and receiver. **Philips researchers at Eindhoven are understood to be developing a system that has a pressure sensor and up-to-date circuitry.**

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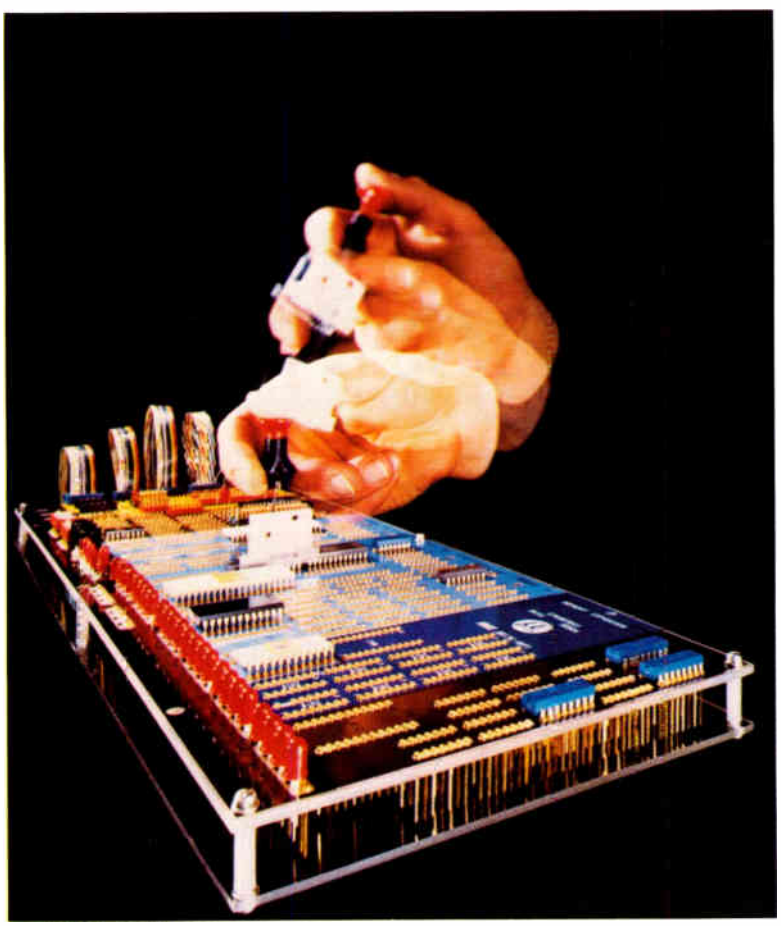

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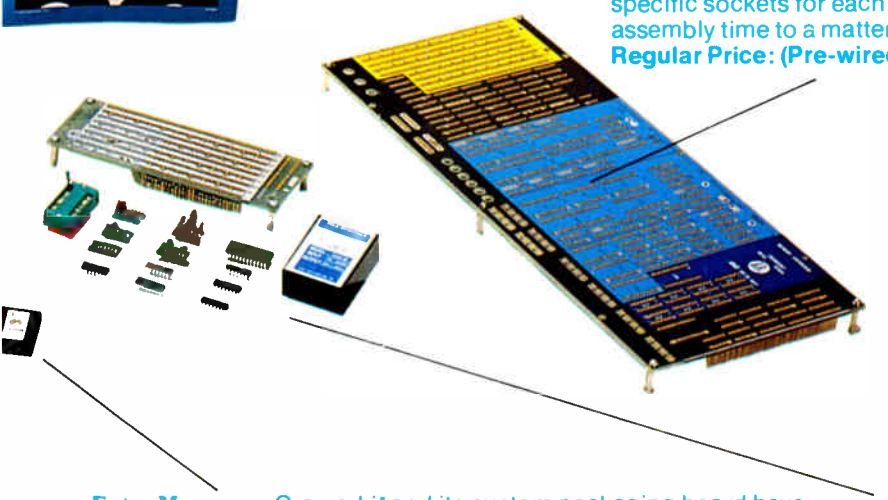

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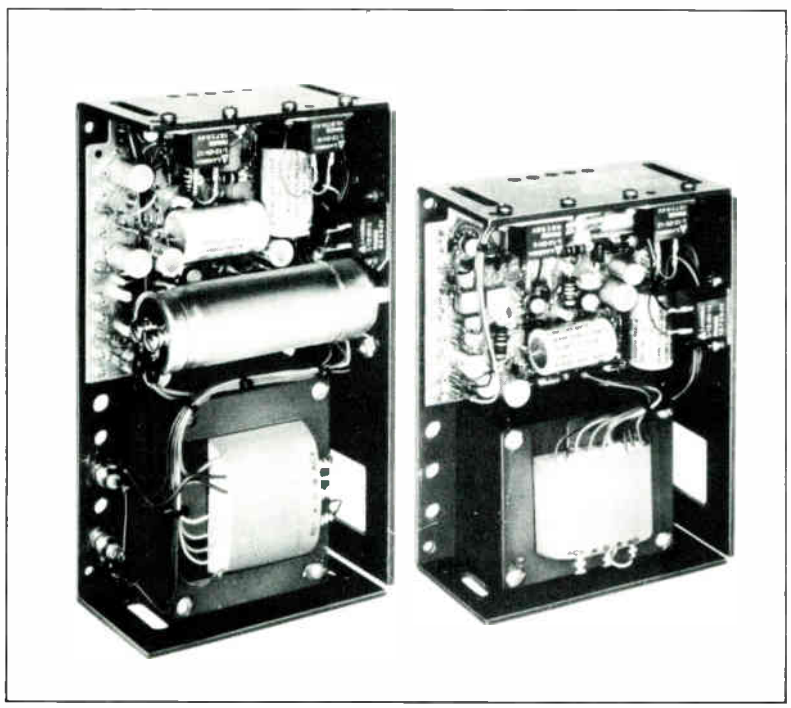

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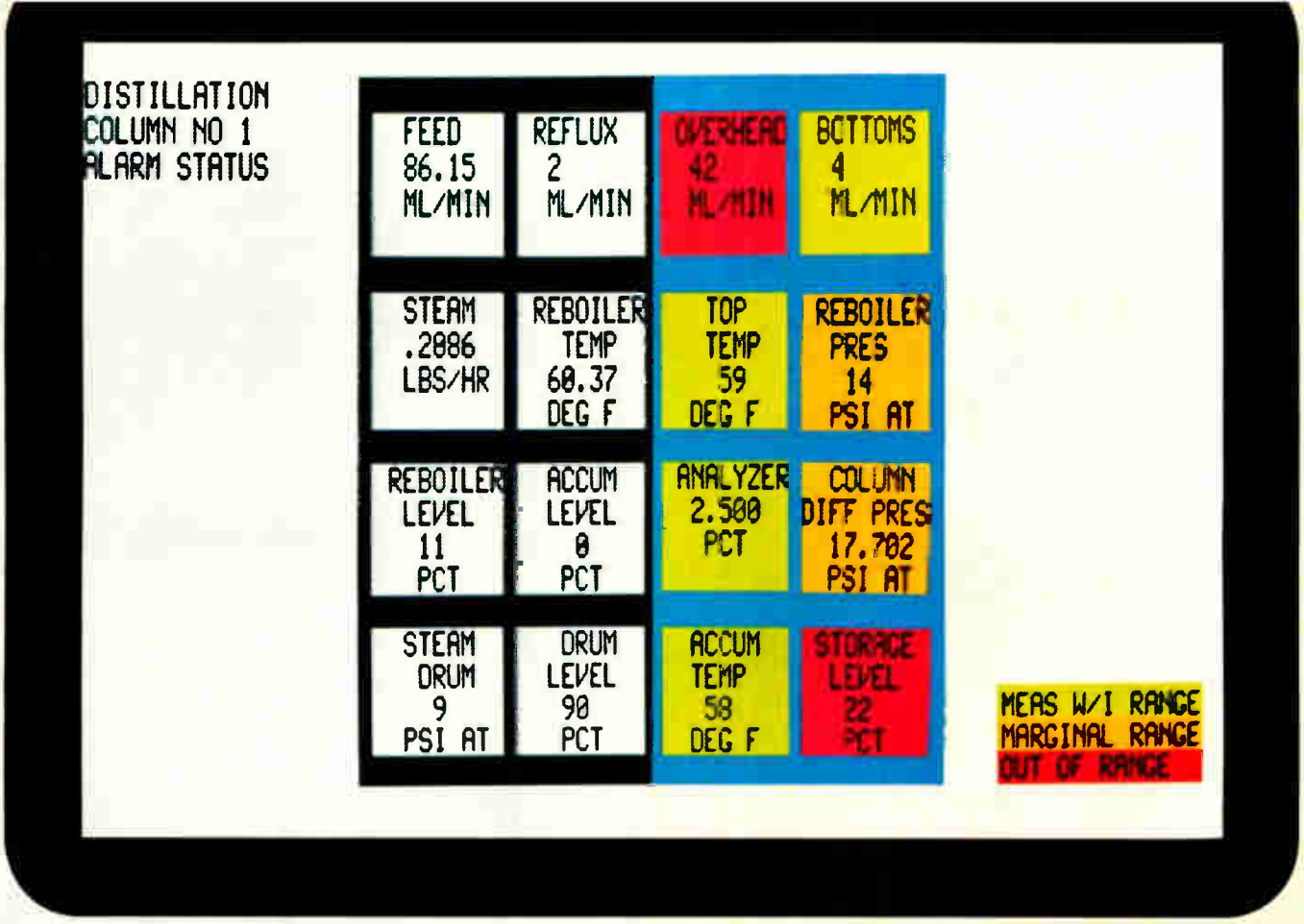

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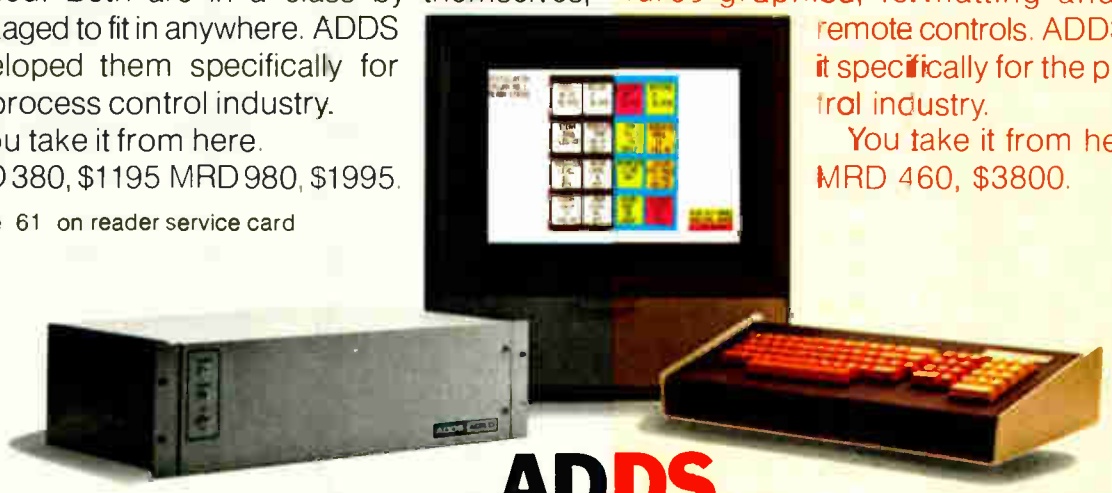

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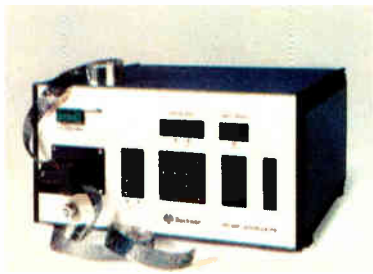

For your own computer, you can purchase our assembly/simulation programs in Fortran IV, or you can use them via time-sharing networks.

But computer or not, the design aids we think you'll use most are our Assemulators—microcomputers equipped with our assembly/simulation programs.

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there with system your microcomputer development.

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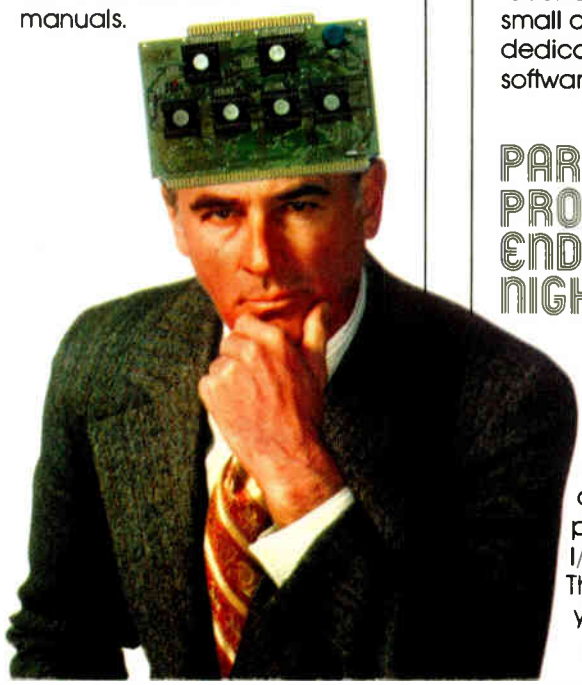

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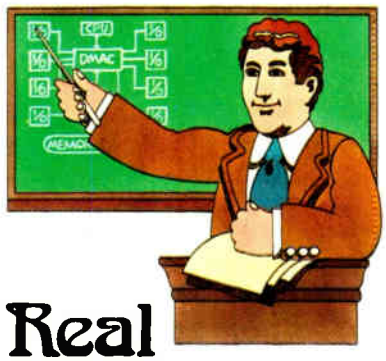

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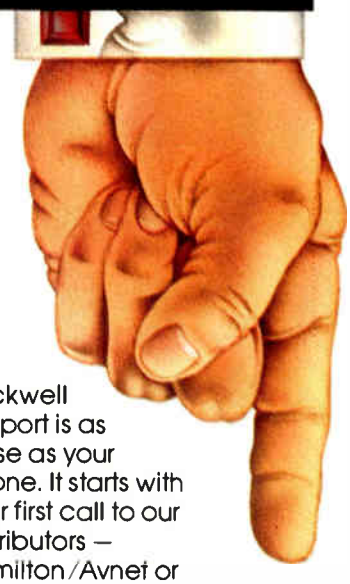

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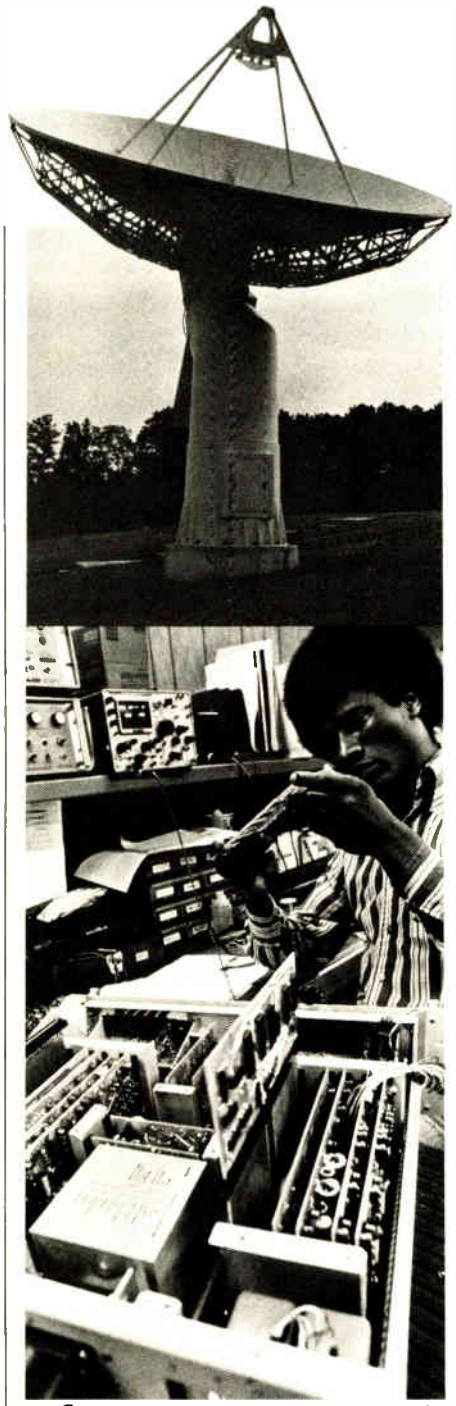

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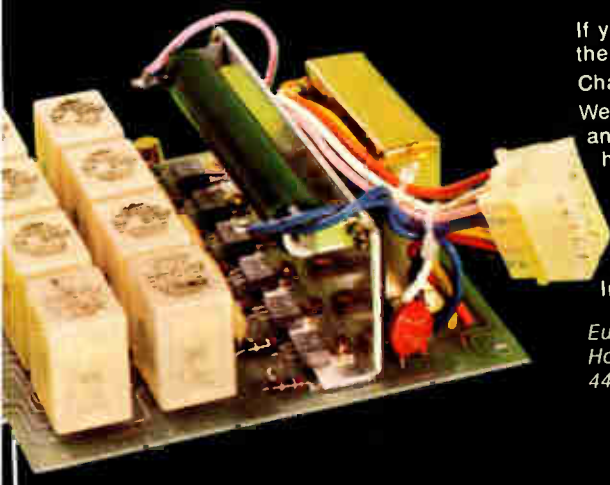

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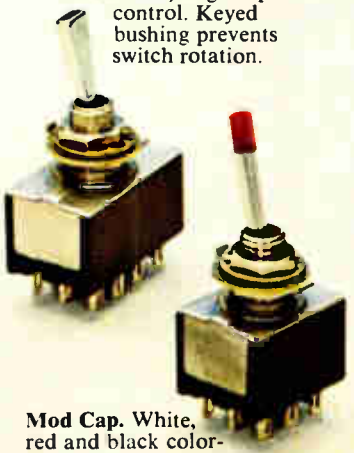
Flat Lever. Designed for comfortable, finger-tip control. Keyed bushing prevents switch rotation.



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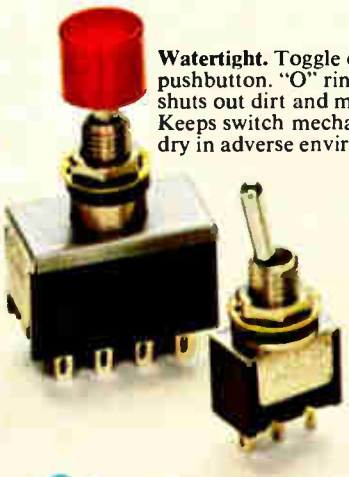

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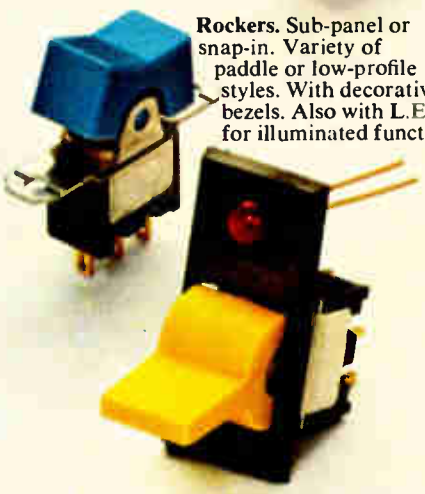

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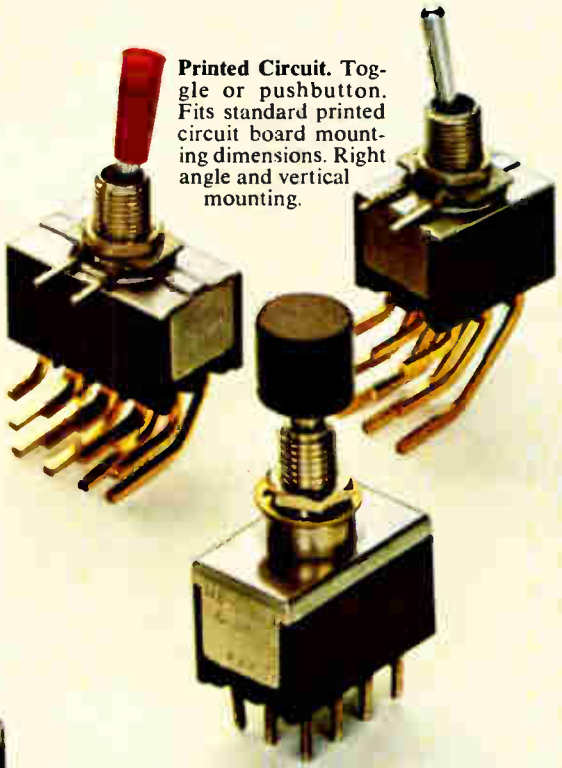
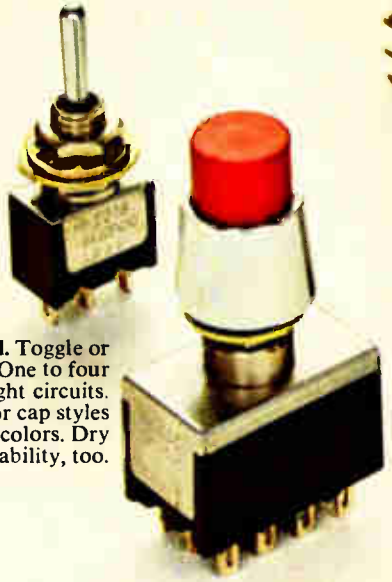


Standard. Toggle or pushbutton. One to four poles. Eight circuits. Two decorator cap styles in a variety of colors. Dry circuit capability, too.



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Circle 67 on reader service card

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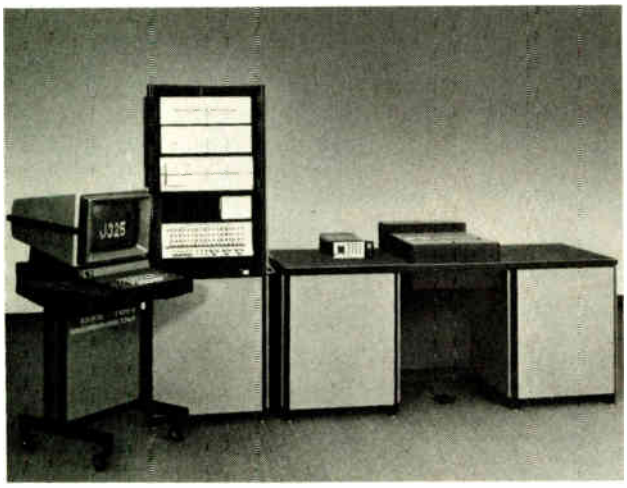

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F-111 becoming electronics platform

Grumman is building tactical jamming craft, designated EF-111A; Air Force's target cost is $5.4 million each for 40 airplanes

by Ron Schneiderman, New York bureau manager

"The old adage that electronics doesn't kill is definitely not true today," insists Col. James L. McKenna, the articulate 41-year-old officer whose job is to manage the development of the EF-111A tactical jamming plane for the Air Force. "Southeast Asia and the Israeli losses in 1973 proved to us that electronics does kill by minimizing the effectiveness of a strike force," he points out.

When operational (that date is classified information), it will be the Air Force's advanced electronic-countermeasures aircraft. It will take the place of the EB-66, which dates back to the mid-1950s and which was retired from the Air Force's active inventory in December 1974.

"The Air Force," says McKenna, "needs a tactical weapons-jamming system that could restore the element of surprise to our forces. We want as modern a jamming system as possible."

McKenna says the Air Force has picked the F-111 for the mission for several reasons. First of all, the plane's speeds—from subsonic to supersonic—cover the entire range of current and planned future attack aircraft.

What's more, it can be refueled in midair and is heavy and spacious enough to lug up to three tons of electronic equipment without major airframe modifications. Equally important, the F-111 can loiter over target areas for long periods or fly long-range missions, and its terrain-following radar allows it to hug the earth's contours automatically, day or night, to slip beneath enemy radar defenses and minimize detection.

Navy experience. The job of turning F-111s into EF-111As has been turned over to Grumman Aerospace Corp. in Bethpage, on New York's Long Island. So far, Grumman has received $42 million—the first major Air Force contract awarded to a company that is known as a builder of Navy aircraft—to modify two F-111 fighter-bombers and turn them into airborne electronic-countermeasures platforms.

Grumman is now taking its two prototype EF-111As through the early ground- and flight-test process. Mission-capability flight tests are scheduled for early next year. Those tests, in turn, could lead to a production-modification contract for a total of 40 aircraft at a design-to-cost objective of $5.4 million for each fly-away copy. "We're on schedule on cost and ahead on technical achievements," enthuses McKenna. That cost figure is in fiscal 1973 dollars.

But why not use the Navy's EA6B, which was also developed by

Jammer. Restoring an electronic-countermeasures aircraft to the Air Force ranks is the mission of the EF-111A, which will not only succeed the EB-66 but will significantly expand on the capabilities of the older plane.

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Announcing the 1-chip COSMAC CPU and the 4-chip CMOS system.

Now, a CMOS system that really delivers the promise of the microprocessor. It's the expanded RCA 1800 family with CDP1802, our new one-chip COSMAC CPU. And it gives you an unsurpassed combination of flexibility, performance and cost effectiveness.

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For all these reasons, we believe no other microprocessor matches the RCA 1800 for system cost effectiveness. What's more, you can get the whole system from us: CPU, ROM, RAM, I/O. Everything you need including complete design support. From the first house in CMOS.

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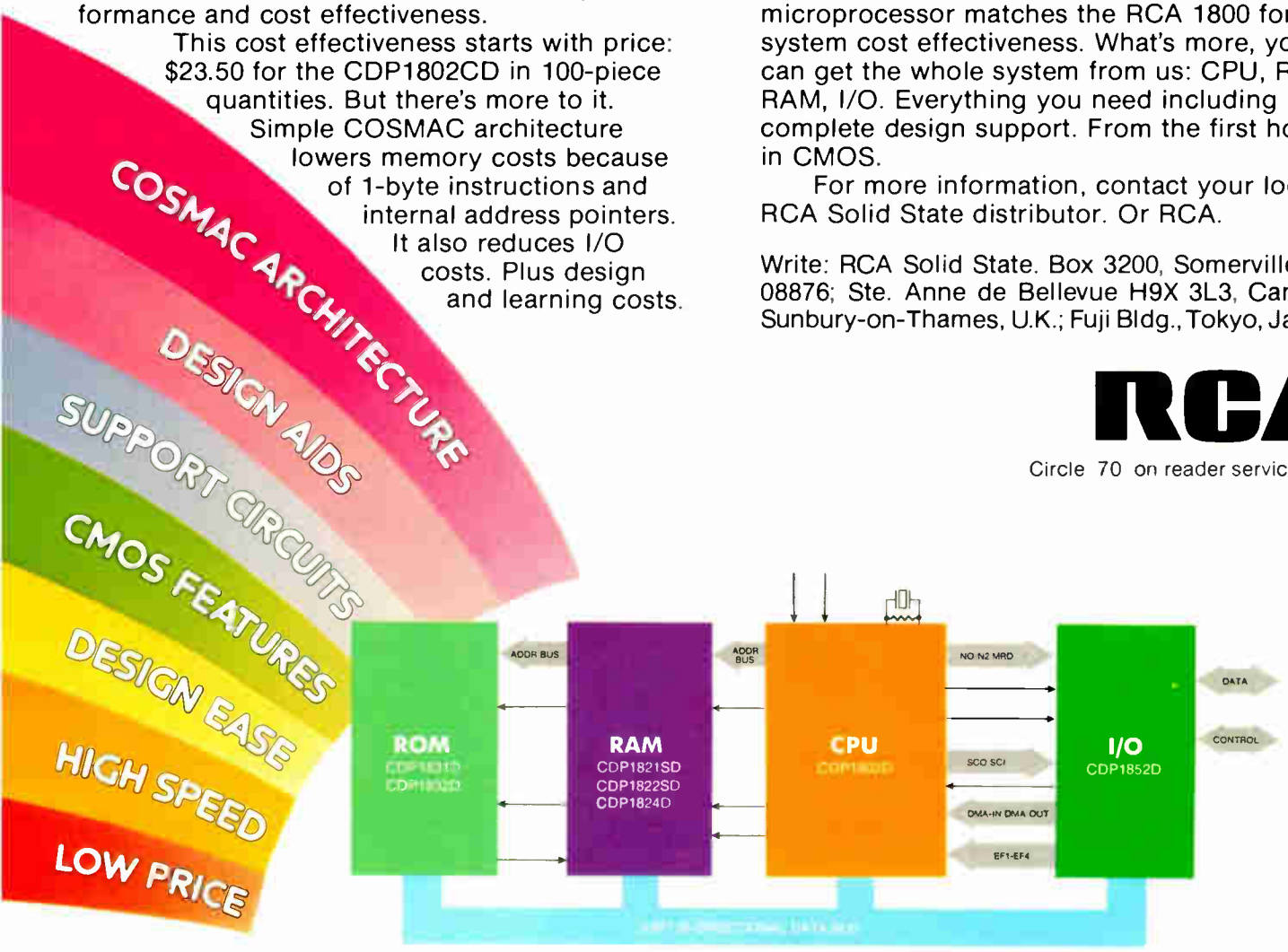
RCA

Circle 70 on reader service card



RCA 1800. The full spectrum in one low cost system.

Grumman, and is currently the only operational electronic-countermeasures aircraft? The answer is simple: the Navy and Air Force planes have different basic missions. "Air Force missions are certainly different than the Navy's," explains McKenna. "The Navy's mission is around the ship and to the shoreline to protect the fleet. The Air Force mission is overland; the geometry and power and tactics are much different. We need a lot more flexibility, particularly when it comes to speed."

McKenna adds, however, "We're endeavoring to use any prior investment by any service for the EF-111A. For example, we are modifying the AN/ALQ-99 [the jamming system developed by Grumman some 10 years ago for the EA6B] extensively for our jamming mission." The EF-111A design team has also managed to use a display processor from the Army's AH-1 Cobra attack helicopter, as well as an aircraft terminal threat-warning system and self-protection subsystems, which were previously used by the Air Force.

Improvements. McKenna, who has BS degrees in chemical and mechanical engineering and master's degrees in industrial engineering and business administration, considers the transmitter/exciter portions of the aircraft the major improvement over the equipment that flies on the EA6B.

"We have developed a multiband exciter for generating the carrier frequency in the transmitters." However, radio signals at watt-level power will be amplified "much higher," and one exciter will service the needs of any of six different transmission bands.

However, whereas the EA6B has two transmitters and one exciter housed in each of 4 wing-mounted pods, in the EF-111A, they are packaged in an aerodynamically "clean" weapons-bay radome beneath the fuselage. The number of EF-111A jammers is classified information.

In the EF-111A, each exciter serves several transmitters at different preprogramed or randomly selected frequencies. There is a certain redundancy among them; the mission commander can select the frequencies as the day's mission requires.

Display. The main display, a 9-by-11-inch cathode-ray tube with a computer-driven raster scan, will display such data as plots of different threat frequencies and their directions of arrival. Tom Street, who is Grumman's EF-111A program manager, points with pride to the new display system.

Says Street: "We used lots more switches in the EA6B. Now we use the digital display plus a keyboard with 10 numerical plus 10 special-function keys. The display for the EF-111A has actually been installed aboard an EA6B."

The total system has the ability to automatically detect and select the threats by separating the various radar signals. It then selects the corresponding response, choosing the appropriate exciters and transmitters to deter a threat automatically. However, the electronic-warfare officer has the opportunity of going completely "hands-on" and operating the system manually, adds McKenna.

Street says the electronic-warfare officer and maintenance crews have a high degree of built-in test capability in the EF-111A, and the Air Force is tailoring support equipment for the aircraft around hardware already available from the F-15, F-14, and EA6B

"In terms of maintainability, the modifications have been considered with the maintenance man in mind," notes Street. "For example, there are inspection meters on all transmitters and exciters to check out this equipment without actually having to remove them from the aircraft."

McKenna is confident that the EF-111A will fill the Air Force's tactical electronic-countermeasures needs for years to come. "There's room for expansion in the plane," he says. "And the design is modular so that as the threat evolves you don't have to throw away the equipment, as has been the case with so many other electronic-warfare systems." □

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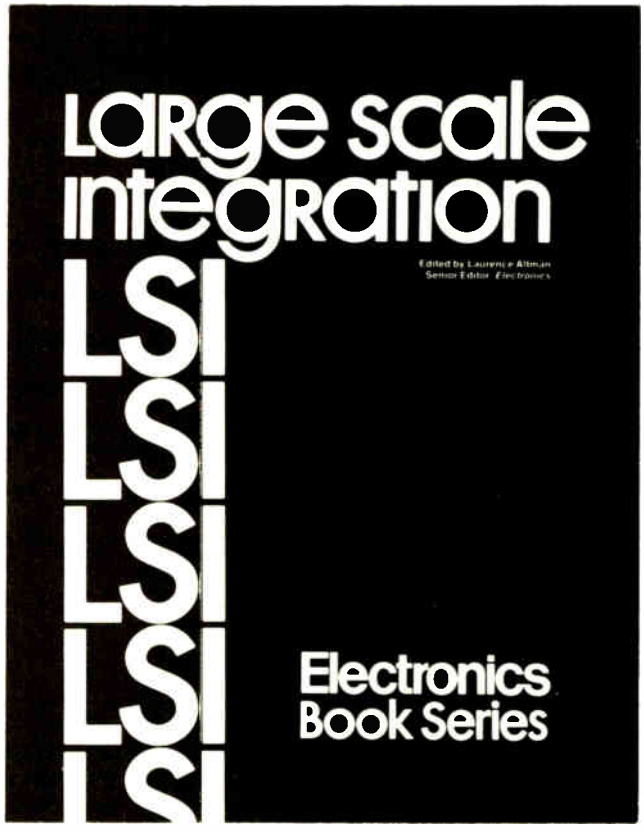

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Electronics IS THE SOURCE FOR BOOKS,TOO

Memories

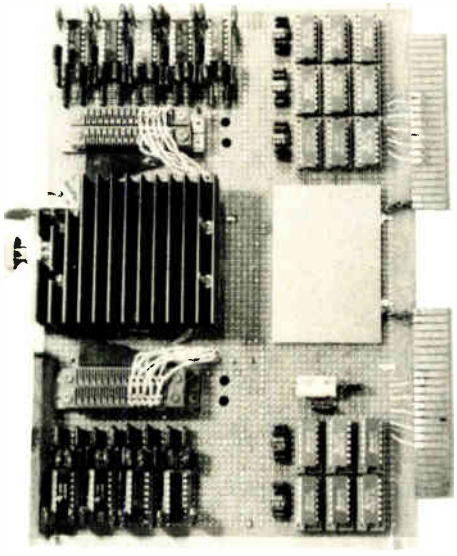
Bubbles making their way to market

Rockwell, TI, Bell, Hitachi say they'll have products within a year; IBM aims for denser devices

The question about bubble memories no longer is, "Will they ever work?" Instead, as the technology moves into products, potential customers are asking, "When can I get it?" The answer varies by manufacturer, but deliveries should begin within the next year.

Here's the outlook for some of the leading manufacturers:

- Typically, International Business Machines Corp. won't talk about product goals or timetables. However, "We have a very substantial involvement in magnetic bubbles," says Andrew H. Eschenfelder, consultant to IBM's director of research. "Our work is in the current state of the art, which to us means 3-5-micrometer bubbles, and it's also aimed at higher densities. We are placing relatively greater interest on higher densities than have some other companies."
- Rockwell International's Autonetics group in Anaheim, Calif., is hewing to the schedule it established several years ago for product development. Its Strategic Systems division—significantly, an operating division—has a NASA contract to develop a bubble recorder. It calls for a 25-million-bit prototype by 1977 and a 100-million-bit model qualified for space a year later.
- Texas Instruments Inc., which has started pilot production, is predicting that "equipment incorporating our bubbles will be out in the market, certainly no later than 1977," says C. Morris Chang, group vice president for semiconductor products. [*Electronics*, March 4, p. 32].
- Bell Laboratories, which has been evaluating two memory-system prototypes [*Electronics*, June 26, 1975, p. 68] has set up two pilot production lines at Western Electric's Reading, Pa., plant.
- In Japan, the two companies developing bubble-memory hardware for the government's pattern-information-processing project are Hitachi Ltd. and Nippon Electric Co.



From Japan. Hitachi's bubble memory is shown on board. Company says floppy disks and cassettes will dominate market.

A third, Fujitsu Ltd., is funding its own R&D, and Hitachi is also involved in a joint development project with Nippon Telegraph and Telephone Public Corp. Hitachi says it won't deliver memories before the end of the year, but Nippon Electric says that it has already developed a 16-kilobit chip.

Assessing market potential. With all this activity, the remaining question is, "What markets will reap the benefits of all this development activity?" The obvious answer is the mass memory, but how that market is divided depends on which manufacturer is doing the dividing.

Hitachi, for one, aimed at drums, but found that cassettes and floppy disks have 80% of the market. Now it's eyeing interchangeable modules that contain bubble chips, magnets, coils, and sense amplifiers. Bell has scheduled field trials next year for automatic message-recording equipment. Also bubbles may become disk-file replacements in the No. 4 electronic switching system.

At Texas Instruments, thinking along product lines is centered on storage to replace a cassette drive in a portable data terminal, as well as replacing disk drives. Bubble-memory speed falls between that of disk drives and semiconductor memories. The TI package holds 100,000 bits, which brings cost down to the range of 20 to 50 millicents per bit, says Chang.

Cost is also vital at IBM. Eschenfelder equates costs with density, saying that at a bubble diameter of 1 micrometer, magnetic bubbles can begin to realize their full potential.

Rockwell expects a major immediate application for bubble systems in mass memories for microprocessors. "We see a whole hierarchy of storage for CPUs and RAMs with bubbles behind them. Since bubbles are nonvolatile, a microprocessor doesn't need programable ROMs," says William C. Mavity, program-development manager. Rockwell expects to have some such developments later in the year. Mavity divides the bubble market into three parts: 300,000–3 million bits, up to 30 million bits, and up to 300 million bits. □

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Calculators

Next goal: nonvolatile memory

Manufacturers see long-term memory as their entrée to market for scientific machines priced at $90 to $200

by Bernard Cole, San Francisco bureau manager

As the price floor for personal calculators drops out of sight, semiconductor manufacturers and calculator makers are simply turning their attention toward penetrating and expanding another, not as competitive, segment of the market. The emphasis is shifting to the more price-stable and profitable lines of sophisticated scientific and programable calculators.

The marketing linchpin, say many executives, is to develop an inexpensive way of storing programs in hand-held calculators for days, months, or years after the battery power supply has been switched off. That means some kind of nonvolatile memory, using relatively new advances in semiconductor technology. Already planned for the 1976 Christmas season is a wide range of hand-held "scientific" calculators, which will be priced at $90 to $200 with nonvolatile memories.

The obstacles that needed to be overcome were formidable. The problem with the high-end programable and scientific hand-held calculators, with their n- or p-channel standard MOS memories, is that they need 40 to 100 program steps, each requiring 6 bits or more, for a memory capacity of 256 to 1,024 bits. For another thing, warns Robert Johnson, director of calculator design at National Semiconductor Corp., the 40 to 100 program steps are in perpetual jeopardy of being erased should the calculator be inadvertently switched off or the battery be discharged completely.

Portability, therefore, prevents the program storage from ever lasting longer than the battery. Another side effect, says Johnson, is that although the cost of additional semiconductor memory to allow storage of multiple programs is minimal, additional capability at present is of little value. "What's the use," he asks, "if it's all lost when the battery is turned off?"

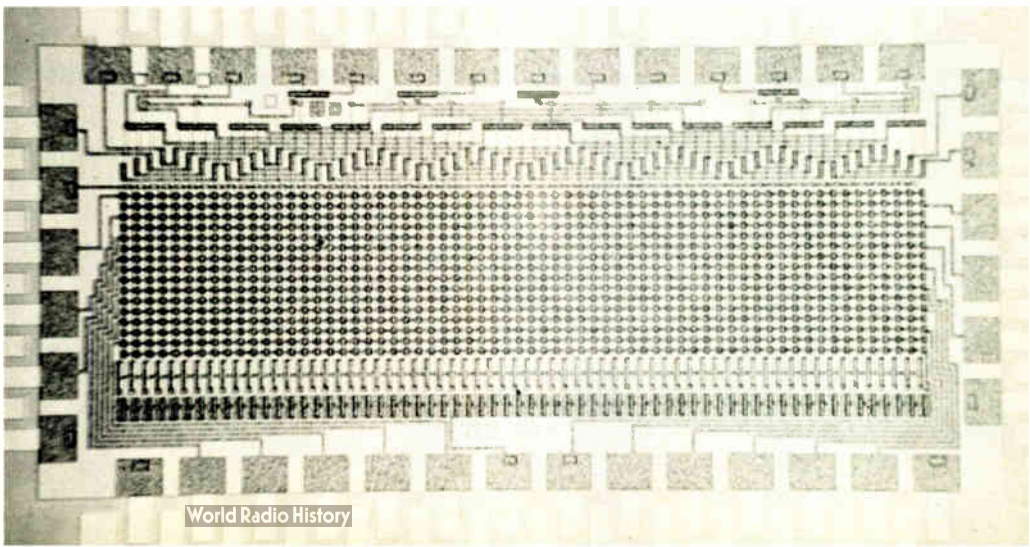
Technology to the rescue. The leading calculator and calculator-circuit makers are taking advantage of two relatively new advances in semiconductor memory technology—clocked static complementary-MOS random-access memories having standby modes that require only a few microamperes of current, and p-channel metal-nitride-oxide-semiconductor (MNOS) memories that retain information for years.

National Semiconductor, for one, will market a line of "nonvolatile-semiconductor-memory chips" by the end of the year—both for the Novus Scientific line of calculators and for customers, says Charles Sporck, president of the Santa Clara, Calif., manufacturer. And most of its competitors—among them, Texas Instruments, Rockwell International, Electronic Arrays Inc., American Microsystems Inc., and Hewlett-Packard Co.—are considering using nonvolatile semiconductor memory functions in their next round of sophisticated scientific calculators and chips.

"Two things are clearly needed at the high end," says Robert E. Hilchey, vice president and general manager of Rockwell International's Microelectronic Products division, which assembles and sells calculators. "One is calculators that draw less power and provide permanent storage. The other is more powerful memories that increase the functions."

Hilchey acknowledges that the company is "examining all alternatives"—including such approaches as C-MOS with trickle current and inherently nonvolatile MNOS chips—but implies that a decision has not yet been made.

Trade-offs. The choice, he says, will trade off cost, time, and availability. But Rockwell won't be the first to come up with these improve-



Pattern. Nonvolatile memories, typified by MNOS chip from Bell Labs, will be hallmark of new crop of scientific calculators.

ments, which he predicted will hit the market in strength by January 1977. "Although we'll probably take longer, our calculators will be proven," Hilchey says.

Actually, some measure of nonvolatility is being provided by Mostek Corp. in one of the cheapest calculators on the market. The company is still selling its Checkmaster with nonvolatile memory for $19.95. Nonvolatility is achieved by using metal-gate MOS with long, thin depletion loads to reduce the chip's power drain.

Small memory, large chip. Because the memory cells are relatively large, that technique works only in machines that don't require much memory, says Robert C. Farrier, the chip's designer. The IC, which Mostek plans to sell to other calculator makers, stores six digits and a sign when the unit is turned off, and when it is in the off position, it draws less than 25 microamperes to maintain the checking-account balance.

However, for the scientific calculator market, according to National Semiconductor's Johnson, "what we'll probably see on the marketplace first is a sort of pseudo-nonvolatility, using 1-k C-MOS RAMs." Until recently, not even this limited memory capability was possible because most of the C-MOS RAMs available are of the conventional type, which are constantly on and draw several hundred milliwatts [*Electronics*, Dec. 25, 1975 p. 90].

But new clocked static 1,024-bit RAMs, such as National's MM54C920/930 series, Intersil's IM6508/18 family, and AMI's S5101, have stand-by modes in the 75- to 100-microwatt range. This drain, says Johnson, is well within the natural self-discharge rate of nickel-cadmium batteries—about 2% to 3% a week.

National Semiconductor is already sampling several handheld scientific/programable calculator-chip sets, which in certain configurations feature pseudo-nonvolatility on a single 8–9.5-volt battery. One is of the HP-25 type and combines ROM, RAM, and ALU on one chip, and is capable of operating with up to four 1-k C-MOS RAMs of the MM54930 type with the addition of a RAM interface chip. The other is a more powerful two-chip set of the HP-55 type.

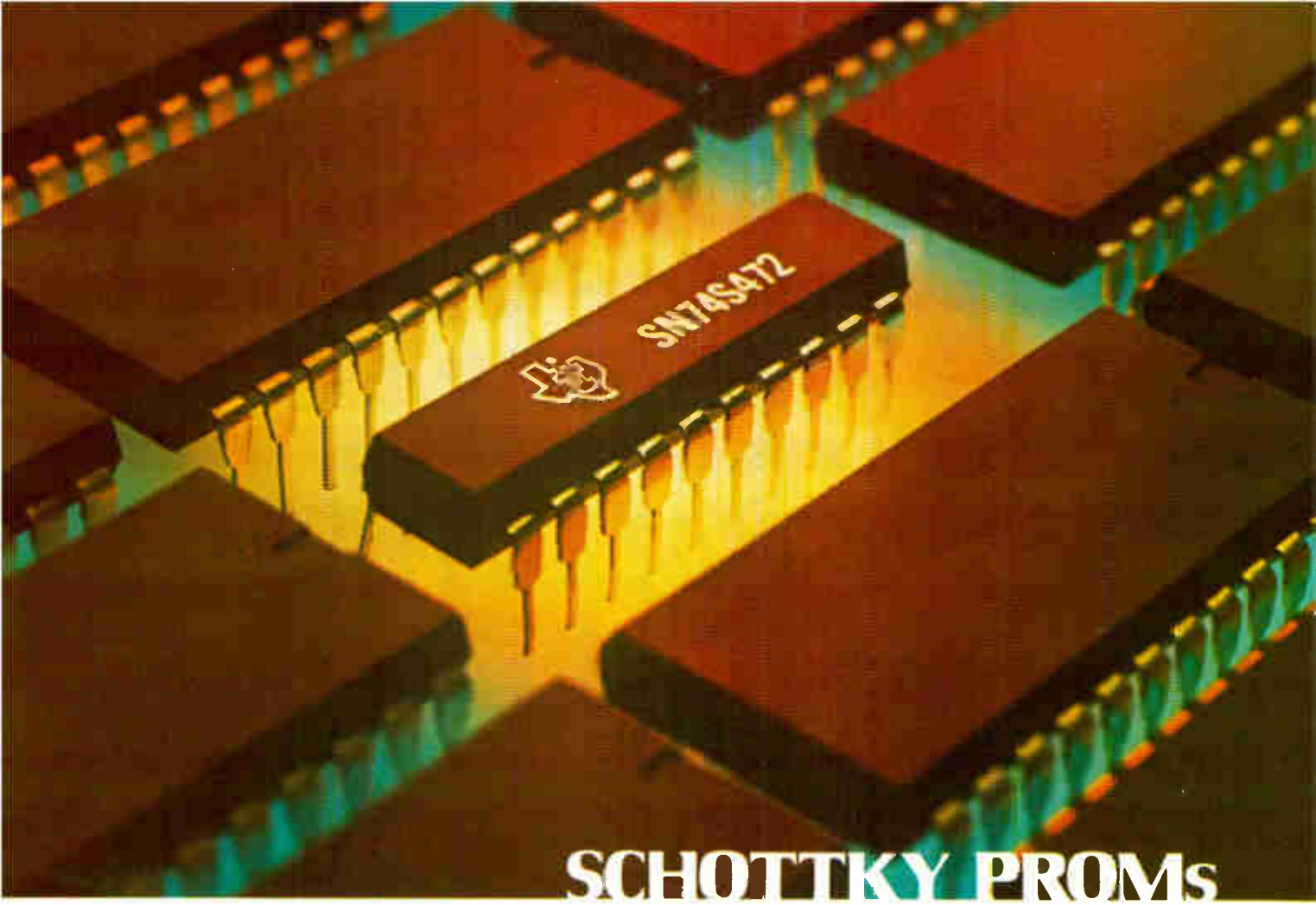
MNOS memories, similar in structure to conventional nitride-passivated p-MOS transistors except that the oxide layer is much thinner, offer true nonvolatility: once the threshold is set, data is stored without further consumption of power, the readout is nondestructive, and the data may be changed electrically.

Gaining speed. Although a number of companies—Nitron, General Instrument, Plessey, and Rockwell—offer MNOS memories, says Johnson, these devices haven't been fast enough and require a long write time, typically 10 milliseconds.

This situation is changing, says Richard Sirocka, manager of new-product planning at Nitron, who cites the company's recently introduced 256-bit MNOS fully decoded memory. Called the NCM 7040, its access time is about 500 nanoseconds, a read-cycle time is 2 μs, and write time is 1.5 to 2 ms. The company is also working on 1-kilobit versions with similar speeds, he says, "and it would be foolish to think that the others in the MNOS business aren't aiming in the same direction."

Japanese calculator makers are looking with interest at the development by Tokyo Shibaura Electric Co. of a 256-bit MNOS RAM that can retain data without power for at least one year, has a read-access time of 500 nanoseconds, a write-cycle time of less than 1 microsecond and a power consumption of 600 milliwatts. A 1,024-bit version of the device is expected before the year is year is out.

Japan's Sharp Corp., however, thinks that MNOS is too expensive. Instead, it is reportedly looking at ultra-low-current n-MOS for continuous battery operation. A company spokesman says that n-MOS is preferred over C-MOS because more functions can be squeezed into the same chip area. □



New 4K PROMs from Texas Instruments slice pc board area by 54%.

TI has placed its newest, high-complexity, 512-word by 8-bit PROMs into compact, 300-mil width, 20-pin dual-in-line packages. These new 4K PROMs are the latest addition to TI's space-saving, cost-effective Schottky PROM family. The result: Improved system density with savings as much as 54% in PC board area. A space-saving package is just one of the benefits TI offers.

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SN74S470N SN74S471N	256 W x 8 B, O-C, 20 Pins 256 W x 8 B, 3-S, 20 Pins	8.37 8.37
SN74S287N SN74S387N	256 W x 4 B, 3-S, 16 Pins 256 W x 4 B, O-C, 16 Pins	3.95 3.95
SN74S188N SN74S288N	32 W x 8 B, O-C, 16 Pins 32 W x 8 B, 3-S, 16 Pins	2.55 2.55
MILITARY – 55°C to 125°C (Ceramic)		
SN54S472J SN54S473J	512 W x 8 B, 3-S, 20 Pins 512 W x 8 B, O-C, 20 Pins	$37.20 37.20
SN54S470J SN54S471J	256 W x 8 B, O-C, 20 Pins 256 W x 8 B, 3-S, 20 Pins	16.74 16.74
SN54S287J SN54S387J	256 W x 4 B, 3-S, 16 Pins 256 W x 4 B, O-C, 16 Pins	7.88 7.88
SN54S188J SN54S288J	32 W x 8 B, O-C, 16 Pins 32 W x 8 B, 3-S, 16 Pins	5.61 5.61

Third, these new devices are made with TI's unique titanium-tungsten fuse links for fast, low-voltage, reliable programming. The same metallurgy used for over five years to fabricate all TI's patented Schottky-clamped PROMs and TTL. Thus, by using these new 4096-bit PROMs, you can upgrade old designs and improve new ones.

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Electronics abroad

Brazil puts clamp on imports

New regulation, designed to push local growth, requires cash value of item to be deposited in bank interest-free for a year

by William Hieronymus, McGraw-Hill World News

Tough and expensive controls placed on imported equipment and materials by the Brazilian government early last December are already beginning to be felt in many of the electronics industries. While it is still too early to gauge their ultimate effect, the controls have accelerated a trend to manufacture more components and materials in Brazil. And some electronics companies have trimmed their sales estimates.

Brazil, which suffered a $3.6 billion trade deficit in 1975, started imposing import controls last July. But the most drastic one came in December, when the government decreed that an interest-free deposit equal to 100% of the import value had to be made in the central bank for 360 days, without benefit of the country's famed monetary correction to offset inflation. Only a few products—none electronic—are exempt. At the same time, government agencies and government-controlled companies have been ordered to trim their imports by 25% in 1976, a measure that concerns equipment for government infrastructure programs.

Multinational firms who wish to keep a stake in Brazil's future have to figure out how to respond. "We will have either to license technology or do it ourselves," says a marketing executive for Rockwell International's Micro Electronic Device division. "It will cause big multinationals to integrate production internally." Rockwell, still weighing its own course, sells calculator chips, microprocessors, and digital-watch parts in Brazil.

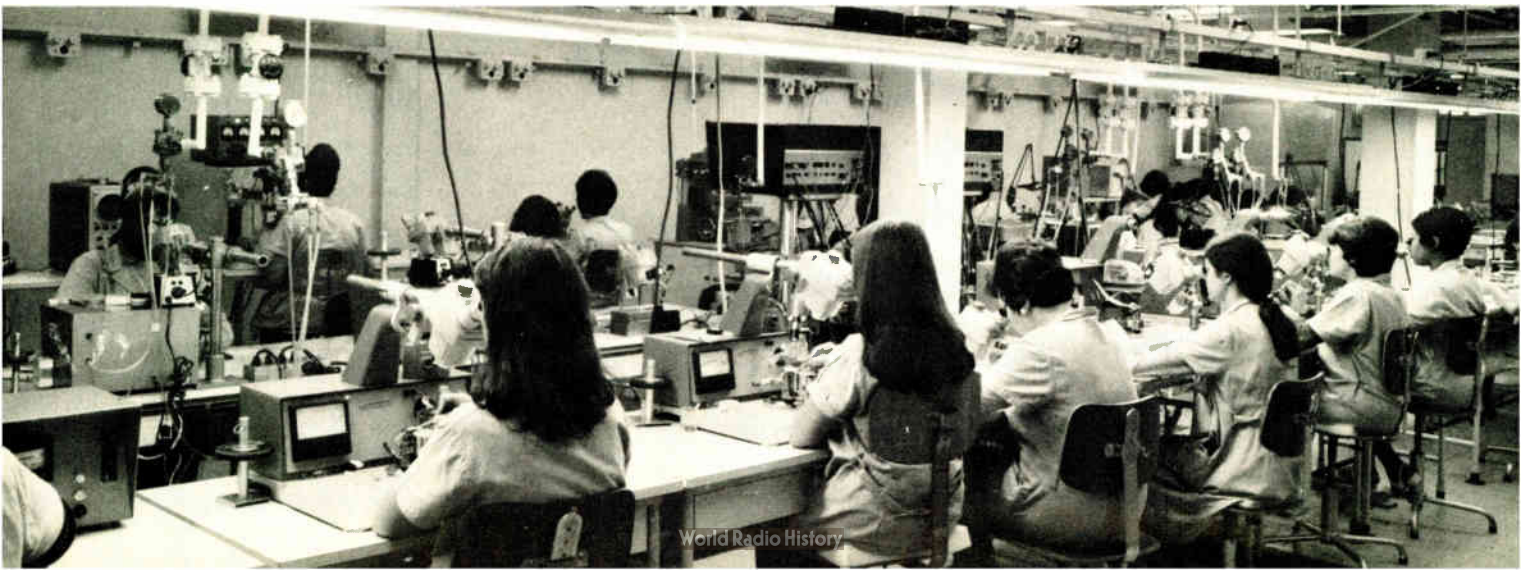
The executive says that Rockwell and other U. S. firms, saw such a move coming, "but didn't know it would be so severe." He estimates the bonding approach will undoubtedly raise the end, or real, price of components about 3½ times, typically from $3 to $11 on some common prices. He thinks the move will reach its goal of stimulating domestic electronics manufacturing, "but there will be lots of trouble for the first year."

Computers, too. Another new regulation, one that especially hurts the computer industry, requires that data-processing imports must also receive the authorization of Capre, the electronic data-processing coordination commission. "Capre is ruling on projects based on analyzing the end-user application," says an official of the Hewlett-Packard Co. Brazilian subsidiary. In other words, Capre must rule that the final application is essential for development of the country.

Foot-dragging. Noting that such government decisions are made especially slowly, a sales representative of International Business Machines Corp. laments, "I'm looking for a very bad year—it's impossible to get approval" within a reasonable time. The foot-dragging by bureaucrats is apparently an effort to discourage imports.

The deposit regulation and, perhaps more important, the government-spending cut will also affect producers of smaller systems and equipment. Ary de Atmeida Santos, instrument-sales manager for Hewlett-Packard in São Paulo, explains: "For the time being, the effect from

Line. Brazil's new import controls abruptly tipped the economic scale toward domestic production, as at Philco in São Paulo.



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All these measures have accelerated the trend to manufacture components and process materials locally. Says Frederick W. Gibbs, managing director of Standard Electrica SA, ITT's Brazilian subsidiary: "We have taken more interest in this than before. We were already trying to increase local content." Gibbs sums up effects of the import controls by saying, "we have forecasts ranging from quite pessimistic to quite optimistic."

At Burndy Corp. in Norwalk, Conn., Michael Cantor sees the new regulations as a double-edged sword. Cantor, area manager for Latin America and Asia, says, "It will make things difficult where you want to import items to test a new market segment. But, on the other hand, if you manufacture in Brazil then you have an advantage over the importer." Cantor adds that the Brazilian subsidiary, Burndy do Brasil in São Paulo, is taking a new look at the possibility of investing in tooling up to make components.

Perhaps the most valid observation about how the Brazilian industry is handling the new restrictions is offered by Riccardo Battistuzzi, general manager of Motorola's Brazilian operation, who says, "Brazilians have unusual flexibility to handle problems."

Perhaps that Brazilian trait of flexibility is behind what, at first glance, is a contradictory boom in consumer electronics, even though prices have increased. Some industry officials say people are buying because they fear prices will rise still more, which could lead to a sales dip later in the year. But some economists say that many Brazilians are merely settling for color TVs and other household items because inflation has priced the houses or cars they really want out of reach.

Sales continue. While prices of color-TV sets rose 15% to 18% between Nov. 1, 1975, and Feb. 1, 1976, the industry association estimates that 48,400 color sets were

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THE SURPRISING NEWCOMER. 1953A COUNTER. FLUKE®

Circle 80 for demonstration, circle 81 for literature

sold in January—up 84% from the year-earlier total of 26,300 sets. February color-television sales maintained the same pace, it is estimated.

"We've had to add a second shift for color," says Adalberto S. Machado, executive director of the Commercial Operations group at Philco Radio e Televisão Ltda., in São Paulo. Although Machado admits that a downturn may come later, he doesn't foresee any layoffs.

Telecommunications spending. Despite the directive to cut back spending, the effects may not be immediate in some important categories of government spending, such as telecommunications, where the government is placing major emphasis. Says ITT's Gibbs, "These are long-lead-time projects that are difficult to cut back." Nonetheless, Gibbs concedes that there may be some dip in his business in 1978 or 1979 as a result of the new restrictions. Meanwhile, the ITT unit has all of its capacity committed this year and hopes soon to have its 1977 capacity filled. But an official of GTE Telecommunicacoes worries that a decision to expand may be reversed because of the edict to government agencies to cut spending on imports.

At the same time, the telecommunications companies are preparing to go after new business for advanced stored-program-control telephone switching equipment. Last August, Quandt de Oliveira, minister of communications, said that future switching exchanges in Brazil would utilize semielectronic switching equipment, rather than electromechanical exchanges. Because 40% of this new business is reserved for "national" companies, or firms with at least 51% of their capital in Brazilian hands, international companies are busily looking for local partners in joint-venture companies.

L M Ericsson of Sweden and Nippon Electric Co. are now actively looking for partners. Already, Standard Electrica and a Brazilian company, Begano, have formed a joint-venture company called Seber Industria Electronica SA to produce advanced stored-program-control exchanges. □

LOGIC BOARD TESTING DOES NOT DEMAND SOFTWARE PROGRAMMERS, AND LOTS OF MONEY.

There is a foolish notion in logic board test circles that says, "Plan on spending all the budget you have, plus a lot more, to get logic board testing results."

What nonsense.

Why, that's as bad as the arguments for testing in the end product. Is there no middle ground? You know, a good testing system for a fair price.

Of course there is. And we built it.

It's our 3000 Series Logic Testers. The 3020A is a console for high-volume production applications. It comes complete with 128 pins for under $30,000*. The 3010A is a compact version for field service and low-volume production at less than half the price.

O.K. So why no high cost?

Most testers share one major shortcoming: the cost and complexity of programming. As logic boards become larger and more complex, test engineers anxiously reach for more computer power and more software.

It just isn't necessary.

The fact is that tediously developed, bit-by-bit sequences are now past history. Instead, we provide powerful groups of general-purpose sequences with various duty cycles and frequencies. Boards respond to them. Their mathematical qualities honor the constraints of your circuits and the laws of logic.

Specifically, the 3000 Series Testers have seven classes of signals. Over 350 unique bit streams and their complements are available to exercise the most complex boards.

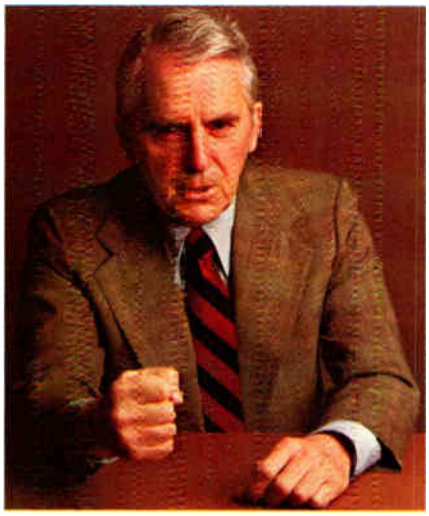
And, where a specific sequence is needed, it is easily added.

The test engineer doesn't program in the conventional sense. He simply develops a test plan which consists of selecting the appropriate stimulus algorithm for each input.

We've pre-programmed the CPU, simplified the peripherals, and eliminated 80% of the programming. That's what keeps the cost down.

The beautiful part is that test confidence ends up higher.

And fault isolation is just as practical as the price. It's hard to imagine any other tester making more common sense.



"Prove it."

Test program assignments and editing are made on-line by pushbutton. Program debugging is simple. Whenever a pin number is entered, the sequence assignment is displayed. Sequences can be changed simply by depressing the appropriate pushbutton.

Again, there are no assemblers or compilers to fuss with. Highly comprehensive programs are completed in hours, not days or weeks.

And once the test program is entered into memory, you can record it easily on a handy little magnetic credit card that looks exactly like those credit cards in your wallet. The programmed card will function interchangeably with the production Model 3020A, or the field service 3010A.

Maybe we've made our point.

You can get a tester that offers four million tests per second, test sequences to 40 million words, and programmable logic levels without subsidizing a computer center and staff of programmers.

We'll prove it to you in dollars and cents.

Write and ask for "The Economics of Logic Board Testing." Everything you need is there to get you into logic board testing. Economically, for a change.

For data out today, dial (415) 965-0350.
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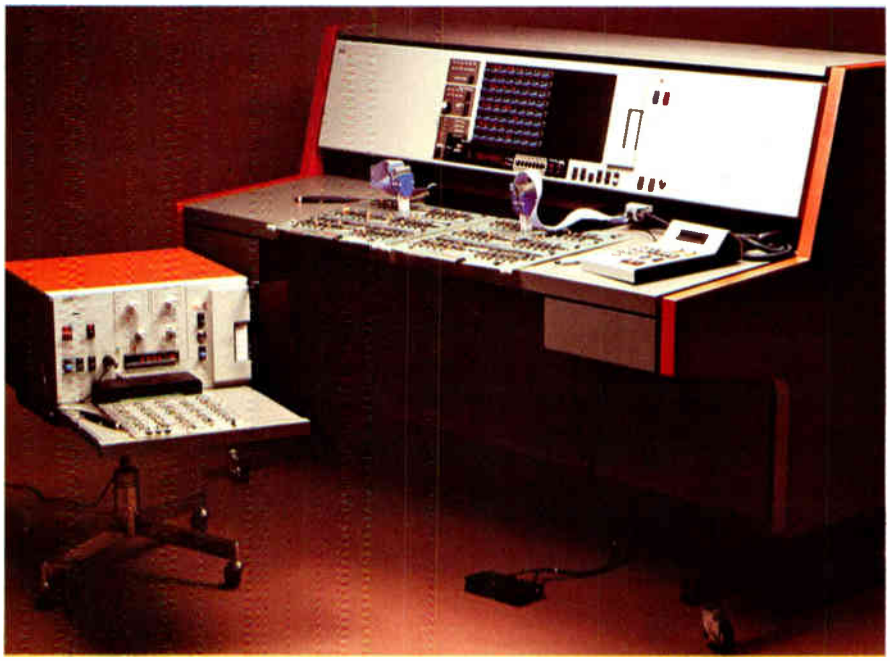


COMMON SENSE 3010A/3020A TESTERS.

FLUKE®

Circle 82 for demonstration, circle 83 for literature

21 YEARS OF REASONS TO LOOK HERE FOR PRECISION MEASUREMENT.

For over 21 years, we have not altered the integrity of our precision measurement line.

Our general instrument line is built to the same standards of quality.

Before you buy a DMM, counter, signal generator or any other general instrument, always take a look at a company's precision measurement line. There is a connection.

Ask about their experience in precision technology. Inquire into the extent of their precision measurement product line. Find out about their standards and traceability.

Then compare to what you see here.

"I wouldn't expect anything less than a long and distinguished history."

1955: Fluke introduces the world's first DC differential voltmeter.

Over 21 years ago, we began building differential voltmeters—in many instances, setting the standards for the industry. Here are three.

The 893A is an AC/DC differential voltmeter with DC accuracy of ±0.01% of input and AC accuracy of ±0.05% of input. There is infinite input impedance from 0 to ±1100 VDC. Resolution is 1 ppm of range.

The 895A DC differential voltmeter achieves an absolute accuracy of ±(25 parts per million of input + 1 ppm of range + 5 uv) from 0 to ±1100 VDC. Over the entire range from 0 to ±1100 VDC, the 895A offers infinite input impedance at null. A unique Fluke solid state, photo-chopper-stabilized 1100 VDC reference supply is calibrated against a zener EMF with state-of-the-art stability and temperature coefficient parameters. Due to the excellent stability of the zener supply, the overall stability of the 1100 VDC reference is better than 5 ppm peak-to-peak per hour, and 8 ppm peak-to-peak per day.

The 931B is a true RMS voltmeter designed for rapid measurements of AC waveforms regardless of their shape. Accuracies to ±0.05% of reading are obtained in a simple-to-operate portable instrument with a five-digit readout. As with all Fluke differential voltmeters, the 931B incorporates a "TVM" or conventional direct-reading mode for rapid indication of the RMS value of input. Frequency response in TVM mode is 2 Hz to 2 MHz. Response in the null or differential mode is 2 Hz to 1 MHz.

The 893A is $1445*, the 895A is $1745*, and the 931B is $1545*.

1957: Fluke introduces ultra-stable DC calibrator.

Two years after introducing differential voltmeters, we expanded our precision measurement line to include DC calibrators. Now, Fluke provides a full range of instruments for all DC calibration needs. Here are three.

The 343A is a seven-dial DC calibrator that provides parameters of stability, temperature, and response required by a wide range of applications. Its accuracy is ± 0.002% of setting with 0.1 ppm resolution.

The 382A operates as a combination ±0.01% voltage calibrator and ±0.02% current calibrator. It offers voltage outputs to 50 V and current capabilities to 2 A. Maximum power available is 100 W. The stability of the 382A is 25 ppm per 24 hours.

The Model 335D provides ±0.001% accuracy as both a DC voltage standard and a differential voltmeter. Accuracy and stability across the operating range is unmatched by any other commercial instrument available.

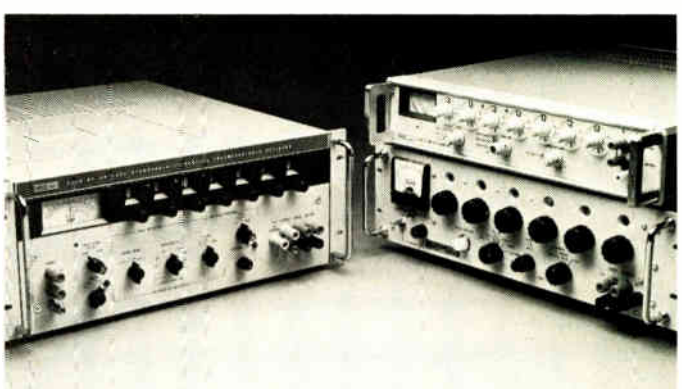
The 343A is $2195*, the 382A is $2245*, and the 335D is $3995*.

1963: Fluke introduces thermal transfer standard.

For 13 years now, we've been in the business of building high technology standards. Here are three standards representative of the Fluke line: 510A, an AC reference standard; 540B, a transfer standard; and 731B, a DC reference standard.

The 540B stands by itself in the industry. Nothing else this good is

893A, 931B, and 895A differential voltmeters.



335D, 343A, and 382A DC calibrators.

For information on the 343A circle 210
For demonstration on the 343A circle 211
For information on the 335D circle 212
For information on the 335D circle 213
For information on the 382A circle 214
For demonstration on the 382A circle 215
For information on the 5200A circle 216
For demonstration on the 5200A circle 217
For information on the 5205A circle 218
For demonstration on the 5205A circle 219
For information on the 7105A circle 220
For demonstration on the 7105A circle 221
For information on the 515A circle 222
For demonstration on the 515A circle 223
For information on the 760A circle 224

commercially available. The 540B is a thermal transfer unit for NBS traceable measurement and calibration of AC voltage and current. Measurement capability is 0.25 V to 1000 V rms AC over 14 ranges, with a frequency range from 5 Hz to 1 MHz. Basic AC to DC transfer accuracy is ±0.01% without the use of calibration curves or correction tables.

The 510A is a precision-fixed frequency AC voltage source suited to calibration or test applications. Outputs of 10 V rms and 10 mA with available frequencies from 50 Hz to 100 kHz at an accuracy of ±0.01%. Total harmonic distortion is less than 0.005% to 50 kHz. Short-term stability is 20 ppm pk-pk.

The 731B DC Transfer Standard is designed to give the calibration facility and standards lab a working standard for production testing. Standard cells are extremely sensitive, especially to shock, vibration and temperature change. Instead, the 731B can be hand-carried and subjected to severe environmental conditions,yet still provide transfer accuracies to a few ppm traceable to the delicate saturated cells. Transfer accuracy is 2 ppm. One year absolute accuracy is 30 ppm.

The 510A is $645*, the 540B is $1795*, and the 731B is $595*.

1964: Fluke introduces total function meter calibrator.

Today, in the field or in the lab, Fluke meter calibrators give you accuracy, flexibility and safety in a total function meter calibrator.

Take the 515A portable calibrator. This lightweight precision calibration source is ideal for on-site calibration of measuring instruments. With four DC voltage ranges, 3 AC ranges, resistance capability from 10Ω to 10 MΩ and a rechargeable battery pack, you can perform eight hours of field operations on battery power. And that's with 0.003% DC accuracy from 1 V to 100 V.

For lab use, look at Fluke's 760A meter calibrator. With its all-solid-state construction, the 760A offers direct percent-error readout (without computation tables),on a single range for AC and DC volts, amps and ohms functions. DC voltage accuracy for the 760A is a respectable ±0.05% + 25 microvolts from 1 mV to 1000 V.

Calibrate with Fluke. In the field (model 515A) for $2145*, or at the bench (model 760A) for $3745*.

1966: Fluke introduces DC calibration systems.

Eleven years after we introduced our first precision measurement instrument, we offered the Fluke-designed system.

Accuracy to 5 ppm is standard in this DC voltage and ratio calibration system, with resolution and ratio accuracy to 0.1 ppm.

In a functional, self-contained enclosure, the 7105A offers voltmeter and power supply calibration capability, a differential voltmeter, ratio calibrator and a null detector.

The system is self-calibrating, and is supplied with certificates of traceability to the NBS. The 7105A sells for $8995*.

1972: Fluke introduces AC calibration system.

We entered the market with a fully programmable AC calibration setup.

Together, the 5200A precision AC calibrator and the 5205A precision power amplifier can calibrate AC devices up to 1200 rms. Frequency range is DC to 1.2 MHz. DC output of 1600 volts is available (using 5205A as a stand-alone amplifier). Maximum output current is 200 mA and will drive a 1500 pF capacitance load. Long-term stability is 200 ppm/6 months, midband accuracy is 0.02% overall, and response is a fast 0.5 sec.

Both instruments are short-circuit proof, fully guarded and interlocked. Phase lock input and quadrature output are standard features.

The calibrators interface easily with almost any system. Field installable serial and parallel isolated programming options are available. The system sells for $8990*.

**U.S. price only.*

For data out today, dial our toll-free hotline, 800-426-0361.

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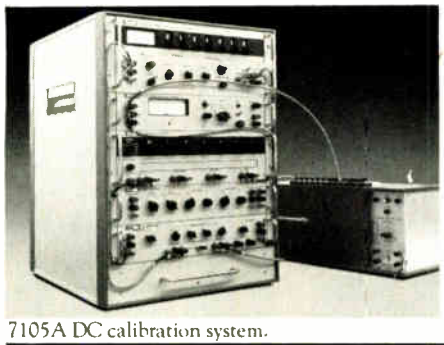
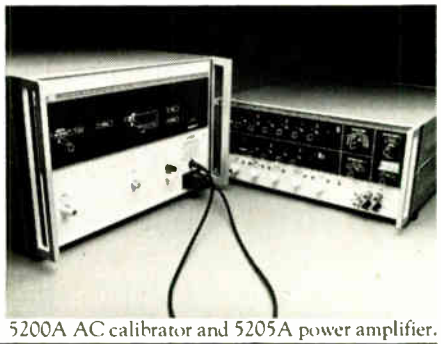
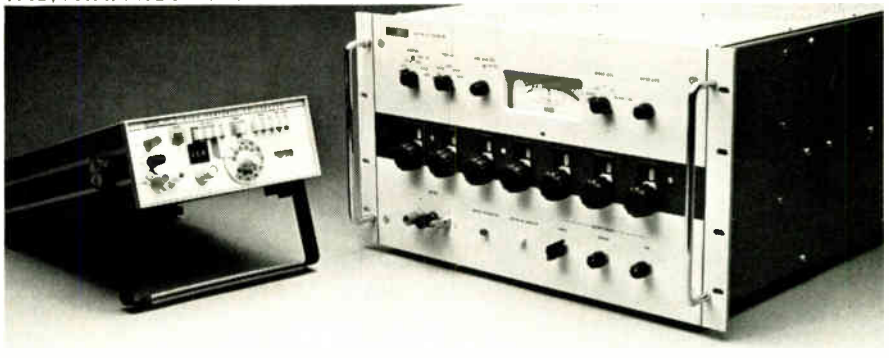


7105A DC calibration system.



5200A AC calibrator and 5205A power amplifier.

731B, 510A, 540B standards.

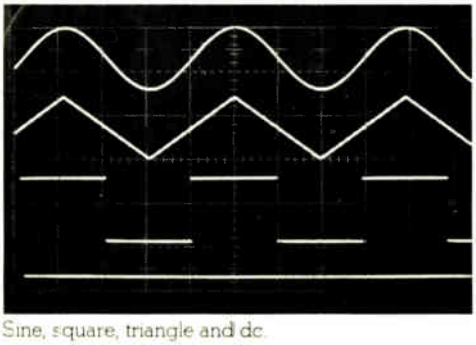


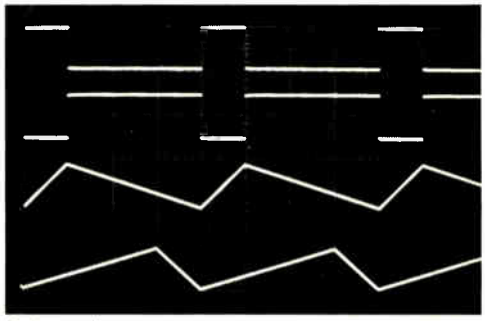
515A and 760A meter calibrators.

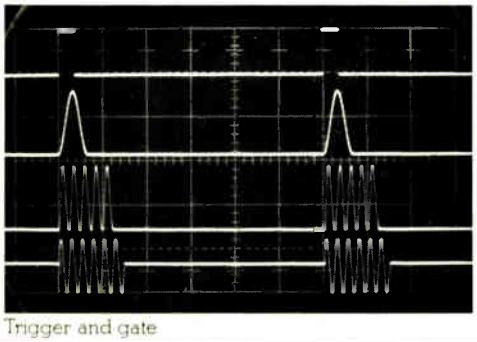
TEST AND MEASUREMENT INSTRUMENTATION. FLUKE®

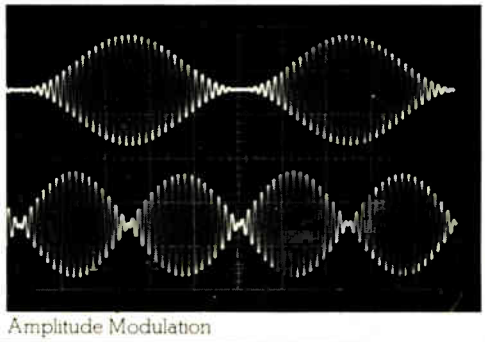
For demonstration on the 760A circle 225
For information on the 893A circle 226
For demonstration on the 893A circle 227
For information on the 931B circle 228
For demonstration on the 931B circle 229
For information on the 895A circle 230
For demonstration on the 895A circle 231
For information on the 540B circle 232
For demonstration on the 540B circle 233
For information on the 731B circle 234
For demonstration on the 731B circle 235
For information on the 510A circle 236
For demonstration on the 510A circle 237

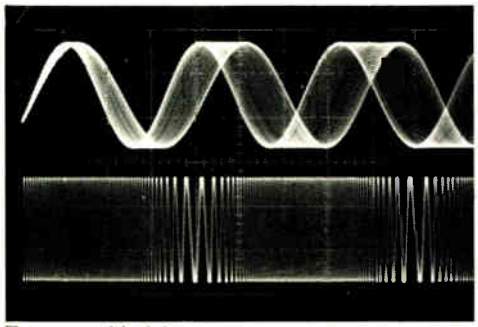
The Model 186 art gallery.

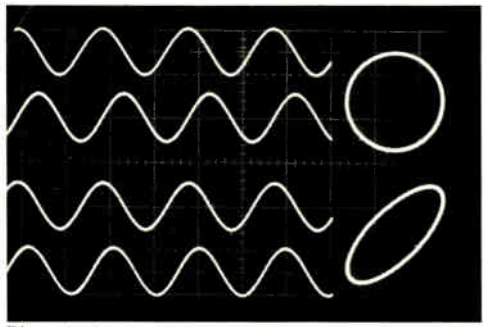

Sine, square, triangle and dc


Pulse and ramp

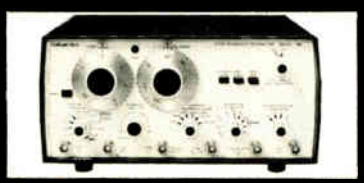

Trigger and gate


Amplitude Modulation


Frequency Modulation


Phase lock

There's a whole lot more to the Model 186 than just pretty pictures. Like its calibrated phase lock and built-in oscillator for 1 kHz AM/FM capabilities. It also has 30 v p-p output plus continuous, triggered and gated modes. And it's the only generator that gives you the combination of AM and phase lock.



The Model 186 has a frequency range of 0.0001 Hz to 5 MHz and sells for just $795.* Just circle our bingo number and we'll send you the complete picture.

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Circle 88 on reader service card

The industrial laser—a special tool for special needs

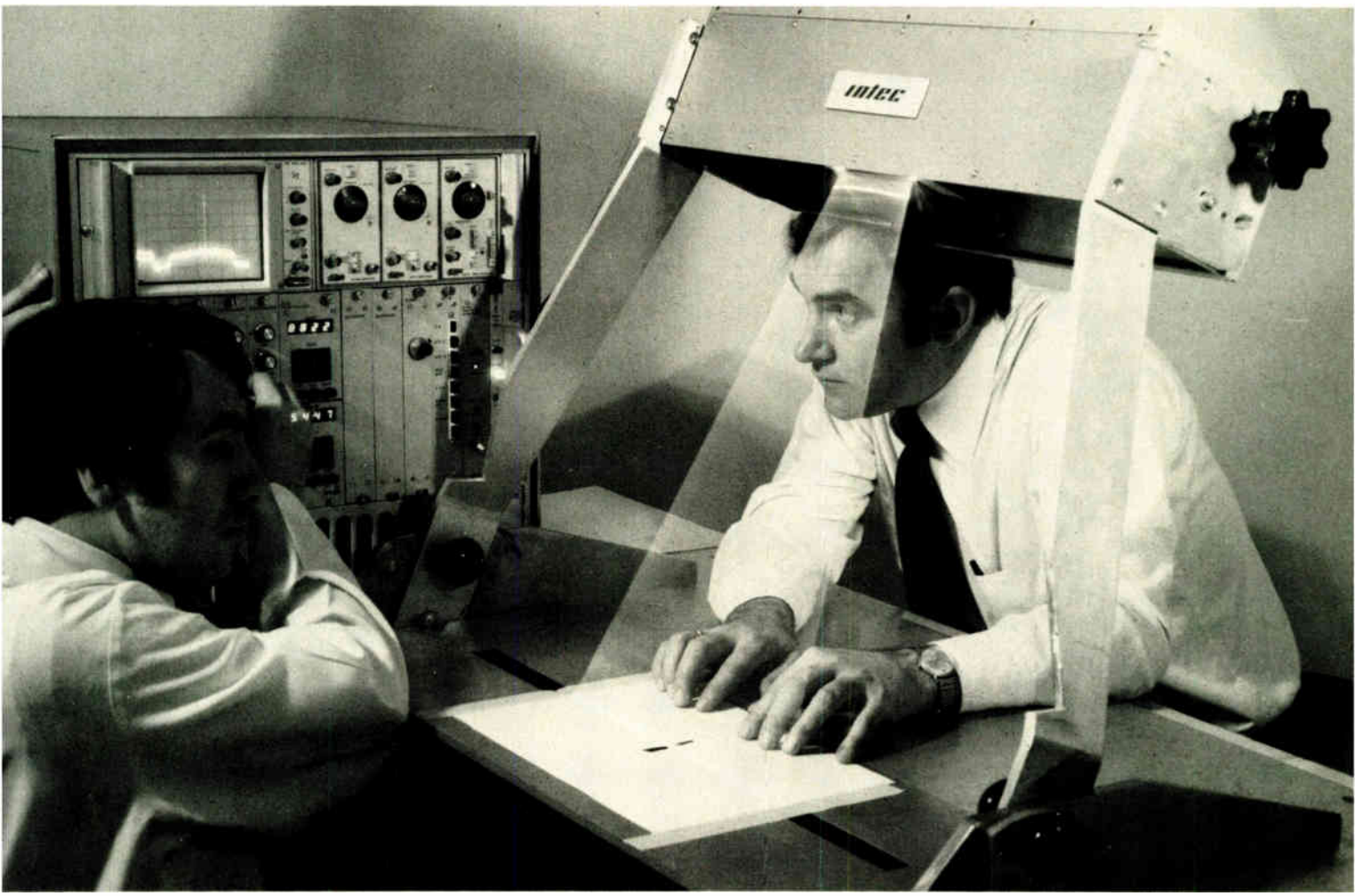
by Margaret A. Maas, *Industrial Editor*

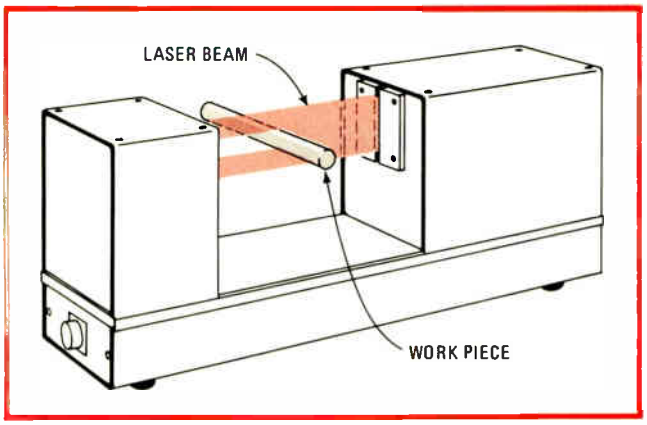
☐ Though still young as industrial technologies go, lasers have by now taken a firm hold of several market areas, even if they are not yet fulfilling all the proud predictions made at their birth. Low-power helium-neon devices are flourishing particularly in alignment and inspection applications, while high-power carbon-dioxide units are succeeding best in highly specialized metalworking jobs.

Actually, however, it is the unexpected development of the consumer laser market that has given the industrial laser its biggest recent boost. Point-of-sale terminals and the video disk, with their potentially high sales volumes, have stimulated the redesign of the 1–2-milliwatt helium-neon laser into a mass-producible low-priced, rugged unit that in power level and type is perfectly suited to many industrial uses.

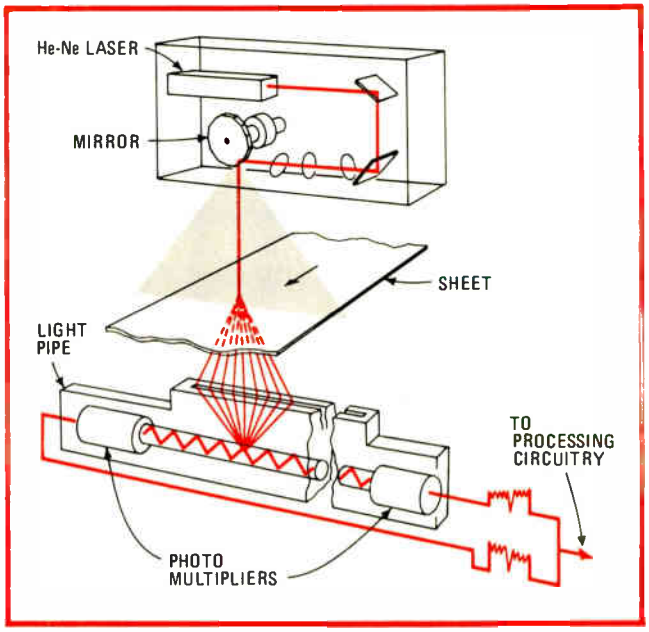
Over 50% of all industrial laser applications use the low-power He-Ne type, primarily because of its high reliability—its operating lifetime is by now 20,000 hours, up from a mere few thousand hours in 1970. Added to this is an ever dropping cost, which mass production has already driven down from close to $1,000 only five years ago to $100 today. (And if the video disk really takes off, it will quickly drop to the $10–20 range.)

Fault finder. Presence of imperfections scatters laser light passing through or reflecting off sheet. Intec Corp.'s system, capable of detecting flaws 0.005 inch across on sheet traveling 5,000 feet per minute, logs data on their number, size, shape, and location.





1. Measuring size. Beam of Techmet's Lasermike, deflected by rotating mirror, sweeps out vertical plane of light that's blocked by part moving down assembly line. Part size determines the length of time the beam is blocked. Resolution is typically ±0.005 inch.



2. Sheet inspection. In Intec system, 12-faceted rotating mirror sweeps reflected laser beam across moving sheet. Two photomultiplier tubes pick up light, and their summed output contains transients whose amplitude and duration indicate flaw size and shape.

Topping all this off is the appearance of second sources. The first truly mass-producible laser was the 1–2-mw model 136 from Spectra-Physics Inc., Mountain View, Calif., designed specifically for the video-disk market. It gained a second source when Coherent Radiation Inc., Palo Alto, Calif., introduced its plug-compatible version CR136 Eyelite in late 1975, and other manufacturers are rumored to soon be following suit.

"Prior to this lasers were not mechanically or electrically compatible," states Dick Tuhro, chief engineer, Computer Identics Corp., Westwood, Mass., a manufacturer of optical scanners for materials-handling and inventory-control systems. "They were not grossly different, but just enough that they weren't compatible—different diameters, different lengths, and different power supplies."

Improvements in reliability and operating life, abetted by decreasing costs and the move toward standardization, are all signs of a maturing technology. These are the characteristics that can place the laser on the threshold of an upswing in both types and numbers of industrial applications. And industry sources are optimistically anticipating a growth rate over the next five years at better than 20% per year.

Why lasers?

No one uses a laser unless his application requires one or more of the four major features of laser light: its monochromaticity, coherency, high intensity, and small divergence.

The single wavelength is easy to distinguish against widely varying background illumination. Because the waveform of the coherent light has a precisely definable frequency, phase, amplitude, and direction, it furnishes an accurate reference for many kinds of measurements. The beam's lack of spread over long distances means that it dissipates very little energy but concentrates almost all of it on its target.

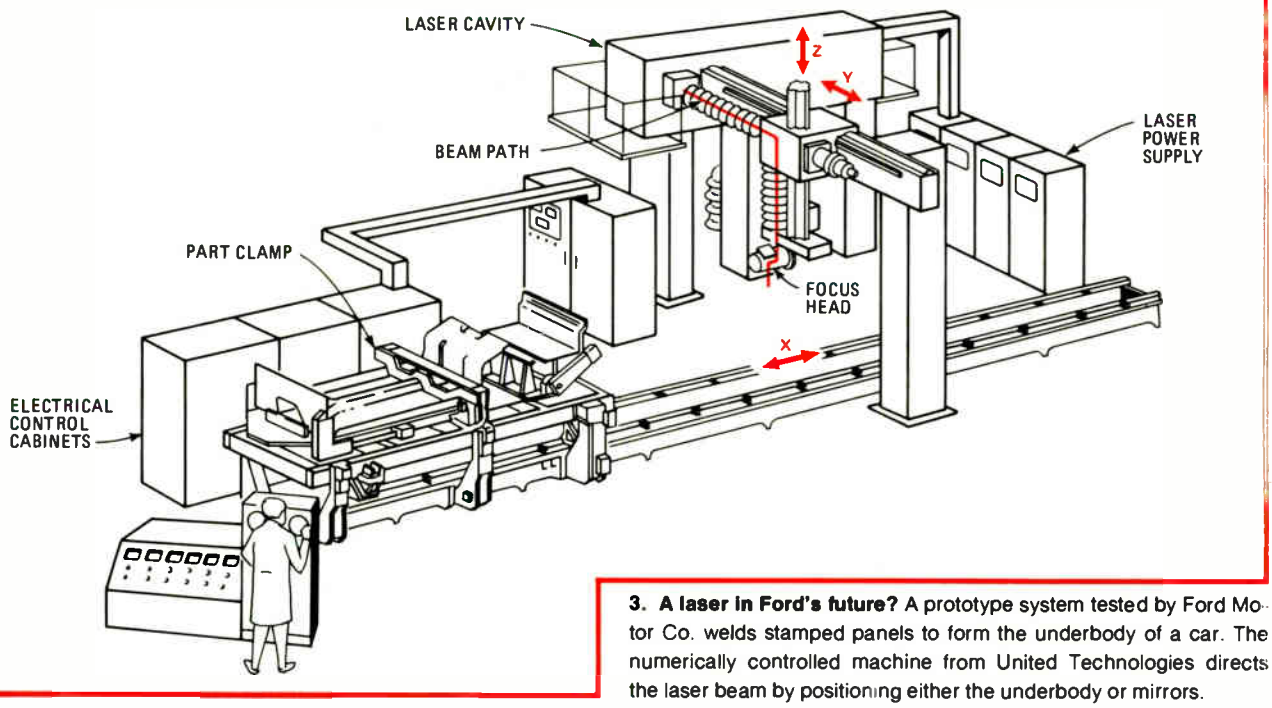
Because of this unique combination of properties, the laser has found applications in alignment, metrology, and inspection, as a welding, drilling, cutting, and heat-treatment tool, and in the area of printing and information handling. Interest is also high in the development of pollution-monitoring equipment, not to mention several relatively new areas with dazzling growth potential—laser-induced chemical reactions, for instance, and isotope separation.

Presently, though, the industrial market is relatively small, at least in dollar terms. The total laser market is estimated at about $140 million annually, most of which is spent by the military on low-volume, very expensive and ultra-high-power systems. In terms of numbers of lasers, however, the industrial market dominates, buying most lasers—roughly 6,000 per year—for use in surveying and alignment equipment.

For alignment applications, the laser provides a bright reference line that stays visible amid widely varying ambient light. This proves its worth in everything from lower-precision jobs such as laying sewers, leveling roads, and setting up the giant rotary kilns used in the cement industry to the ultraprecise task of machine-tool and turbine alignment.

A turbine generator, for instance, may consist of as many as six sections, each so heavy that it sags under its own weight. Alignment in this context means mounting the sections, not in a simple straight line but in the more complex catenary. The job normally required two or three optical instruments. But a new laser-based instrument developed by Westinghouse Electric Corp., Broomall, Pa., and Hamar Laser Instruments Inc., Wilton, Conn., can handle it by itself. The single reference beam of its 1-mw HeNe laser allows the inner and outer pressure shells and couplings of six 180-ft-long turbine generator units to be aligned simultaneously.

To establish the center line for the entire system, the laser is mounted on a rigid baseplate at the unit's governor end and beamed at a target mounted on a similar baseplate at the generator end. This target is a quad silicon-cell array which directly measures the position of



3. A laser in Ford's future? A prototype system tested by Ford Motor Co. welds stamped panels to form the underbody of a car. The numerically controlled machine from United Technologies directs the laser beam by positioning either the underbody or mirrors.

the laser beam in relation to the target center—a displacement that can be read off directly from the instrument's digital display. Identical targets are magnetically mounted concentrically with the bore at either end of every turbine-generator section. Then each section is offset from the laser center line by an amount established by a sag chart, which defines the ideal catenary.

The instrument can perform leveling as well. Besides the laser, it contains a pentaprism that can bend the beam 90° to form a vertical plumb. When the pentaprism rotates, the beam sweeps out a plane that is level to within ±0.00075 inch over a circle 50 feet in diameter.

Single units like turbines present only one kind of alignment problem. No one has, as yet, used lasers to tackle another kind—the alignment of many parallel cylinders or rolls, like the ones to be found in production machinery in paper and steel rolling mills. However, Hamar is considering developing a laser instrument that would project multiple parallel lines and help improve overall mill alignment. The payoff would be reduced wear of both rolls and bearings.

Beaming in on inspection

Used for inspection, lasers can sort, measure size and shape, and check for the presence of components, the completion of operations, and the absence of defects—all at very high speeds. Each year sees an increase in the number and variety of their applications in this area.

The reasons are obvious. Lasers have all the advantages of other optical instruments over mechanical gages—no part damage, no gage wear, no pressure-contact error, and faster, remote operation. But unlike other optical instruments, they have no focal-length problem because they produce collimated light. They also do better than their pneumatic and electronic counterparts when it comes to high accuracy, high resolution, or wide measurement range. They're not affected by radio-frequency interference or by optical interference if appropriate filters are used, and their output is compatible with photodiodes, TV cameras and other high-level output devices.

In fact, lasers have only a few limitations. They cannot deal with very small bores or concave molds, and dirty parts, covered with heavy oil, grinding fluid, and other debris, are impossible for them to measure to close tolerances. They're also no good in blind-access locations that are hard to illuminate.

Where the laser excels is in finding scratches, pits, breaks, burrs, slivers, and dents and in catching gross defects in parts before they jam the automatic assembly machinery. It can check whether parts are aligned relative to the assembly machine and whether they emerge properly assembled. It can sort parts by size or number of threads, and it can measure the diameter and width of extruded parts, the thickness of paper, the roughness of seals, the flatness of piston rings, the profile of razor blades, and the orientation of piston ring grooves.

In particular, because the laser has no focal-length problem, it can measure parts that are not precisely positioned, as they would have to be with other optical measurement systems. A product from Techmet, Dayton, Ohio, takes advantage of this characteristic to measure small objects passing by at high speeds, such as wire, textile fibers, nuts, and bolts.

Inside Techmet's Lasermike, a mirror rotating at constant speed deflects the beam of a 2-mW He-Ne laser so that it continuously sweeps out a vertical plane of light. For most of the sweep the light is blocked by the housing in which the laser and mirror are mounted. But for a short portion of the sweep, the light strikes a focusing lens and exits through an aperture in the housing (Fig. 1). This light travels to the opposite side of the instru-

4. Cutting to suit. Laser cutter (left) developed by Hughes Aircraft cuts the fabric for men's suits, one layer at a time, at the rate of 80,000 inches an hour. A similar system (top) is now being used by McDonnell Douglas to cut boron epoxy material for the F-15.

ment, where it enters a similar aperture and hits another lens, which focuses it onto a photodetector.

If an object passes perpendicularly through the beam during its sweep from top to bottom of the aperture, it will block the photodetector. Since the beam is sweeping at constant speed, the dimension of the object is directly proportional to the period during which the beam is blocked.

The synchronous motor that drives the mirror is powered by a frequency-divider circuit operating off a 45-megahertz clock. The same clock provides the timing pulses for measuring the on/off periods of the photodetector. Typically each clock pulse is equivalent to ±0.0005 inch, and the accumulated clock pulses are scaled and displayed as a five-digit representation of part dimension.

Autometrix, a division of Systems Research Laboratories Inc., Dayton, Ohio, uses the Lasermike as a component in many of its systems, most often for controlling processes where the manufacturer wants to conserve material. The systems accept very diverse products—fluorescent light bulbs, cigarette filters, automotive radiator hoses, and camera parts, for example—measure them, compare them to an ideal, and then regulate the production machinery accordingly.

Explains Dennis Swing, Autometrix manager: "Without accurate gaging, the manufacturer often has to make a part oversize to make sure it has sufficient coating or wall thickness to prevent failure. Shaving a couple of thousandths of an inch from a dimension can save a plastics extruder perhaps $30,000 to $50,000 per year. He can use the gaging measurement to regulate the tension and speed with which the material is pulled out of the extruder or to alter the speed at which material is fed into the die."

Checking for length

A similar requirement exists among consumers of sheet metal. If an automotive or can producer is buying a 10,000-foot coil of 60-inch-wide steel at some nominal thickness, and the coil is 1% short, then it yields 500 square feet less from which to stamp or draw parts. If they are small parts, the inventory can end up with sizeable shortages. Consequently, the major users of sheet metal like to check out the precise length of all incoming coils.

"Our laser-based equipment can measure these coils to within 0.1% accuracy, which is five times better than the previous technique," claims Ted W. Lasiewicz, president of M.E.A. Inc., Elk Grove Village, Ill. "Depending on sheet thickness and width and type of steel, we can save the consumer as much as $100 per 10,000-ft coil over previous gaging techniques. And some plants may use 10,000 coils per year."

Previously length was measured by a small wheel that rode along the edge of the steel sheet as it was coiled. Since this wheel could and did slip, accuracy at best was 0.5%. With the M.E.A. approach a 3-mW He-Ne laser located in front of the coil is beamed at a photodetector located behind the coil. Neutral position is when the laser beam is tangent to the coil.

The laser/detector assembly is mounted on a servo system. As the coil builds up, it begins to block the beam causing the detector to signal the servo system which, in turn, raises the assembly until it is again in the neutral position.

A built-in moiré-fringe interferometer, manufactured by Bausch & Lomb Inc., Rochester, N.Y., and accurate to 0.0005 inch, measures the servo system movement, which is equal to the increase in coil diameter. A microcomputer, built by Pro-Log Corp., Monterey, Calif., around an Intel 4040 microprocessor, samples this measurement 10 times every revolution of the coil and, on the basis of sheet thickness, calculates the sheet length averaged over 10 readings and outputs the data on a hard-copy printer.

Finding faults

While some inspection systems are concerned with dimensions, others are primarily concerned with flaws. A small defect in an inexpensive part can create a costly reject if that part ends up in an assembled item.

Intec Corp., Norwalk, Conn., employs relatively sophisticated signal analysis to perform 100% inspection of paper, plastic film, and other sheet products as they come off the production line. Intec's system can detect holes, pits, bubbles, scratches, and contaminants as small as 0.005 in. in sheets up to 15 ft wide and moving at 5,000 ft/minute. The system warns the operator, marks the sheet, calculates the number of flaws of each size that exist per unit length of sheet, and even performs on-line process control to correct the source of the problem by changing line speed, process temperature, or some other parameter. As Intec president Cole H. Baker observes, "Unlike human inspectors, the system never has to cope with tiredness, blinking, or errors in judgment."

Intec bases its design on a 5-mW He-Ne laser, using a 12-faceted mirror to deflect its beam (Fig. 2). As the mirror rotates, the beam scans the sheet 5,000 times per second—so fast that its light appears on an opaque sheet as a thin but solid line. Depending on whether the sheet is transparent or opaque, the light hitting it either passes through it or is reflected off it into a light pipe placed between two photomultiplier tubes.

As the beam scans across the sheet, the summed output of two photomultipliers remains relatively constant, apart from some slight variations caused by the material. (For example, a ripple would characterize the signal reflected by the orange-peel surface of some paint finishes.) But when light hits a defect, it scatters, creating a signal whose amplitude and width indicate the type and width of the flaw. Length of signal, and therefore length of the flaw, is determined by counting the number of times the beam scans the same flaw. To differentiate a new flaw from a continuation of one spotted on a previous pass, the defect position is compared with position data stored for several (typically four) preceding scans in a rotating shift register.

An Intel 8080 microprocessor assembles the incoming data, tabulates the data on flaw size and location, logs the results on a chart recorder, and in some cases automatically activates a cutter to remove the defect.

The plant operator can use the flaw data to detect problems in his production machinery. For example, the appearance of a ⅛-in. hole in the middle of the sheet at 9-ft intervals could indicate a burr on a particular roll.

The system is constructed of various processing modules that allow it to be customized for the particular material. For example, a blue-coated metal, which is defective when the shiny silver primer shows through, will produce an entirely different flaw signal from a transparent plastic sheet that has dark contaminant particles embedded in it. Thresholds must be established in advance for the particular thickness, color surface finish, texture, etc., of the material and these in turn are used to set filter bandwidths, gain settings, and so forth on the modules.

While Intec is tackling sheet inspection, another small Connecticut firm, Automation Systems Inc. in Bethel, is producing equipment for performing piece-part inspection at rates of 600 parts per minute. Its systems can spot missing parts, sort mixed parts, and detect surface and size flaws.

For most applications Automated Systems uses a 2-

Pollution, eyes, and lasers

The eye is much more vulnerable than the rest of the body to damage from a laser beam, because the retina is susceptible to much lower power levels. But if a laser is used to monitor pollution, the beam must be sprayed around outdoors, and it is impossible to guarantee that the light won't be reflected into people's eyes. At the power levels generally used, the beam is classified as a potential source of eye damage.

This problem has put a brake on many of the studies sponsored by the Environmental Protection Agency into the application of lasers to pollution monitoring. But an idea being tried out at Sanders Associates Inc., Nashua, N.H., may be a solution.

Sanders is developing a laser with an output wavelength in the infrared, 2-micrometer-and-above region. This would increase eye protection "by at least four orders of magnitude," says Charles Naiman, manager of the laser systems department, because "at this wavelength the light is absorbed by the water of the eye and never reaches the retina where it can do damage."

The Sanders device is an optically pumped solid-state crystalline laser. Holmium is the active ion acting in an yttrium-lithium-fluoride crystal ($YLiF_4$), which can be pulsed at rates ranging from 10 hertz to 5 kilohertz. To tune it to the different absorption lines of pollutants such as vinyl chloride, ammonia, ethylene, and other chemicals, it would be used with a parametric oscillator, a nonlinear material that can produce different wavelengths from the laser's single wavelength.

5. A graphic example. Xerox Telecopier 200 reads outgoing information and records incoming data with a He-Ne laser at twice the speed of the laserless model. Facsimile equipment is but one of many potential applications in graphics for lasers.

mW He-Ne laser with its beam divided into two by a beam splitter. One serves merely as an optical limit switch, which is tripped by the incoming part to start the inspection cycle. The second beam is deflected by a rotating mirror, so that it scans the parts and is reflected into an on-axis optical detector.

When the object under inspection has uniform characteristics, the detector will produce a static dc level. If the object is misaligned with respect to the laser, the detector merely produces a sine wave that is some harmonic of the scan frequency caused by the beam traversing on and off the part.

But if a defect or surface discontinuity exists, the output contains a transient signal where amplitude and frequency are a function of scan velocity and defect size. After analyzing the signal's polarity and pulse duration and amplitude and comparing them with thresholds established by data gathered on normal and defective parts, the system either accepts or rejects the item. The selection criteria may be part size, surface condition, or the absence or presence of some characteristic such as threads. If the part is defective, the system usually actuates an air jet to eject it from the production line.

The system is being used to examine the inside of nuts to make certain they had been threaded and to check nut blanks before tapping to make sure they have been drilled. It can distinguish between two nuts with slightly different numbers of threads, examine bearing races for flaws, or reject parts slightly longer or shorter than they should be.

Though the laser has been touted for some years as the wave of the future in welding, drilling, and cutting in the metalworking industry, the fact is that these operations are still overwhelmingly done by conventional methods. However, there are specialized jobs, difficult to accomplish in other ways, that the laser can do efficiently, and for this reason more laser-based machine-shop equipment is moving onto the production line.

Welding, drilling, and cutting all require lasers with high enough power to melt or vaporize the work material. The equipment must permit selection of the power level, pulse-repetition rate, and spot size that are appropriate for the material, its thickness, and the operation being performed. Here, since the power levels of the helium-neon laser are much too low for any type of machining, the carbon-dioxide laser and neodymium-doped yttrium-aluminum-garnet (Nd:YAG) laser come into their own. Today, the newer carbon-dioxide systems are capable of generating as much as 60 kilowatts.

Lasers have some desirable assets in the machine shop. First, they minimize the risk of distorting the part being welded. By applying heat quickly and in small areas, they keep to a minimum the area affected by the heat of the weld. What's more, there is no contact pressure to deform small parts. Second, they can weld safely in any industrial atmosphere. The beam is not attenuated in air so the laser can operate at a distance from the material. In addition, it can weld through transparent materials and therefore has developed such novel applications as repairing cathode-ray-tube gun assemblies by rewelding wires inside the glass envelope.

Third, the size and shape of the spot can be varied over a large range, with several useful consequences. Varying the diameter permits continous control over power density. Focusing the beam finely allows excellent spot-welding of miniature instrument parts and, in combination with numerical control, permits fairly complex paths to be followed. And focusing the beam into different shapes allows noncircular holes to be drilled. Lasers are particularly suited to drilling extremely small holes, especially if they have large aspect ratios (large diameters in relation to depth)—an application in which the equivalent mechanical drills tend to break.

In the machine shop

Al Battista, president of Laser Inc., Sturbridge, Mass., claims that lasers can drill holes 0.015 inch in diameter or smaller more cheaply than other techniques. For example, AC Spark Plug division of General Motors uses a Laser Inc. system to drill bleed holes a mere 0.008 in. in diameter and 0.022 in. deep in the fuel-pump valves of the Chevette.

Finally, among other advantages worth noting, laser welders do not consume fillers or fluxes, they can easily weld metals with different thermal conductivities, and their cutting rates are independent of a material's hardness.

These same cutting rates, however, are dependent on a material's reflectivity. To counteract this problem, strides have been made with coatings that reduce the high surface reflectivity of such materials as aluminum.

Ford Motor Co. has been investigating laser welding and hole cutting for some time and has tested a 6-kW CO_2 laser underbody welding system built by United Technologies Corp., Hartford, Conn. Though the recent recession put a crimp in Ford's plans for a production

version, the prototype welds together several stamped panels to form the underbody of a car. The beam is directed to the proper location by a system of moving mirrors that provides four axes of motion (two translation and two rotation), while the underbody, which is carried on a transfer table, provides a fifth axis of motion (Fig. 3). Operating under computer control, the system performs welds along a preprogramed path at selected weld speeds. Clamping and unclamping of the fixture is also computer-controlled.

Several years ago Hughes Aircraft Co., Carlsbad, Calif., in an effort to diversify from its aerospace orientation, developed a high-speed laser-cutting system for the apparel industry, which cuts the cloth for more than 40 suits an hour, one layer at a time (Fig. 4). The technique has now made a full circle to the aerospace industry. McDonnell Douglas Corp., St. Louis, Mo., is saving on labor by using the system with a 500-W CO_2 laser to cut single layers of boron epoxy. The material eventually forms the skin surface member on the empennage of the F-15. Previously this cutting process was a highly labor-intensive hand operation.

Much smaller parts are being cut by Corning Glass Co., Bradford, Pa., which exploits the laser's speed and resolution in resistor production. The resistor, in the form of a tin oxide or nickel chromium film on a ceramic or glass substrate, rotates in a lathe-type machine while the laser moves across the surface and removes resistive material until the desired value is attained. According to Tom Sturiale, plant manager, the laser is up to 50% faster than other techniques and can control resistance to much tighter tolerances, ±0.15% versus 0.8% for mechanical cutting.

Heat treating

One potentially large application of lasers in the machine shop is just now getting off the ground—heat treating. Here the laser's intense energy induces the same metallurgical effects now produced by an induction furnace but with several significant differences. Some materials that do not respond well to conventional heat treatment may be hardenable by laser. Also, "the treatment can be very selective," points out Tom Conklin, marketing manager, GTE Sylvania Inc., Mountain View, Calif. "For example, we can treat only the teeth on a chain saw or gear instead of the entire saw or gear. Treatment is completed faster than with furnaces. Since the whole part doesn't have to be heated, less energy is consumed."

Lasers for this application need to be in the 1-5-kW range, and all are CO_2. Presently five firms are pursuing this application: GTE/Sylvania, Coherent Radiation, Photon Sources, United Technology, and Avco.

The laser heat-treating system resembles a welding system, with one exception. The beam is either defocused or oscillated to reduce its average intensity so that the metal never becomes hot enough to melt. If the beam is scanned like a TV raster, it is possible to control the size of the area treated.

"GM is the only company in the world now doing laser heat treating on a production basis," claims Jim Wineman, supervisor of manufacturing research at General Motors' Saginaw Steering Gear division in Michigan. According to Wineman, the laser cuts heat treatment costs by 80% by avoiding part distortion and thus eliminating the need for post-treatment machining.

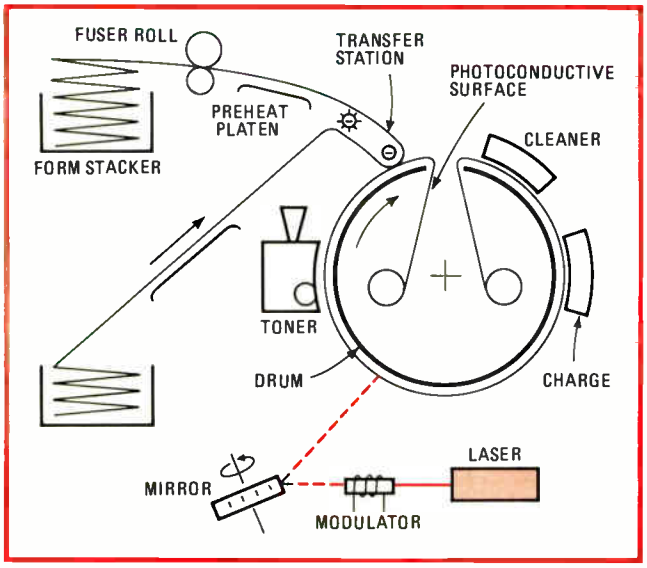
With the process, Saginaw is currently putting five hardened strips on the wall of the power-steering gear bore. These strips, approximately 0.080 in. wide and 6 in. long, serve as the bearing surface for the hydraulic cylinder. "Collapsible bumpers, emission controls, etc., add weight to cars, increasing the loading on the power steering gear and resulting in increased wear," says Wineman. "Heat treating reduces wear by a factor of 10 compared to untreated parts."

Obviously pleased with its experience, Saginaw will, by May of this year, have boosted its laser hardening operation to 12 machines, mostly 1,000-W CO_2 lasers from Photon Sources Inc., Livonia, Mich. These will treat a total of 30,000 parts per day.

While most surface-hardening equipment uses the laser as a heat source, Battelle Columbus Laboratories in Ohio is experimenting with a technique in which hardening occurs as a result of pressure. A high-power neodymium glass laser is pulsed for approximately 0.1 microsecond, heating a surface rapidly and creating a shock wave under it. The shock wave, which can reach a peak pressure of 200 kilobars, produces plastic flow of the metal on a microscopic scale and essentially work-hardens it. Though only strain-hardenable materials like certain grades of stainless steel and structural aluminum alloys are adaptable to the technique, the approach requires lower energy density than laser heat

PRINCIPAL INDUSTRIAL LASERS

Type	Wavelength (μm)	Peak power	Characteristics
Gas			
Helium-neon	0.6118 – 3.381	150 mW continuous	Lowest cost, high reliability, visible red light, low power; used for surveying, measurement, inspection, alignment
Carbon dioxide	9.2 – 10.8	60 kW continuous	High power, high efficiency; used for cutting and welding
Argon	0.3511 – 0.5145	10 W continuous	High resolution, high-power continuous output, but low power compared to CO_2 lasers; used in holography
Helium-cadmium	0.325 – 0.4416	50 mW continuous	Higher cost and shorter life than He-Ne; but attractive for graphics applications because of its blue light
Solid state			
Neodymium: YAG	1.06	10^9 W pulsed or continuous	High pulse rates, high efficiency, shorter wavelength than CO_2, gives better resolution for fabrication applications
Neodymium: glass		10^{10} W pulsed	
Ruby	0.6943	10^9 W pulsed	High-power pulse, visible; but has mostly been replaced by higher-pulse-rate, higher-efficiency Nd:YAG in fabrication applications
Gallium arsenide	0.85 – 0.905	24 W pulsed 100 mW continuous	Small size, high divergence; used for range finding, attractive potential future in communications



6. Printing without impact. Modulator interrupts laser beam in IBM printer, exposing the photoconductive surface of a rotating drum in a dot pattern. Multiple horizontal scans form line of characters, which are made visible by toner and then transferred to paper.

treating and not only hardens the surface but also improves its corrosion resistance.

Battelle is also evaluating the possibility of using laser-generated pressure waves as a source of ultrasound to replace conventional ultrasonic sources in nondestructive testing. Ultrasound acts like light in flaw detection—the reflected sound is analyzed for various amplitude and frequency changes—but has the added advantage of being able to "see" inside a part.

"In this application the pressure wave is kept below the threshold for changing material properties through shock hardening," explains principal physicist Barry P. Fairand, "but more intense than that developed by conventional ultrasonic generators. As a result you can work with larger and more lossy [higher sonic attenuation] materials. With the very short pulses, on the order of a billionth of a second, a laser will provide more resolution than conventional techniques and therefore make it possible to look at smaller defects."

Graphics and printing

In the area of information handling, the laser's chief assets are its speed and resolution. It can write on photosensitive paper at very high speeds and with high resolution. In fact, Herbert Elion, director of electro-optics studies, Arthur D. Little Inc., Cambridge, Mass., predicts the fastest growth in laser usage between now and 1980 will be in this area which, besides the video disk, also includes copiers, optical character readers, computer line printers, platemaking for the newspaper industry, and facsimile equipment (Fig. 5). "The whole area of graphic arts is just beginning to open up for the laser," says Elion.

Several newspapers are now preparing to use laser platemaking. In the two-laser system developed by EOCOM Corp., Irvine, Calif., a 4-mW helium-neon laser scans the page mockup. As the light is reflected from the light and dark areas, it is picked up by fiber optics that transmit the signals to an acousto-optical modulator. This modulator controls the intensity of a 2.5-W argon laser that, in turn, exposes the photosensitive printing plate. A standard 17-by-24-in. newspaper plate can be made in 2 to 5 minutes, depending on the sensitivity of the particular plate.

IBM's nonimpact laser-based printer can write 45,000 characters per second in a variety of character sizes and styles. A low-power laser prints the characters on a light-sensitive surface covering a rotating drum (Fig. 6).

The light beam scans the drum like a conventional print head moving across the paper: a rotating mirror deflects the laser horizontally as the drum advances. Multiple scans are required to form a character, which is printed as dots. The characters are stored as a bit configuration on a magnetic disk, and this information is used to control a modulator, which blocks the laser beam's passage as necessary to produce the desired dot pattern.

When a developer station brushes toner across the drum surface, the toner adheres wherever the surface has been exposed. This image is then transferred to the paper and fused to it by pressure and heat.

Blue would be better

At present, lower-priced facsimile systems are being designed around the helium-neon laser because it costs the least and is the most reliable laser available. But the helium-neon emits red light, while photographic papers and photodetectors are more sensitive to blue light, and a blue-light laser could write on them twice to three times as fast as the helium-neon type.

A helium-cadmium laser emits blue light, but it is expensive and its operating life is relatively short. Typically a 15-mW He-Cd laser costs approximately $3,400 yet is rated at only 2,000 hours. As a result, states Herbert Elion, "the helium-cadmium market is only about 1/20 that of the helium-neon."

But the tremendous potential of the graphics market has encouraged RCA to actively try to improve this situation. "While the growth in the graphics market, hasn't changed dramatically the last few years, the consensus is that we're on a threshold," states Ted Grabowski, marketing manager at RCA's Electro-optics and Devices, Solid State division, Lancaster, Pa. "It could take off to over 25% growth per year. But that will depend on the development of more readily interchangeable and longer-life tubes. I feel most users would be content with 6,000-to-10,000-hr life in exchange for the gains in operating at the blue wavelength."

Grabowski feels that the major potential applications for the helium-cadmium laser lie in phototypesetting, computer output microfiche, nonimpact printers, and facsimile and pattern-recognition equipment.

Presently about 300 companies are competing enthusiastically in the worldwide laser market. They see a bright future for their industry as the signs of a maturing technology—increased reliability and reduced cost—win even more converts to the laser's unusual talents. If predictions hold true, the laser industry between now and 1980 could grow at three to four times the rate of the rest of the industrial world. □

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Diodes switch high power to protect sonar receiver

by F. E. Hinkle
Applied Research Laboratories, The University of Texas, Austin, Texas

A sonar system that uses the same transducer for both transmission and reception must include a transmit/receive (T/R) switch. This switch protects the sensitive receiving amplifiers from the high-power pulses applied to the transducer elements during the transmission phase. It also prevents the transmitter circuit from degrading the returned signal during the receiving phase.

In the solid-state switching network described here, pairs of diodes perform the transmit/receive switching automatically, without any extra driving or timing circuits. They are simply driven by high signal voltages into conduction during transmission and lapse into nonconduction during reception. This system transmits kilowatts of power efficiently and is adaptable to various numbers of transducer elements.

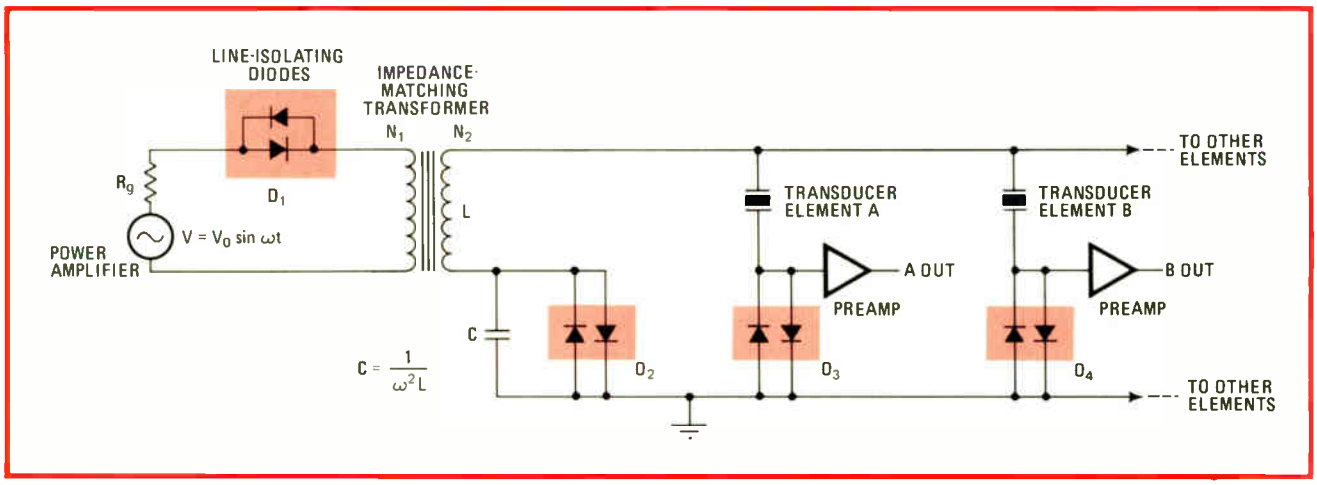
Figure 1 shows the circuit of the automatic solid-state transmit/receive switch. A transformer matches the impedance of the power amplifier to the impedance of the transducer load. Diode pairs D_1, D_2, D_3, and D_4 are placed in the circuit to pass the high currents and voltages that are present when the transducer is used for signal transmission. When the voltage is greater than 1 volt peak-to-peak, the diodes conduct and therefore appear to be short circuits.

Figure 2a shows the equivalent circuit during the transmission phase. Note that all transducer elements are in parallel, so that the same voltage is present across each one. Because diode pairs D_1 and D_2 are in series with the primary and secondary of the transformer, respectively, they must be able to carry the full source and load currents during transmissions. Diode pairs D_3 and D_4 need to carry only the currents that flow through transducer elements A and B, respectively. Diodes D_3 and D_4, acting as short circuits, protect the preamplifiers from the kilovolt-level voltages during the transmission phase.

At the end of the high-power transmitter pulse, all of the diodes stop conducting. Pulse echoes that return to the transducer elements generate only millivolt-level signals, so all of the diodes act as open circuits. (In reality, the diodes look like small capacitors—typically less than 100 picofarads.)

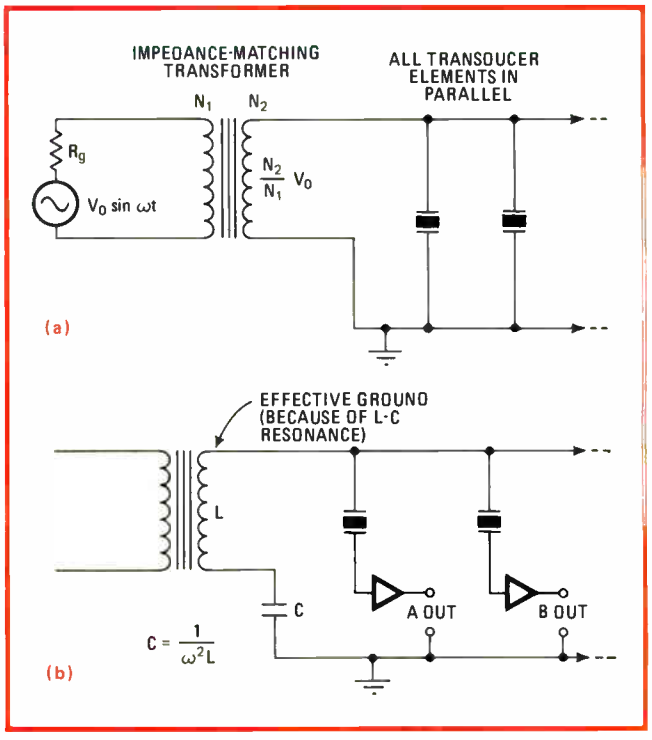
Figure 2b shows the ideal equivalent circuit of the system in this receiving condition. Note that capacitor C is made series-resonant with the secondary of the transformer, i.e., $C = 1/\omega^2 L$ where ω is the angular signal frequency and L is the inductance of the transformer secondary coil. This LC resonance, by creating an effective ground at the common side of all of the transducer elements, prevents crosstalk between them. The preamplifiers are connected to the other side of each element, and each amplifies only the signals from the element it is connected to. Because each element has its own amplifier channel, directional reception can easily be optimized by giving different gains, or weights, to each element. Diode pair D_1 open-circuits the primary side of the transformer to keep noise from entering the effective ground circuit from the power amplifier during the receive mode.

In the system, this transmit/receive technique is used to drive 5 kW into a transducer, which has 16 different elements that all have different gains during the receive mode. A directional receiving beam pattern is formed by summing the signals from all of the elements together after the preamplifier. If it is also necessary to



1. Self-controlled. Automatic solid-state transmit/receive switch uses pairs of diodes. High voltages during transmission drive diodes into conduction so that they appear as short circuits. Low voltages during reception leave diodes nonconducting so that they appear as open circuits. Capacitor C resonates L so that common sides of all transducer elements are grounded during receive mode.

2. T and R equivalents. With diodes short-circuited by high voltages that occur during the transmit phase (a), all transducer elements are in parallel and have equal voltages. During the receive phase (b), the diodes act as open circuits. Each element's signal is amplified separately, so that a directional beam-reception pattern can be formed by controlling the weight (i.e., amplifier gain) for each signal.



weight the elements separately during transmissions, several transformers can be employed to give different drive voltages across the elements.

The diodes used in the working circuit are the 1N3899 and the 1N3899R, which differ only in polarity. These 20-ampere units are stud-mounted for convenient installation and heat-sinking. For signal frequencies on the order of 10^4 hertz, the value of capacitor C is about 0.01 microfarad; because it is shunted by diode pair D_2, it does not need a high voltage rating and therefore can be mica or ceramic. The preamplifiers are type 739 operational amplifiers.

Since the transmit/receive switch does not use relays, no settling time is required prior to transmission. With no moving parts, this transmit/receive switch is quiet, efficient, and very reliable. Power limitations are defined largely by the current capabilities of diode pairs D_1 and D_2 together with the transformer. □

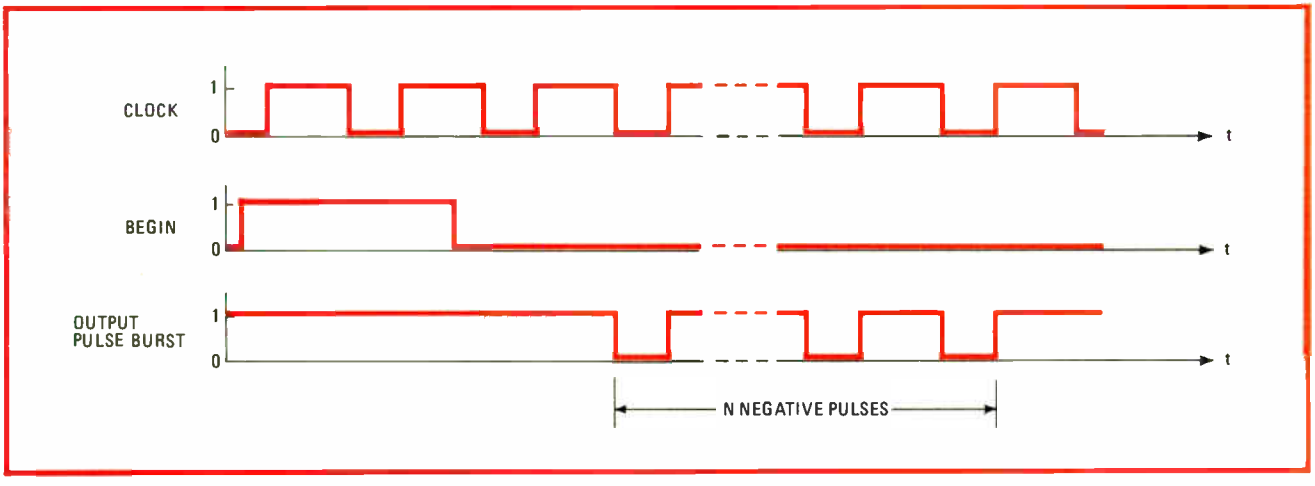
Pulse generator produces programable burst

by John F. Wakerly
Stanford University, Stanford, Calif.

In debugging digital circuits it's often desirable to pass a predetermined number of pulses from a free-running clock and then stop, without producing any shortened pulses or glitches. There are also many systems, such as graphics interfaces, where such a capability may need to be built in. A programable pulse-burst generator is a circuit that fulfills this need.

This kind of generator should have n input lines to set N, the number of pulses to be passed. It should also have a begin input to begin a pulse burst, a clock input for the free-running input clock, and a pulse-burst output for the programed number of output pulses. The circuit should behave as shown in Fig. 1. The begin input is not synchronized with the clock, but it is assumed to be asserted for at least one clock period. The pulse-burst output is normally high; after begin is asserted and then de-asserted, N negative pulses are produced at this output in synchronization with the clock input.

A circuit that has the desired behavior has been built



1. Controlled pulse burst. Applications such as circuit debugging require generation of a predetermined number of pulses. Basic timing is provided by a free-running clock, and the pulse burst is initiated by a begin signal that lasts for at least one clock period. Note that the negative output pulse sequence follows the first rising clock pulse after the begin command goes low.

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Last year alone we introduced the first standard chip capacitor marking system . . . offered leaded chips . . . added X7R and Z5U dielectrics to chips and leaded ceramic parts . . . doubled and tripled the capacitance ranges of all NPO and BX components . . . produced the unique 'Vee Cal' Adjustable-Fixed Chip Capacitor.

Now we're offering 'VK' NPO Ceramic Capacitors with low ±0.25% tolerances.

We've also expanded our 'Vee Cal' Adjustable-Fixed Chip series — capacitors you can adjust in or out of circuit. 'Vee Cal' is now available in a *smaller* .120" x .100" size, with values 1-55 pF, and *0.5 pF* steps. (Nearly 100 values in one part.)

In short, we're building ceramic and porcelain capacitors better than ever before — and delivering what we offer.

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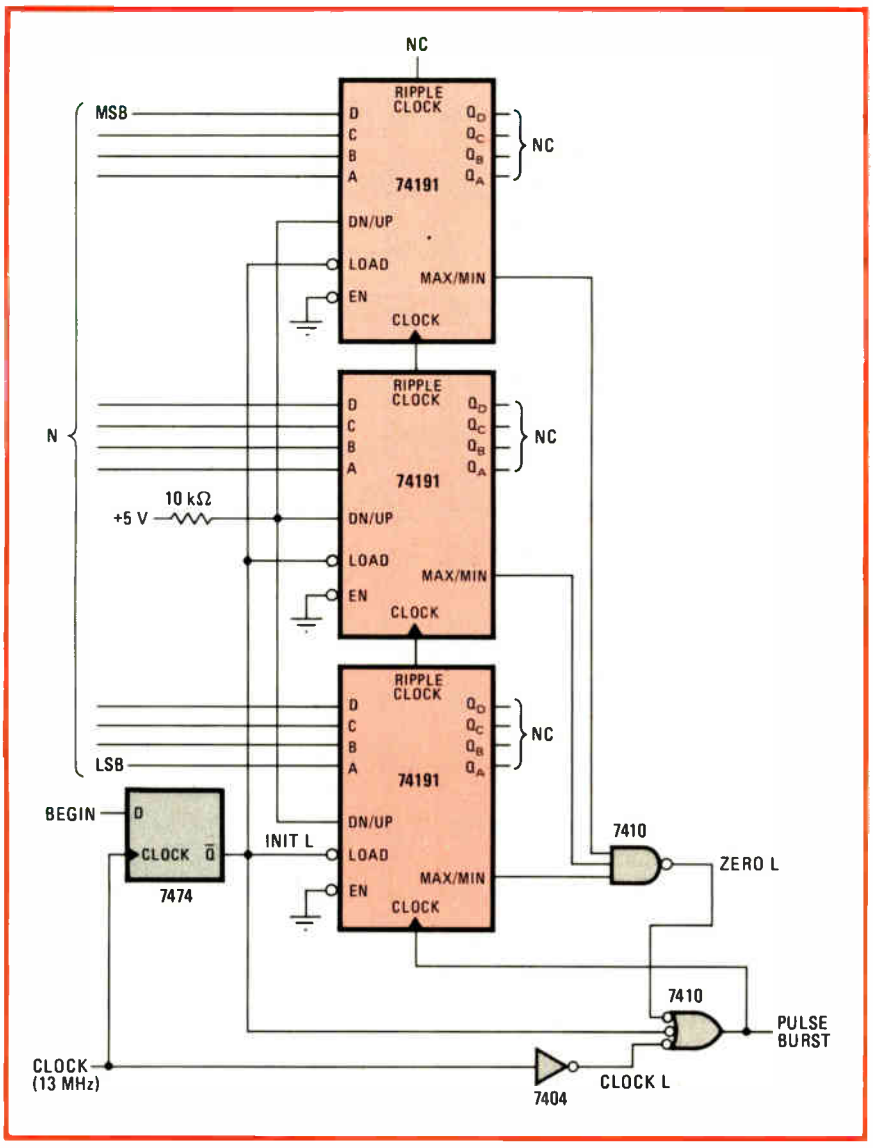


2. Compact circuit. This arrangement has 12 input lines, and therefore can produce pulse bursts of any length less than 2^{12}; for example, if the binary input number N is 000000000100, the output burst consists of four negative pulses. The circuit shown uses few packages. It operates at clock rates up to 13 MHz at room temperature and up to 10 MHz under any conditions. Adding more counters enables it to produce longer pulse bursts, while changing the counter type adapts it for BCD inputs.

from commercially available MSI counters (see Fig. 2). In this circuit n = 12, so that any burst of length less than 2^{12} can be generated. Three 74191 up/down counters are used to form a 12-bit down-counter. A D-type flip-flop is used to synchronize the begin and the clock inputs. The flip-flop output labelled init L (where L indicates active low) is used to load the counters with the number N and to hold the pulse-burst output high while the counters are being loaded. When the begin signal is removed, the counters count and the pulse-burst output passes pulses as long as the zero-low signal is high. The zero-low signal is derived from the max/min outputs of the counters and is used to hold the pulse-burst output high when the counters have counted down to zero. Thus, if the counters are loaded with N, exactly N negative pulses are passed before the counters count down to zero. Note that the circuit behaves properly even for N = 0.

For the circuit to work properly, all changes of zero-low must take place while clock-low is low. This sets a minimum time that the clock input must be high—about 50 ns typically for the parts shown. This time is computed as the sum of the delay of the 74191 counter clock to the max/min terminal and two TTL gate delays.

The generator can be extended to handle longer bursts by simply cascading more 74191 counters and using a wider NAND gate to produce the zero-low signal. The cascading can always be done with the ripple-carry outputs as in Fig. 2 without degrading the maximum system speed because only the least significant counter is active when the critical transition of the zero-low signal from high to low is made. At this time, the max/min outputs of all other counters have long since been high; on all other transitions, the max/min output of the next lower-order counter goes low before any max/min output goes high, holding the zero-low signal high.

The programable pulse-burst generator of Fig. 2 can be made to accept binary-coded-decimal inputs by simply substituting 74190 BCD counters for the 74191s. Positive pulses can be produced instead of negative by simply inverting the pulse-burst output. □

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.

Choosing the right programs for computer-aided design

by D.J. Blattner, *Circuit Design Editor*

☐ There's a new maturity reflected in computer-aided design and analysis programs. The engineer in quest of computer help in his design problems can choose from many programs, some of which can perform complex analyses with speeds and accuracies that reduce the cost of circuit development significantly.

Of course, no one of them combines highest accuracy, fastest run time, widest versatility, best documentation, and easiest familiarization and use. The designer must identify and weigh the relative advantages and disadvantages. A recent Air-Force sponsored study of 16 major CAD programs makes the task easier. It tells:

- What kinds of problems each program can handle (linear, nonlinear, large, small, etc.).
- Which programs fit a given computer, and therefore what kinds of design problems can be handled.
- The programs' comparative speeds, accuracies, flexibilities, and other capabilities.

The programs considered represent the latest, third-generation CAD tools. The investigators used them to analyze 18 sample circuits of varying complexity and a wide range of time-constants. Most of the well-known first-generation programs are not included in this survey because they can't compete in speed or versatility. However, some of the lesser-known European linear programs are included.

Important considerations for the designer are the level of complexity of the format of the CAD programs and the degree of explicitness in the accompanying manuals. Some formats are simple and straightforward, while others consist of many rules and many exceptions to the rules.

Testing the programs

The manuals that come with the program tape or from the customer's computing service usually present format instructions and more general information on the applicability of the program. But they differ greatly in content, organization, and language. Therefore, the first step in the Air Force survey was preparation of brief, uniform "minimanuals" for each program.

One of the most useful products of the study, they occupy about eight pages per program in the report. They summarize instructions, analysis capabilities, type and size of circuits analyzed, hardware requirements, and availability. Some of this information is in Table 1.

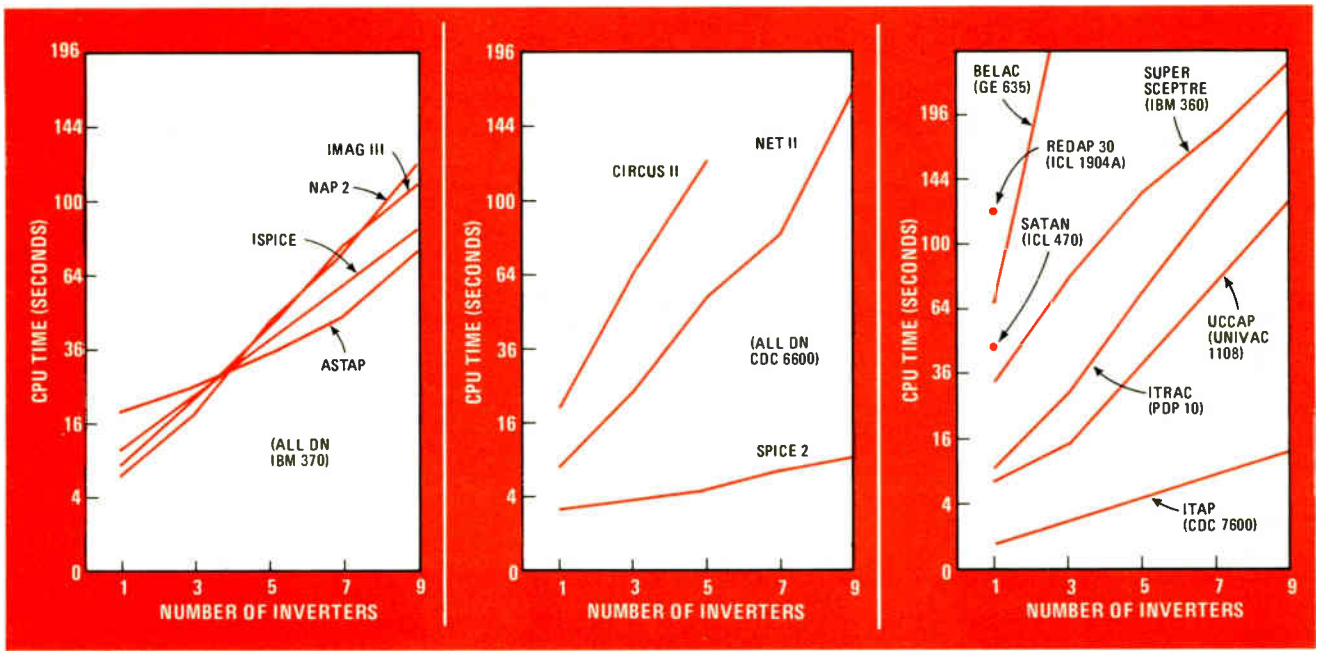
Circuits 1–3 were nonlinear transistor circuits with relative time-constant ranges of 1, 100, and 1 million, respectively. With any of the three, when the effects of smaller time constants have died out, a program should automatically increase the size of its integration steps in order to minimize running time and cost. If it does not

TABLE 1:

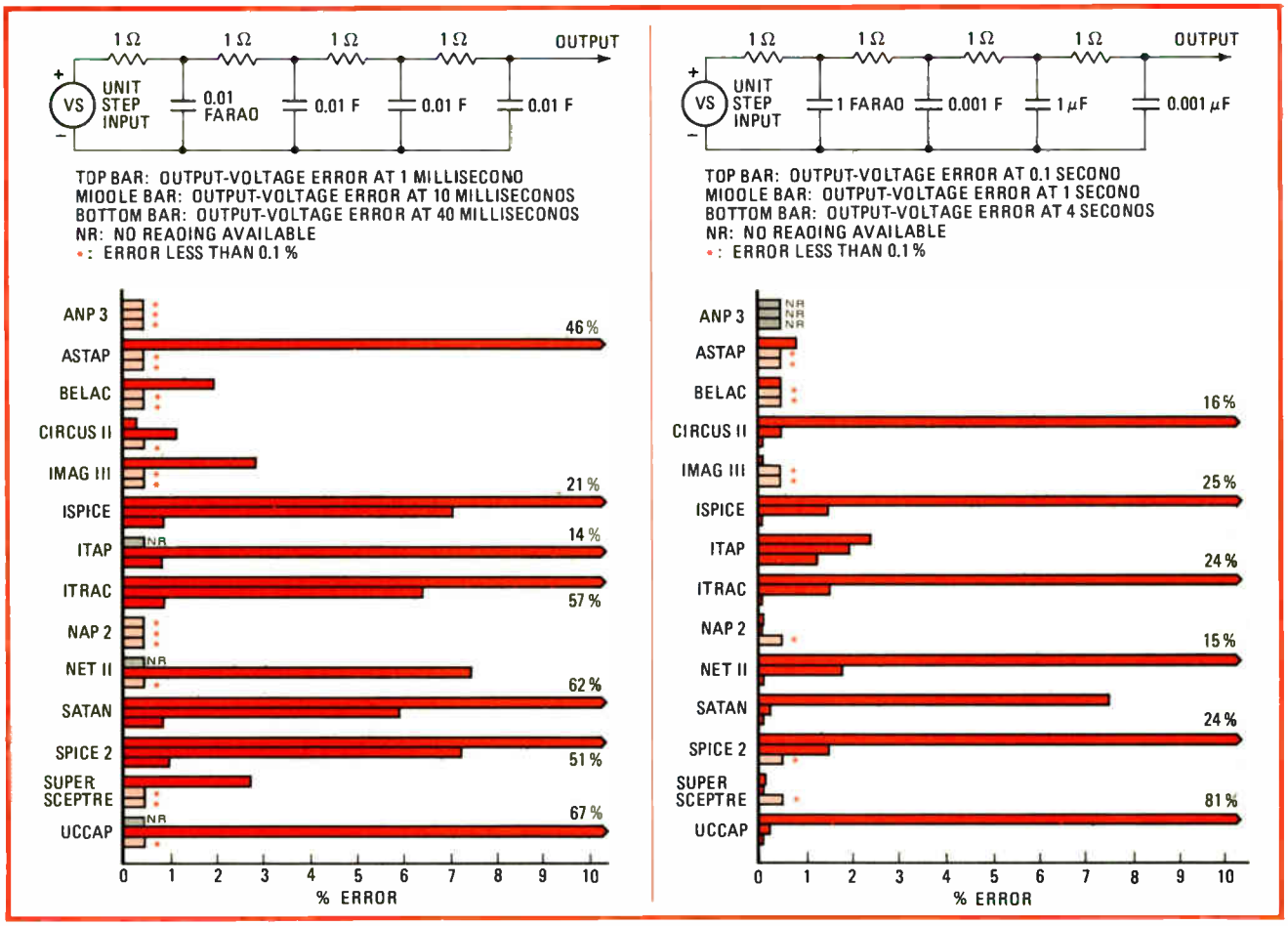
PROGRAM	TYPES OF CALCULATION PERFORMED
ANP 3	Gain constant; pole and zero locations; frequency and transient analyses of linear, lumped, time-invariant circuits.
ASTAP	Ac, dc, transient, statistical (including Monte Carlo and random-number generation), and circuit-failure analyses.
BELAC	Small-signal ac, nonlinear dc, transient, sensitivity, worst-case, Monte Carlo, fast Fourier transform, and optimization analyses.
CIRCUS II	Transient and dc analyses.
COD	Optimum component values for user-specified dc and ac responses in time-invariant circuits, which may contain diode and transistor nonlinear elements.
IMAG III	Transient, ac, dc, and sensitivity analyses of nonlinear circuits.
ISPICE	Single-and multipoint ac and dc analyses; transient and temperature analyses.
ITAP	Dc and transient analyses of circuits that may contain diode and transistor nonlinearities.
ITRAC	Dc and transient analyses of nonlinear circuits.
NAP 2	Dc, ac, transient, Fourier, and noise-signal analyses; pole and zero locations; parameter sensitivities, root-sum-squared, and worst-case error analysis; optimum component values for user-specified dc and transient responses.
NET II	Dc, ac, radiation, and transient analyses on nonlinear arbitrary networks; parametric variation, statistical, and network optimization studies; topological modification for multiple runs.
REDAP 30	Transient analysis of nonlinear circuits.
SATAN	Dc and transient analyses of nonlinear networks.
SPICE 2	Ac, dc, transient, sensitivity, Fourier, temperature, noise, and ac-distortion analyses; small-signal transfer response; driving-point impedance.
SUPER-SCEPTRE	Dc and transient analyses on nonlinear arbitrary networks with the capacity of describing transfer functions and digital models as parts of the network; IBM version also allows ac small-signal analysis, dc sensitivity, optimization, worst-case, and Monte Carlo analyses.
UCCAP	Ac, dc, transient, worst-case, ac and dc failure, and ac and dc component-sweep analyses. All analyses can handle nonlinear networks except the ac analysis, which linearizes the network about its operating point.

OPERATIONAL DATA FOR CAD PROGRAMS

CIRCUIT-SIZE LIMITATIONS	COMPUTER REQUIREMENTS	AVAILABILITY
Maximum number of nodes is 40. Maximum number of elements is 100.	IBM 360/370; 104-k bytes of core memory with overlay.	Available for a handling charge from Erik Lindberg Institute of Circuit Theory and Telecommunications Technical University of Denmark, Bldg. 343 DK-2800 Lyngby, Denmark
The maximum number of nodes and elements depends on the available core memory.	IBM 360/370; a minimum of 220-k bytes of core memory.	Commercially available from the nearest IBM representative
The maximum number of nodes and elements depends on the available core memory.	GE 635; a minimum of 120-k bytes of core memory.	Available for handling charge from General Electric Co. Utica, New York 13503
The maximum number of nodes and elements depends on the available core memory.	IBM 360/370, CDC 6600, Honeywell 6000; a minimum of 180-k bytes of core memory.	Available for handling charge from M.A. Espig P.O. Drawer QQ General Electric TEMPD Santa Barbara, California 93102
Maximum number of design variables is 30.	IBM 360/75; 198-k bytes of core memory.	Commercially available from Lee Morton Optimal Systems Research, Inc. Box 1169 Wall, New Jersey 07719
None	IBM 360/370 or French CII; 89-k bytes of core with overlays.	Commercially available from SESA, Professor Kuntzman Departement C.A.O. 39, Rue de la Grange aux Belles 75010, Paris, France
The maximum number of nodes and elements depends on the available core memory.	IBM 360/370; version 2, due shortly, has dynamic memory allocation.	Commercially available from Alan Schwartz ISPICE Product Manager National CSS, Inc. Norwalk, Conn. 06851
The number of nodes plus inductors plus transistors must be less than 48	CDC 7600; 24-k bytes of core.	Commercially available from Professor K.G. Nichols University of Southampton, Dept. of Electronics Southampton, England
Maximum number of nodes is 50. Maximum number of branches is 200.	PDP-10	Commercially available from: S. Bernstein, Berne Electronics, Inc., White Plains, New York 10605 and Time Sharing Limited, 179 – 193 Great Portland Street, London, England
Maximum number of nodes is 50 or 500 depending on core size. Maximum number of elements is 195 or 1500 depending on core size.	IBM 360/370; 104-k or 250-k bytes of core.	Available for handling charge from Erik Lindberg Institute of Circuit Theory and Telecommunications Technical University of Denmark, Bldg. 343 DK-2800 Lyngby, Denmark
None	IBM 360/370 and CDC 6000/7000; 100-k 60-bit words of core.	Classified, but available at no charge to government installations or subsidiaries from U.S. Army Material Command Harry Diamond Laboratories Washington, D.C. 20438
Maximum number of nodes is 40. Maximum number of branches is 80. Maximum number of loops is 30.	ICL 1904A; 30-k 24-bit words of core.	Commercially available from RACAL-REDAC Ltd. Tewkesbury, England
Maximum number of elements is 30 for terminal version and 80 for batch version.	ICL 470	Commercially available from G.A. Richards Marconi Electronics Ltd. Research Laboratories West Hanningford Road Great Baddow, Chelmsford CM2 8HN, England
None	CDC 6000/7000; 50-k 60-bit words of core.(An IBM 360/370 version is under development. The older, more limited, SPICE 1 is available for IBM use.)	Available for handling charge from D.O. Pederson Dept. of Electrical Engineering and Computer Sciences University of California Berkeley, CA 94720
Maximum number of nodes is 301. Maximum number of elements is 300.	IBM 360/370; 240-k bytes of core. CDC 6000/7000; 39-k 60-bit words of core.	Program available for handling charge from: J.C. Bowers, Dept. of Electrical Engineering, University of South Florida, Tampa, Florida 33620. To obtain manual, request AD-A011 348 from National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, VA 22161
Maximum number of nodes is 400.	UCC 1108; 64-k bytes of core.	Commercially available from University Computing Company P.O. Box 6171 Dallas, Texas 75222



1. Running time. For a specified input waveform, the time required for central processing units to calculate output from an inverting circuit is shown as a function of the number of inverting stages in the circuit. Since run time depends on the computer used as well as program efficiency, the curves are grouped according to hardware. Because the number of steps in the circuit-matrix equations increases with the square of the number of inverters, a square-root scale is used on the time axis in order to get approximately linear graphs.



2. Accuracy. For the two four-stage RC ladder networks shown, the variation of the value computed by 14 CAD programs from values calculated by the investigators is given as a percentage error. The three times chosen represent points in the transient, settling, and steady-state phases of the circuits' operations. For programs accurate to a fixed quantity, small early errors can appear as a large percentage.

TABLE 2: SUMMARY OF PROGRAM EVALUATIONS

PROGRAM	ADVANTAGES	DISADVANTAGES
ANP 3	Small run times Excellent accuracy	Linear circuits only Time domain analysis has limited stop-time capability Limited to one output response per computer run
ASTAP	Capable of handling very large complex circuits Good documentation and service support from IBM Small run times	Available only on rental basis
BELAC	Good accuracy	Large run times No initial conditions No user-created models Documentation in state of flux Program capabilities changing
CIRCUS II	Availability of user-generated models Availability of Fortran subroutines to generate arbitrary nonlinear elements	Large run times Limited to dc and transient analyses
COD	Facilities for specifying constraints on circuit elements and responses Facilities for specifying correlations between circuit parameters	Necessity of writing equations for all circuit responses desired Fixed fielding of part of program's input coding
IMAG III	Good accuracy Availability of user-created models Availability of arbitrary nonlinear elements whose value may be specified using Fortran expressions or a logical IF statement	Lack of error-analysis capability Available only on a rental basis
ISPICE	Moderate costs User-created models available Good software support and maintenance Charges based only on actual hardware usage	Arbitrary nonlinear elements cannot be functions of circuit currents or voltages Only available on a rental, interactive terminal basis
ITAP	Very fast run times Moderate accuracy	Dc and transient analysis capabilities Pulse and sinusoidal current source inputs only No user-created models allowed Limited circuit size – less than 48 nodes
ITRAC	Transient radiation analysis Interactive mode of analysis	Dc and transient analysis only Limited circuit size User-defined models must be in a mathematical format
NAP 2	Excellent accuracy Availability of arbitrary nonlinear elements, Fortran subroutines, and user-created models	Moderate run times
NET II	User-created models available	Moderate run times Questionable accuracy in certain cases Lack of support and clear documentation
REDAP 30	Wide range of program capabilities available Continuous support of the programs by the REDAC staff	Large run times Convergence problems noted for the larger circuits
SATAN	Available with implicit and explicit integration routines	Limited to dc and transient analyses Questionable accuracy in some cases No user-defined models Limited to 80 elements
SPICE 2	Very fast computer run times	Questionable accuracy in isolated cases Difficulties noted in converging to the correct solution Support not readily available, and documentation limited
SUPER-SCEPTRE	Availability of transfer function, digital logic, nonlinear, and mechanical models Availability of user-created models Good accuracy Good documentation and support	Longer run times
UCCAP	Small run times Availability of user-created subcircuits Continuing support and good documentation	Questionable accuracy in isolated cases Available only on rental basis

have this capability, the length of time that the central processing unit (CPU) runs for circuit 3 is many times greater than for circuit 1. The programs under test handled all three circuits in about the same running time.

Circuits 4–8 were inverters of 1, 3, 5, 7, and 9 cascaded stages, respectively. Comparison of their CPU run-times (Fig. 1) demonstrates how operating costs increase with circuit complexity.

Circuits 9 and 10 were oscillators used to test for errors in solving an unstable feedback circuit and for the ability to handle nonlinear elements. Circuit 2 was a high-Q filter of two very closely spaced complex pole pairs. It tests for truncation errors.

Circuit 12 was a full-wave rectifier that tests the treatment of mutually-coupled circuits. Circuit 13 was an integrated-circuit video amplifier, testing the ability of a CAD program to handle large complex circuits.

Circuits 14–18 were resistance-capacitance ladders used to check the accuracy of the computer solutions. For a unit-step input voltage, the investigators calculated values of output voltage for representative times in the transient, settling, and steady-state phases of the circuit's response. They compared their answers to those computed by the CAD programs (Fig. 2).

The two figures do not include any data on the Redap 30 or COD programs. Redap 30 was tested before the investigators had decided to use the RC ladder circuits. COD is used only for determining optimum component values to provide specified dc or ac responses. Therefore it has no transient-analysis capabilities, and the 18 circuits could not be tested. The investigators did run several tests of COD and included the results in the study.

Putting it all together

Table 2 summarizes the conclusions of the University of South Florida investigators, which they drew from their study of the user's manuals and related information, their experience with the programs, and the data obtained in circuit solutions (only a small portion has been spotlighted here).

The tradeoff of the features evaluated must be made by the user, in terms of his or her needs. For example, one program may offer greater versatility and convenient documentation, while another may balance these deficiencies by solving a wide range of problems with phenomenal speed. Also, renting a program may be a disadvantage to some with limited funding, but it offers the important and often critical advantages of updating, debugging, maintenance, and a ready source of help. □

Copies of "A Survey of Computer-Aided Design and Analysis Programs" are available from project engineer Phillip C. Herren Jr., AFAPL/POD-1, Wright-Patterson AFB, Ohio 45433. The study was carried out at the University of South Florida in Tampa under James C. Bowers, professor of electrical engineering. Assisting were George Zobrist and graduate students Charles Lors, Tom Rodby, and John O'Reilly. The Air Force Aero-Propulsion Laboratory sponsored the project through the Rome Air Development Center postdoctoral program under contract F30602-75-C-0118.

NEW VITALITY EVIDENT AS BIG SHOW CHANGES LOCATION

The first IEEE convention on an alternating plan regains much of the lost excitement, reflecting happy days return in the electronics industries

by the *Electronics* staff

Whether it's the move to the Boston-area market, the general improvement in business, the financial respite from New York's Coliseum, or whether it's just the promise of May weather, this year's IEEE show, named Electro/76, shapes up to be a winner. The 509 booths have been sold out since early winter, and there's a waiting list of companies for any space cancelled by the 265 exhibitors.

Also, the 34 technical sessions look to be among the best ever presented by the Institute of Electrical and Electronics Engineers. The whole May 11–14 operation will be conveniently sited, with the show filling Boston's Hynes Auditorium, and the technical sessions at the nearby Sheraton-Boston Hotel.

Adding to this year's attractions, of course, will be a raft of Bicentennial observances and displays that the city and its neighbors have been organizing for over a year (see "Boston: It offers delights for the Bicentennial visitor," p. 112). All in all, there's an interest and excitement in Electro/76 that hasn't been apparent since New York's Intercon (its previous title) hit the skids in the late 1960s. Attendance may go past the expected 25,000—not like the 60,000-plus enjoyed in the high-flying early '60s, flush with aerospace-defense contracts, but not bad for today's economy.

A sure sign of the resurgence has been the number of companies returning after a hiatus or signing up for the first time. Among the former are such firms as Motorola Semiconductor Products Inc., Phoenix, Ariz.; Oak Industries Inc.'s Crystal Lake, Ill., switch division; Methode Electronics Inc., Chicago, and Burr-Brown Research Corp., Tucson, Ariz. Newcomers include small and large companies such as Interface Technology, Covina, Calif.; Solitron/Microwave, Port Salerno, Fla., and Data General Corp., Southboro, Mass.

Not to be forgotten, of course, is the steadying influence of the important perennials at IEEE shows, such as Hewlett-Packard, Palo Alto, Calif.; Tektronix Inc., Beaverton, Ore.; Digital Equipment Corp., Maynard, Mass.; Sprague Electric Co., North Adams, Mass., and AMP Inc., Harrisburg, Pa.

Electro/76 is the first international IEEE show in Boston. It will alternate from now on beteen New York City and Boston, as with Wescon's rotation between Los Angeles and San Francisco. It also marks the official end of the regional Nerem show, which is being phased into the Boston show.

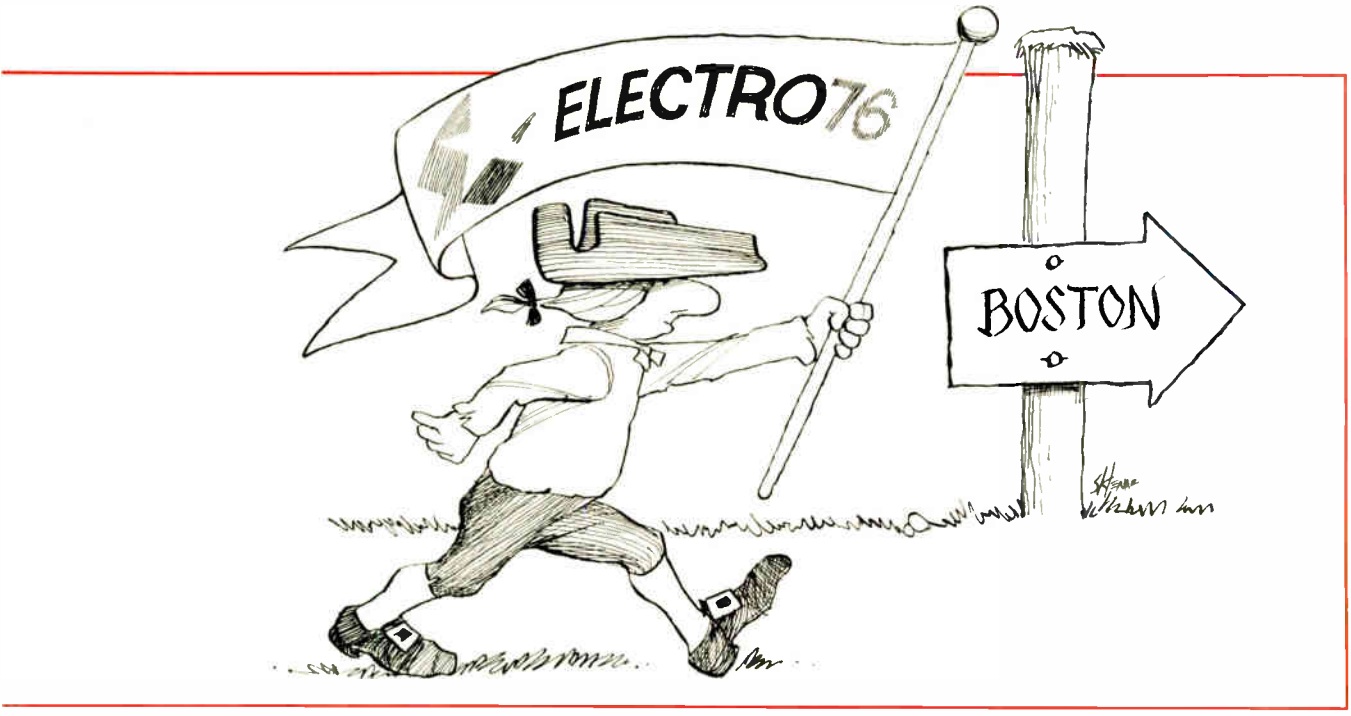
This year's exhibition promises the unveiling of more new products than in the recent past (see page 121) and the first public demonstration of some recently announced products. For some exhibitors, particularly those from the West, Electro/76 will be the first showing of new lines in the New England market.

The technical program continues the trend toward applications papers and away from research updates, with emphasis this year on microprocessor applications. "To the engineer, the application of microprocessors is a bigger transition than the transition from tubes to solid-state devices," says program chairman Ralph Anderson, engineering manager of the Concord, Mass., test systems division of GenRad Inc.

"It has certainly been more difficult than the switch from transistors to integrated circuits, and the content of the program reflects that. At the same time, the sessions are balanced with instrumentation and communications topics."

Exhibits reflect interest in Route 128

Boston-area electronics companies are enthusiastic about this year's show, not only because it's in their own backyard, but because the economy is in much better shape than last year. Robert Fox, marketing manager for distributor Gerber Electronics of Dedham, Mass., says that Electro/76 will be the first IEEE show the company has ever joined, although the firm had participated in Nerem. Gerber's booth will be featuring Fair-



child microprocessors, including a working F-8 module.

Ned Chang, vice president for marketing at Wang Laboratories Inc., Tewksbury, Mass., says his company dropped out of the show last year for the only time in 10 years because of the poor state of the economy. "It was quite a significant thing for us not to be in the show last year," he explains. "Indicators show that R&D expenditures are pulling slightly ahead of inflationary increases, as opposed to the last two years when inflation consumed R&D funds. If there's more money in R&D, we'll have more sales at this show."

Electro/76 will mark the first time since 1966 that Motorola Semiconductor has exhibited at the IEEE show or at Wescon. Plans call for the integrated-circuit division to show its 6800 microprocessor and associated equipment, including its Exorcisor design-analysis system, and software. A new product or two may also be introduced, depending on the timing. Part of the appeal for the firm is the concentration of computer manufacturers in the Boston region.

Motorola is not the only long-time absentee to return. "I can't remember the last time we went," says William T. Jensen, executive vice president of Chicago's Methode Electronics. "We dropped out of New York because the cost of doing business there is exorbitant. But we're going back because it's in Boston and it will be *the* show for that territory this year." Methode will be showing its Reliaplane printed-circuit board system, a double-sided board with plated-through holes and press-fit terminals; a line of low-temperature conductive and resistive pastes and inks, and a trace analyzer for checking continuity and high-potential voltage breakdown on pc boards.

Texascan Microwave Products, Indianapolis, Ind., which has not been in any shows for some time, plans to bring several new products to Electro/76. The firm will have a tracking sweep generator, a large-screen display scope, and new oscillators among its lineup. Similarly, International Micro Systems, Gaithersburg, Md., has stayed out of all shows for several years, because it primarily has been doing custom work in microprocessors and microprocessor controls. This year, though, the company is ready to show 4-bit and 8-bit microcomputer systems and programers for read-only memories. Again, the interest in Boston is for the computer industry found in the region.

Several factors made going into Electro/76 an attractive prospect in the view of Randy Gaskill, vice president and general manager of Data Technology Corp., Santa Ana, Calif. For one, the timing is right, after 18 months to two years of business conditions that were "pretty skinny." Also, the Boston environment is good for the show because of the abundance of electronics companies on Route 128. Data Tech has strip-chart recorders, frequency meters, universal counter-timers, and a pH meter to unveil at the show.

Because of the economy, Electro Scientific Industries, Inc., Portland, Ore., had been selecting shows carefully and hadn't attended an IEEE exhibit in two years. However, the company is returning to show 10 products, all benchtop instruments. Among them are a new digital capacitance meter, an IC tester, and an induction-resistance-capacitance impedance meter with a microprocessor control.

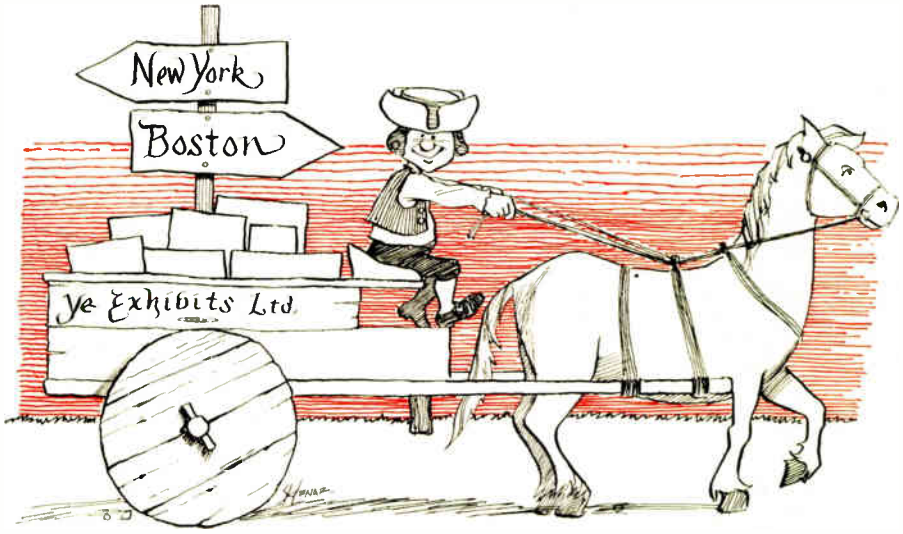
Alternating format hailed

Perhaps the enthusiasm of the new or returning exhibitors was best summarized by Roy Meadows, Burr-Brown's trade-show coordinator: "The new alternating format is a super idea. Changing the format creates new interest and a better turnout." The company likes the Boston area "where the heart of our competition is," to display its data-conversion equipment and new lines of data-acquisition and computer input/output products.

With the accent on product development and applications useful to engineers during the next 18 to 24

months, the technical-session organizers also expect to draw crowds. Attendees not only will see microprocessors demonstrated on the show floor, but also will hear quite a bit about their applications.

Seven sessions are devoted totally or partially to microprocessors. The program is organized on a track of nonconflicting microprocessor sessions, which begins with session 3, an overview, "Microprocessors: The Future is Now," chaired by Charles Popper, a computer systems consultant in New York City. The program will cover four major aspects of microprocessors—devices, software, interfaces, and future development. If time allows, a panel discussion will follow the presentations, Popper says.



Jerry L. Ogdin, president of Microcomputer Technique Inc., Reston, Va., will lead off the session with "Microprocessors: Promises and Practices, Revisited," a discussion of the various devices available. Then Geoffrey C. Leach, head of software development at Sycor Inc., Ann Arbor, Mich., a manufacturer of intelligent terminals, will review the state of the art in software.

How to program microprocessors

The basic requirement, Leach says, is for reliable error-free software that is inexpensive to produce—not so different from larger computers. But the problem with the microprocessor, he says, is that applications tend to be quite small in terms of program size and so usually are developed by a design engineer, rather than a programer. He will look at the available tools—simulators, development systems, minicomputers whose architecture is the same as microprocessors, and software tools such as assemblers, microinstructions, and high-level-language compilers.

Robert M. Smith, Bell Laboratories, Holmdel, N.J. will cover interfaces—but not just the circuit interfaces, he says. He also will discuss power interfaces, and for that matter, people interfaces. One important pitfall, which he says is ignored by many designers until too late, is the danger of noise pulses. This is particularly true on three-state buses in the high-impedance state, in which a pulse from a relay—such as in a telephone central office—can play havoc with the processor and switch it to an unknown state. The only cure is to make the leads as short as possible and to shield them, he says.

Session 8, "Design Aids for Microprocessors" will cover various semiconductor makers' prototype design systems, including those of National Semiconductor Corp., Intel Corp., Raytheon Semiconductor division and Motorola Semiconductor.

The scene switches to software in session 23, "Higher-Level Languages for Microprocessors," chaired by Michael D. Lippman, RCA Laboratories, Princeton, N.J. The session includes an analysis of the cost-effectiveness of languages by Terry Dollhoff of Microcomputer Technique, an interpreter for Basic described by Paul Allen and William Gates of MITS Inc., Albuquerque, N. Mex., and a paper on the Forth method of programing by Elizabeth D. Rather and Charles H. Moore of Forth Inc., Manhattan Beach, Calif.

The Forth method is an extension of the macroinstruction concept, according to company president Rather. Like the macroinstruction, it allows routines to be defined by one word, but it also allows new routines to be defined by other words. Thus a vocabulary can be built in pyramid fashion.

Eugene R. Fisher of Lawrence Livermore Laboratory, Livermore, Calif., will compare two high-level languages: PL/M and a version of Basic developed at Livermore. The major difference is that PL/M is compiled in a batch mode while Basic is an on-line interpretive language with each statement compiled as it is entered from a keyboard. His comparison shows that Basic is many times faster than PL/M or assembly languages. Basic programs are developed in an interactive mode without a compile or assembly cycle, which accounts for their speed and cost-effectiveness.

The unifying theme of the instrumentation sessions also will be microprocessors. In addition to applications of these devices in instruments, emphasis will be on testing microprocessors and processor-based products in the laboratory, on the production line, and in the field.

Instruments can use higher IQs

Among the highlights will be the paper given by Dan Abenaim, GenRad product-engineering manager, in session 24, "Smart Instrumentation—How Intelligent Should it Be?" Until now, processors have been used chiefly to replace other digital circuits, he says. "But the microprocessor can also drastically change the way analog designs are done. For example, one device can act on a set of results before presenting them to the outside world."

Maintenance and testing of processor-based products will be the focus of three sessions. "Designing and Debugging Microprocessor-based Systems," session 28, will feature a paper on troubleshooting processor-based designs by Bruce Farly of Hewlett-Packard's Colorado Springs division. Another session paper, by Roy Tottingham, product manager at Biomation, Cupertino,

Calif., will describe instrumentation to analyze logic timing in microprocessor-based systems.

High-volume processor testing will be discussed at session 18, "Microprocessor/Microcomputer Testing." It will cover each stage of the production cycle: product development laboratory, production line, and field services. Robert E. Anderson, vice president of Omnicomp Inc., Phoenix, Ariz., says of field service: "The cost of the tester becomes more important because a firm is buying more instruments, and the tester need not be as fast because the test time is so small compared to the time it takes to travel to the site."

Field service needs are sufficiently different to justify a separate session. In session 9, "The Automatic-Test-Equipment Role in Field Service for Printed Circuit Boards," Roger M. Boatman, president of Testline Instruments Inc., Titusville, Fla., will describe a test technique that gains access to a pc board's logic by clipping onto integrated circuits. This provides a more precise isolation of faults than is possible with card-edge testers.

Communications takes wide view

The program organizers made a special effort to attract worthwhile communications papers, such as session 20, covering trends in communications design. "We have tried to put together a session that will interest all communications designers, not just something for the ham-radio audience," reports session chairman Doug DeMaw of the American Radio Relay League Inc., Newington, Conn.

For example, W. H. Hayward from Tektronix's spectrum-analyzer group will show design approaches for improved dynamic-range performance of receivers and measurement techniques for determining the parameters, a topic that's not widely publicized.

Fitting microprocessors to communications chores is the subject of a paper by Thomas McMullen of the ARRL and Dominic Bruno of Data Corp., Torrington, Conn. They will discuss processing continuous-wave, Morse-code signals into elements that can be recognized by a microprocessor that translates them into perfectly formed code. "In weak-signal communications, there's about 18-decibel improvement over voice communications," McMullen says.

Rounding out the session is perhaps the most extensive treatment of broadband transformers since Ruthroff's paper on the subject in 1959. Jerry Sevick, Bell Laboratories, Murray Hill, N.J., has designed a device model that acts as a transmission line at low and high frequencies. "At the low-frequency end it performs like a short transmission line with a large shunting inductance in parallel, although mathematically it's treated like a transformer," he says.

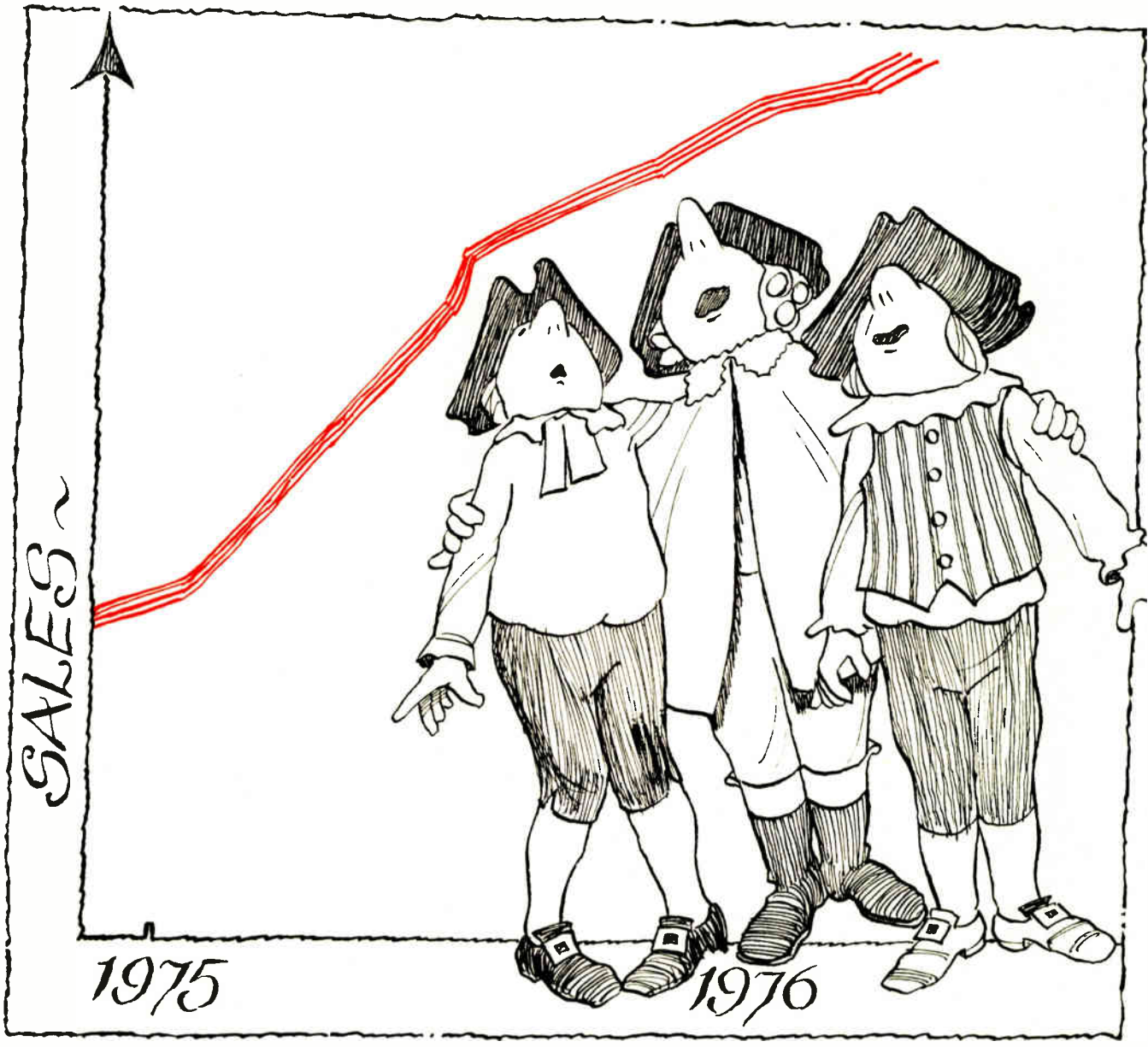
Session 2, organized by John E. Fulenwinder of GTE Laboratories, Waltham, Mass., will present the state of the art in fiber-optic technology with a look at the roles it will play in future communications systems. Robert D. Maurer of Corning Glass Works, Corning, N.Y., will cover low-loss, single-fiber-cable technology. Brian A. Shortt, Mark L. Dakss, and John D. Schlafer, also of the GTE labs, will review developments in optical sources and detectors. Marc P. Mills of Bell-Northern Research, Ottawa, Canada, will deal with splicing and coupling optical fibers, and James E. Goell of ITT's electro-optics division, Roanoke, Va., will point out some of the problems of putting components together in fiber-optic links.

Industrial sessions tackle nitty-gritty

Industrial uses of the microprocessor also come in for attention. For example, at session 13, "Microprocessor Applications," the noncomputer specialist can get hints as to whether there is a microprocessor in his future. "The five papers on subjects ranging from biomedical to industrial control will provide a well-balanced presentation," claims session chairman Andre Vacroux, Illinois Institute of Technology, Chicago. "I asked speakers who are well known in the computer field to explain the types of problems microprocessors can solve and what can be expected to happen to future product design as a result."

Included in the five papers is one from Arch W. Conway, Dana Laboratories, Irvine, Calif., who will explain how a processor turned a standard timer-counter into a more versatile unit. Bernard J. Carey and Joseph M. LaRosa, University of Connecticut, Storrs, will discuss development of a speech synthesizer that will convert the computer display into an audio output for a blind operator.

Session 34, "A-d- and D-a-to-Processor Interfaces: Can We Standardize Them?" will explore a series of knotty questions. A monolithic microprocessor needs an analog-to-digital or a digital-to-analog converter to interface with the real world. But there is no agreement on the hardware and software involved. Such questions as how the input/output should be addressed and



whether the converter should control the processor or vice versa remain unanswered.

"Presently no group is dealing with these specific problems, although a planning committee has been organized to attack the situation," says Herman Schmid, of General Electric Co., Binghamton, N.Y., chairman of the session.

The session's five speakers will include computer designers, converter designers, and systems designers who will outline various techniques used and problems encountered in interfacing converters with processors.

"Session 14," says its organizer Stephen E. Grossman, Faultfinders Inc., Latham, N.Y., "is intended to impart firsthand experience of automatic-test-equipment users with a variety of equipment to engineers considering or about to buy ATE for testing pc board assemblies." In the first paper, John Lang and Pablo Roth of Analog Devices Inc., Norwood, Mass., will explain the problems that led to the acquisition of an automatic tester—high density boards incurred decreasing yields and increasing repair costs. They will tell why they selected in-circuit component testing over other possible techniques.

The Electro/76 program devotes a day's worth of sessions to computer-aided design. The first, "CAD I: Modeling, Analysis Programs, and Problems," will cover applications to a variety of circuits. "CAD II: Digital Circuit Development Aids" will touch on simulation and testing programs for digital circuits. Both are intended to give the designer a clear picture of how computer programs can help him today and tomorrow.

Getting ahead in CAD

"On Benchmarking CAD Programs" by Randall W. Jensen, Hughes Aircraft Co., Los Angeles and L.P. McNamee, UCLA, will help the prospective user select the program that is best for solving his or her problem. Other papers in session 21 will deal with setting up a general-purpose CAD activity and its effects on such design decisions as tolerance assignment and how simulation makes possible the analysis of performance on the ever-bigger circuit in large-scale integration.

The more advanced session 26 will start with a description of an integrated system of CAD programs and interface programs that convert a designer's schematic into the documentation for construction and testing of a digital circuit. Also on tap will be a paper outlining a software program that simulates the performance of a logic circuit. Given a description of the gates and their interconnections, the simulator displays the output waveforms that the circuit would produce.

Useful to designers of circuits composed of custom LSI chips and standard ICs will be a paper on making breadboards of chips in their system environment. Overall, these two sessions will stress the dollars and cents aspect of CAD.

Zeroing in on power semiconductors

Two sessions, 5 and 16, will aim at establishing sound design procedures in an area traditionally dominated by trial-and-error techniques: power semiconductor applications. Both will be valuable, because designing power circuits is a tricky business involving electrical and thermal factors, as well as mechanical ones.

Session 5, chaired by James C. Miller, marketing director for power at RCA's Solid State division, Somerville, N.J., will be concerned primarily with trends in medium-power devices. The other, chaired by David Cooper, vice president of engineering and development for the semiconductor division of International Rectifier, El Segundo, Calif., will concentrate on power semiconductors for switching supplies that operate directly off the ac power line.

In the first session, there will be a paper on designing reliable automobile-ignition systems with power Darlington transistors. Also included will be papers on the use of gate-turn-off silicon controlled rectifiers in medium-power switching and guidelines for selecting power transistors for radiation environments.

Session 16 will have papers on more reliable power Schottky diodes and on improved analysis techniques for designing off-the-line switching supplies.

Also on tap in the components area will be session 7, "Advances in Display Devices," chaired by Vernon J. Fowler of GTE Laboratories. This group of papers will cover five different types—plasma-charge, light-emitting diode, liquid-crystal, dc electroluminescent, and electrochromic displays. "There are various meetings devoted to display technology for specialists, but this session is devoted to recent developments that will make their way into products coming out in the next few years," Fowler explains. "We have soft-pedaled research in favor of product application."

General-interest sessions stress the practical

Clearly the tenor of the technical sessions will be toward the practical rather than the theoretical. Even the general-interest papers will follow this line. For example, Rudolf Panholzer, associate professor at the U.S. Naval Postgraduate School, Monterey, Calif., has organized session 32, on the use of hand-held calculators. Discussions will cover Hewlett-Packard, National Semiconductor, and Texas Instruments machines, as well as where to get general applications information for all programable calculators. "We expect a lively discussion, especially on the pros and cons of reverse Polish versus algebraic notation," Panholzer says.

In the first part of "Crime and Computers," session 22, the organizer, Jacob Sternberg, president of Veripen Inc., New York City, and George H. Warfel, a Menlo Park, Calif., consultant, will cover computers as tools and objects of crime and computers used in crime prevention as elements of security programs.

The second part will cover the vulnerability of data and software and the need for security measures. Robert V. Jacobson of the Chemical Bank of New York City will deal with the economic tradeoffs and cost benefits of installing data-communications safeguards. The two papers in the third part of the session will get into the role of automated signature, fingerprint, and voice-verification identity systems. Finally, Steven B. Lipner of Mitre Corp., Bedford, Mass., will discuss system architecture required for security.

According to Sternberg, the activities of criminally-inclined computer users are on the increase, and so is their level of sophistication. He points to a rise of thefts in electronic funds transfers among banks as a growing problem.

Air travelers may be interested in session 31, "What's New in Air Traffic Control," organized by Paul R. Drouilhet, MIT Lincoln Laboratory, Lexington, Mass. The papers will cover such controversial topics as collision avoidance, in the air and on the ground.

Drouilhet points out that the collision-avoidance paper to be delivered by the Federal Aviation Administration's Martin Pozesky and Ernest Lucier will be particularly interesting because their organization is due to report to Congress about its plans. Pozesky has played a key role in FAA policy in this area.

Low profile for professional topics

Nontechnical, career-related subjects in past IEEE programs have produced only middling turnouts, so there will be very little such discussion at Electro/76. An exception, session 27, promises to be a blockbuster. It covers the controversial issue of the EE past 40.

Harold Goldberg, president of Data Precision Co., Wakefield, Mass., and former vice president of the IEEE's Manpower Planning and Member Employment Committee, has chosen his speakers and the issues to be provocative. The four panelists will have just 10 minutes each to state their positions. Then there will be 40 minutes of discussion among panelists, and then 40 minutes devoted to discussion from the floor.

Among the debating points picked by Goldberg are: continuing education does not help the engineer or the company, or insure job security; if you're not a manager by 35, go into selling insurance; after 40 an engineer's vulnerability to layoff increases as the years to retirement dwindle, and engineers need job counseling, not more technical training.

"We need to air this problem now before it's masked over by a short-term, Band-aid effort of creating jobs in an election year," Goldberg says. "The engineer after 40 is a legitimate problem created in the 1960s, when we overstocked the pond." □

BOSTON: IT OFFERS DELIGHTS···

by Pam Leven, Boston bureau

Electro/76 in Boston means that your ICs and peripherals will be served to you in equal portions with beans and cod and Bicentennial. "The city where it all began" has never been more ready for out-of-towners.

Boston 200, the official Bicentennial Commission, has papered the city with historic markers and maps. It even has put up arrows pointing to nearby telephones, restrooms, water fountains, and information booths. By the time Electro/76 rolls around in May, Bostonians should have had ample experience at helping visitors get about.

There are numerous historical reminders as well as new shows especially produced for the birthday observance. In fact, a visitor is likely to find almost as many residents taking in these new productions as tourists.

Don't miss one of the most imaginative introductions to the city: "Where's Boston?" an eight-screen, multiimage, quadriphonic sound show of today's city and its people. Daily continuous showings are on the hour, 10 to 10, in the red-white-and-blue (what else?) pavilion behind the Prudential Center. Admission: Adults, $2; children, $1.

Another presentation is Victorian Boston, a museum of a century of progress and growth. It features a multimedia show that highlights 19th-century scenes and personalities. It's at Arlington and Stuart streets from 9 to 5. Adults, $1.50; children, 75¢.

"Revolutionary Boston" is another exhibit the visiting Bicentennial buffs will appreciate. If you want to put yourself in the colonists' buckled shoes, take in the computer-and-multimedia presentation at Faneuil Hall Marketplace. After hearing the debates, you can decide your 18th-century political sympathies—revolutionary or loyalists. Hours are 10 to 5. Adults, $1.50; children, 75¢.

If you've already decided you are a revolutionary, you can almost join the fighting at a multimedia reenactment of the Battle of Bunker Hill at the Bunker Hill Pavilion in adjacent Charlestown, 10 to dusk. Adults, $1.50; children, 75¢.

Visitors do not have to depend on shows to get their history, however. A walk along Boston's Freedom Trail, which follows a new route this year, will provide plenty of firsthand history. The historical markers are prominent, and the red bricks that lead the way have been scrubbed.

Pick up a map at the Boston Common on the Tremont Street side or at City Hall, and use either spot as the starting point. During the trek you'll see the site of the Boston Massacre, Old South Meeting House, Granary Burial Ground, Paul Revere's house, Old North Church of one-if-by-land fame, and the Boston Tea Party ship and museum—not to mention the modern city around these spots.

Music moves outdoors in the springtime. There are sidewalk serenaders, ranging from one-person concerts to classical music quartets. For less impromptu musical programs, you can walk easily to a number of inexpensive or free concerts in the area of the auditorium.

The Boston Pops will be at Symphony Hall Monday through Saturday at 8 p.m. The Engineering Societies of New England Inc., 1012 Summer St., Boston, MA 02110 is sponsoring the May 13 Engineers' Night at the Pops. Tickets cost $10.50, $9, $7.50, and $5. Payment must accompany reservations, but the seats are all gone in the $10.50 and $9 sections. For other musical fare, call the Isabella Stewart Gardener Museum (734-1359) and the New England Conservatory of Music (262-1120) for their schedules.

The Red Sox won't be in town until Friday night, against the Milwaukee Brewers. The Bruins (hockey) and Celtics (basketball) could still be in the running for their championships, but don't count on getting tickets.

All you've ever heard about Boston streets (complicated) and Boston drivers (devil-may-care) is true. Parking is even worse. So a good bet is to take the subway when you can, except during rush hours. The Massachusetts Bay Transit Authority lines run from 5:20 a.m. to 1 a.m. and the fare, based on distance, is usually 25¢. To get a map or information, go to any hospitality center (listed below) or call the MBTA at 722-5700.

The local IEEE section will run a shuttle bus every 20 minutes from the parking lot of the RCA facility, Route 62 in Burlington to the auditorium for only $1 round trip. Motorists may also park their car for 25¢ at two stops on the Riverside trolley line and ride in to the auditorium stop for 50¢ (exact fare, please). The lots are at the Riverside stop on Grove Street off Route 128 and at the Woodland stop, Route 16 off 128. The Woodland lot isn't too big, and the trolleys aren't a 24-hour-a-day operation.

There's also much history to relive in Boston's outlying areas. If you don't like guided tours, call the Visitor's Bureau (262-8000) for directions to any of the following:

- Lexington and Concord. See the battle sites as well as the homes and graves of famous authors Alcott, Thoreau, Hawthorne, and Emerson. Colonial Inn in Concord is nice for lunch, by the way.
- Salem and Marblehead. Both are former shipping towns. Salem also has the witch-hunt museum and the House of the Seven Gables.
- Old Sturbridge Village. This recreated working world of New England in the early 1800s is open daily, 9:30 to 5:30; adults, $4, children over six, $1.50.
- Plymouth Rock. Yes, there really is a Plymouth Rock, and nearby are the Mayflower II, a replica, and a recreated Pilgrim settlement. On the way, stop off in Quincy at the Adams Mansion, home of two presidents.
- Gloucester. Famous for its Fisherman's Memorial and its fishing fleet. Adjacent Rockport has a busy harbor beloved of amateur painters.
- Cape Cod. It will be too cold for swimming, but the Cape Cod beach communities are fun to visit, including Chatham, Orleans, and Wellfleet—not to mention artsy Provincetown.

···FOR THE BICENTENNIAL VISITOR

Boston features cuisines from the world over, as well as the region's famous seafood. The list of places to eat, below, has price comments for dinner only. For lunch, quick or leisurely, gourmet or junk food, the Back Bay neighborhood of Hynes auditorium is dotted with cafes and pubs, many within a 10-minute walk.

Back Bay

Cafe L'Ananas
281 Newbury St.
French/Continental
Mon–Sat noon–2:30; 6–11
Moderate.

Cafe Budapest
90 Exeter St.
Hungarian
Sun–Thurs noon–10:30
Fri–Sat 12–12
Expensive; jacket and tie for dinner.

Casa Romero
30 Gloucester St.
Mexican
Tues–Fri noon–2:30
Daily 6–11
Moderate.

Charley's Saloon
344 Newbury St.
American
Daily 11:30–1 a.m.
Moderate.

Copley's
Copley Plaza Hotel
American
Mon–Fri 11:30–3; 6–midnight
Sat 6 p.m.–midnight
Sun 12–12
Moderate; jacket and tie at dinner.

Genji Restaurant
327 Newbury St.
Japanese
Mon–Fri 11:30–2:30
Daily 5:30–11
Moderate.

Half Shell
743 Boylston St.
Seafood
Daily 11:30–2 a.m.
Moderate

J.C. Hillary
793 Boylston St.
American
Daily 11:30–midnight
Fri–Sat 11:30–12:30 a.m.
Moderate.

Joseph's
279 Dartmouth St.
French
Mon–Sat 11:45–11
Lavish; jackets and ties.

Ken's
549 Boylston St.
Deli
Daily 7 a.m.–3 a.m.
Low-moderate; no credit cards.

La Crepe
731 Boylston St.
French crepes and omelettes
Daily 11:30–midnight
Moderate.

Magic Pan
45 Newbury St.
French crepes
Mon–Sat 11:30–midnight
Sun 11:30–10
Moderate.

Ritz Carlton Dining Room
15 Arlington St.
New England and Continental
Daily noon–2:30; 6–9
Lavish; reservations and jackets for dinner.

Stockpot
119 Newbury St.
Soup and salad
Mon–Sat noon–8:30
Low-priced

Top of the Hub
52nd floor of the Prudential Tower
American
Mon–Sat 11:30–3:15; 5:30–midnight
Sun 11–2; 4:30–midnight
Moderate–expensive; jackets for dinner.

Zachery's
Colonnade Hotel
Continental
Daily 5–2
Lavish.

Downtown

Benihana of Tokyo
201 Stuart St.
Japanese
Mon–Fri noon–2:15; 5:30–9:30
Sat 5:30–10:30
Sun 4:30–8:30
Moderate; dinner reservations.

Bette's Rolls Royce
(parked outside), 1 Union St.
American
Daily 11:30–2 a.m.
Moderate.

Dini's
Park Square
Seafood
Mon–Sat 10:30–10:30
Sun 11–10:30
Moderate.

Dunfey's Last Hurrah
Tremont and School streets
Seafood and steaks
Daily 11:30–2 a.m.
Moderate.

Durgin Park
30 North Market St.
Boisterous New England
Mon–Sat 11:30–9
Moderate; no credit cards

Jacob Wirth's
31–37 Stuart St.
German
Mon–Sat 10:30–9:15.
Low-priced; no credit cards.

Locke-Ober
3–4 Winter Place
French and American
Mon–Sat 11–10
Lavish; reservations and jackets.

Maison Robert
45 School St.
French
Mon–Fri 11:35–2:30; 6–10
Sat–Sun 6–10
Expensive.

Union Oyster House
41 Union St.
Seafood
Sun–Mon 11–9
Fri 11–9:30
Sat 11–10
Moderate.

Waterfront

Anthony's Pier 4
140 Northern Ave.
Seafood specialties
Mon–Sat 11:30–11
Sun 12:30–10:30
Expensive; jackets and ties for dinner.

Chart House
60 Long Wharf
American
Mon–Thurs 5–11
Fri–Sat 5–midnight
Expensive.

Dom's
236 Commercial St.
Northern Italian
Mon–Fri noon–2:30
Mon–Sat 5:30–1:30 a.m.
Sun 12–12
Moderate–expensive.

Jimmy's Harborside
242 Northern Ave.
Seafood specialties
Mon–Sat 11:30–9:30
Moderate–expensive; jackets for dinner.

No-Name Restaurant
15½ Fish Pier
Very fast seafood
Mon–Sat 8 a.m.–9:30 p.m.
Low-priced; no credit cards.

Here are numbers
to call for places to go and things to do:

338-1975, 1976 *When it All Begins*, a service of Boston 200, provides daily recorded information on Bicentennial and other activities:

261-1600 *Artsline*, a service of the Mayor's Office of Cultural Affairs, provides daily recorded information of the city's cultural activities:

1-800-0980 *Massachusetts Bicentennial Commission's* toll-free information on statewide activities.

Hospitality and information centers:

Where's Boston exhibition at Prudential center, Mon-Sat 10 a.m.-11 p.m.;
City Hall at Government Center, Mon-Fri 9-5;
Boston Common, daily 9-5.

For more information (with maps) on eating, drinking, and numbers to keep handy, get a copy of *"Boston. The Official Bicentennial Guidebook,"* blessed by Boston 200. Costing $1.50 at most bookstores, it tells all about shopping, museums, attractions, theater, music, dance, taxis, buses, rentals, shuttles, and gives a brief history of the city.

Op amp improves plasma probe's sensitivity

by P.J. Cherian and P.R.M. Panicker
Vikram Sarabhai Space Center, Trivandrum, India

In measuring extremely small currents, a probe electrode must have its voltage supply isolated from the current amplifier if leakage of the supply currents is not to limit the accuracy of the measurements. The need for such isolation vanishes, however, if the voltage is applied to the probe through an operational amplifier, as shown in the figure.

One use for this technique is in the measurement of the electron density and temperature of a plasma. An alternating voltage is applied to the electrode in contact with the plasma, and currents ranging from milliamperes to picoamperes are collected [*Electronics*, May 25, 1962, pp. 18–19]. The circuit shown here was developed for use in the ionosphere, with the probe projecting from the body of a rocket into the atmospheric plasma.

Voltage E_i is applied at the noninverting input terminal of operational amplifier A_1 and, because of the enormously high open-loop gain of the operational amplifier, appears at the inverting input terminal. This inverting input terminal is connected directly to the electrode without any series resistance so that currents drawn by the probe will not change the probe's voltage level. Operational amplifier A_1 has a field-effect-transistor input with a bias current of only a few picoamperes. Therefore, if I is the current drawn from the plasma, the output of A_1 is given by:

$$E_{o1} = E_i + IR_1$$

The second operational amplifier, A_2, is used as a differential amplifier to prevent applied voltage E_i from appearing at the output. The final output voltage is:

$$E_o = (R_3/R_2)IR_1$$

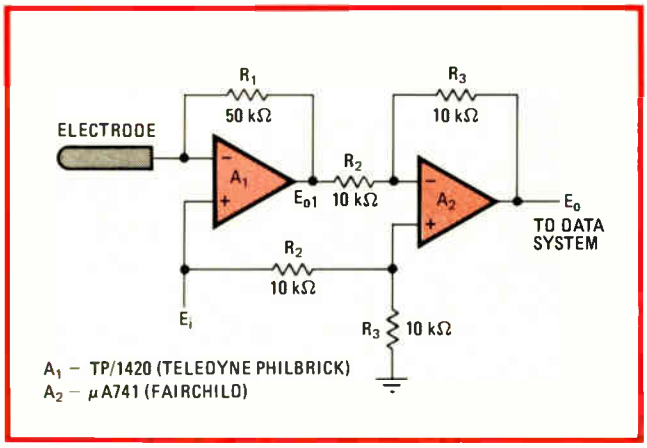
so the current drawn by the probe is given by:

$$I = R_2E_o/R_1R_3$$

The output voltage can be recorded on board the rocket or telemetered to a ground station.

To permit measurements over a large dynamic range—a necessity in most plasma-probe measurements—feedback resistor R_1 may be replaced by a network with a logarithmic response.

The circuit has measured currents from 1 milliampere to 0.1 nanoampere. The bias current of A_1 is only 15 picoamperes, so currents as small as 50 pA can be measured. □



Plasma probe. Rocketsonde studies of density and temperature of electrons in the ionosphere may be achieved by measuring the current drawn to an electrode that projects out and is well insulated from the rocket body. The circuit shown here applies potential to the electrode through an op amp, thus avoiding voltage-supply-insulation problems and leakage errors in current measurement. Circuit measures currents from 10^{-3} amperes down to 5×10^{-11} A.

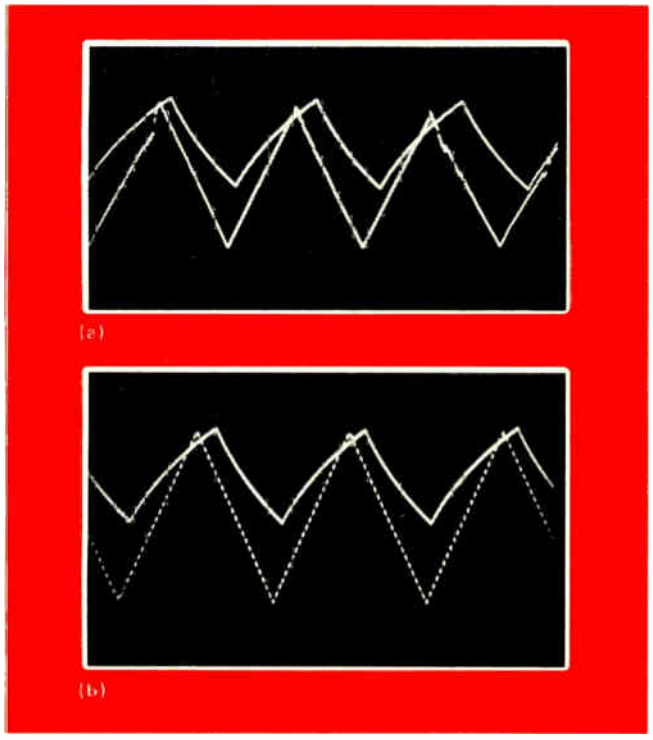
555 timer tags waveforms in multiple scope display

by Howard M. Berlin
Edgewood Arsenal, Aberdeen Proving Ground, Md.

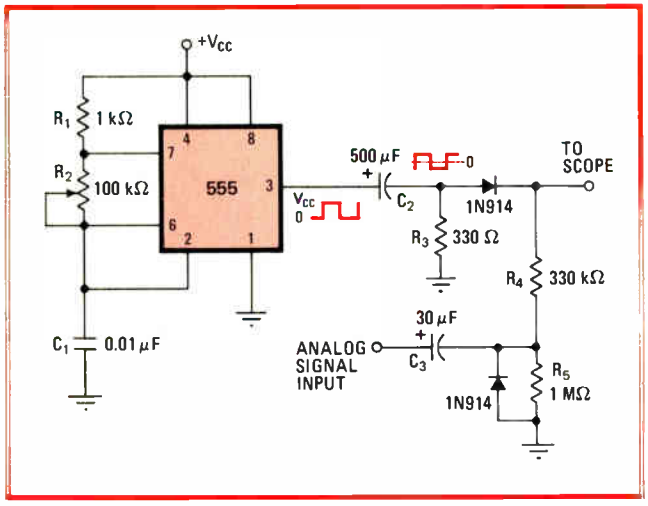
When two or more analog signals referenced to a common base line are simultaneously displayed on an oscilloscope, it is sometimes difficult to distinguish between the waveforms. By using a 555 integrated-circuit timer, dotted or dashed line markers can be added easily to one or more analog signals (Fig. 1).

By means of the circuit shown in Fig. 2, the 555 is connected as an astable multivibrator. The scope's trace position at any instant is determined by the sum of the voltages across R_4 and R_5. When the square wave across R_4 is zero, the trace position is determined solely by the analog input signal. When the square wave across R_4 is not zero, it drives the trace off the screen. The fast rise and fall of the pulse cannot be seen at normal scope intensity.

The supply voltage V_{CC}, and, consequently, the output voltage of the 555, must be greater than the peak-to-peak voltage of the analog signal, which can range from 4.5 V to 16 V. Also, for proper operation, the square-wave frequency should be at least 5 to 10 times the analog frequency. The timer's frequency is easily



1. Tagging. When two or more waveforms are displayed on a single scope (a), identifying markers can be added to the analog input signals to display them as dotted or dashed traces (b).



2. Dots all, folks. A 555 integrated-circuit timer generates pulses that drive the scope trace off scale with fast rise times and fall times, to produce a dotted or dashed display of a waveform. The timer frequency, set by R_2, determines the appearance of the trace.

adjusted by varying R_2. The value of the frequency in hertz is $1.44/(R_1+2R_2)C_1$, where resistance and capacitance values are in ohms and farads, respectively. With the components shown, the circuit can handle without distortion input signals having a peak-to-peak voltage of 1 v. □

An abbreviated guide to electronics abbreviations

by John C. McKechnie
Maitland, Fla.

The use of abbreviations and acronyms in electronics literature enhances the reading, the writing, and the comprehensibility of information exchange. However, the pervasiveness of such terms has made understanding more difficult for many readers who are not familiar with specialized aspects of the technology under discussion. This alphabetized list of more than 150 terms has been compiled during recent months from a large group of technical periodicals. Since new abbreviations are constantly being generated, readers can add new definitions as they are encountered.

a-d	analog to digital
ADS	address data strobe
AIM	avalanche-induced migration
ALU	arithmetic/logic unit
ANSI	American National Standards Institute
AOI	AND/OR invert
ASCII	American Standard Code for Information Interchange
ATE	automatic test equipment
ATS	automatic test system
BBD	bucket-brigade device
BCD	binary-coded decimal
Boram	block-oriented random-access memory
b/s	bits per second
CAD	computer-aided design
CAM	content-addressable memory
CATT	controlled avalanche transit time
CCD	charge-coupled device
CML	current-mode logic
C-MOS	complementary-metal-oxide semiconductor
CMRR	common-mode rejection ratio
CPU	central processing unit
CROM	control read-only memory
CRT	cathode-ray tube
CRC	cyclic redundancy check
CVD	chemical-vapor deposition
CVT	constant-voltage transformer
d-a	digital to analog
DAS	data-acquisition system
DFA	digital fault analysis
DI	dielectric isolation
DIP	dual in-line package
DMA	direct memory access
DMAC	direct-memory-access control
DMM	digital multimeter
D-MOS	double-diffused metal-oxide semiconductor
DMS	dynamic mapping system
DMUX	demultiplexer
DPM	digital panel meter
DTL	diode-transistor logic
DVM	digital voltmeter
Earom	electrically alterable read-only memory

0.05% Portable DC V/A Standard

The highly reliable Type 2554 combines a ±0.05% voltage and current standard packed into a compact, rugged case and can be both AC-line and battery operated. Rechargeable battery operation makes Type 2554 truly portable and completely isolated from the power line. This new instrument delivers output voltages from 0 to ±120V in 5 ranges and output current from 0 to ±120 mA in 3 ranges at a setting accuracy of ±0.05%. Different from other battery-operated DC standards of this class, Type 2554 provides a 100V range and a maximum output of 15V on the 100mA range. Other nifty features include polarity reversal selector, over-current and-voltage protection and fast, exact operation by dial and paddle switches.

Main Specifications

Output Voltage: 0 to 119.99V DC in 5 ranges
Output Current: 0 to 119.99mA DC in 3 ranges
Min. Resolution: 1 μV, 0.1 μA
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EBCDIC extended binary-coded-decimal interchange code
ECL emitter-coupled logic
EDP electronic data processing (or processor)
EFL emitter-follower logic
EFTS electronic funds-transfer system
EOC end of conversion
EPROM erasable programable read-only memory
EROM erasable read-only memory
ESS electronic switching system
Extnd extended data transfer
FDM frequency-division multiplex
FET field-effect transistor
FFT fast Fourier transform
FIFO first in, first out
FPLA field-programable logic array
F-PROM field-programable read-only memory
GDS graphic data system
HiNIL high-noise-immunity logic
HTL high-threshold logic
IC integrated circuit
ICE in-circuit emulator
IDS input-data strobe
IEC infused emitter coupling
I^2L integrated injection logic
I/O input/output
J-FET junction field-effect transistor
JI junction isolation
Laput light-activated programable unijunction transistor
LASCR light-activated silicon controlled rectifier
LCD liquid-crystal display
LED light-emitting diode
LIC linear integrated circuit
LIFO last in, first out
LNA low-noise amplifier
LPTTL low-power transistor-transistor logic
LRU least recently used
LSB least significant bit
LSI large-scale integration
MDS microprocessor-development system
MESFET metalized semiconductor field-effect transistor
MHL microprocessor host loader
MIS metal insulator silicon
MLA microprocessor language assembler
MLB multilayer board
MLE microprocessor language editor
MNCS multipoint network control system
MNOS metal-nitride-oxide semiconductor
Modem modulator/demodulator
MOS metal-oxide semiconductor
MOSFET metal-oxide-semiconductor field-effect transistor
μP microprocessor
MPU microprocessor unit
MSB most significant bit
MSI medium-scale integration
MTBF mean time before failure
MTD mass tape duplicator/verifier
MTTF mean time to failure
MUX multiplexer
NAND inverted AND gate
NDRO nondestructive readout
n-MOS n-channel metal-oxide semiconductor
NOR inverted OR gate
NRZ non-return to zero
NRZI non-return to zero inverted
OCR optical character recognition
ODS output data strobe
OEM original-equipment manufacturer
OPAL operational performance-analysis language
PAR program-aid routine
pc printed circuit
pcb printed-circuit board
PDP plasma display panel
PIA peripheral interface adapter
PLA programable logic array
PLL phase-locked loop
PM phase modulation
PMG permanent-magnet generator
p-MOS p-channel metal-oxide semiconductor
POS point of sale
PPI plan-position indicator
also, programable peripheral interface
PRACL page-replacement algorithm and control logic
PROM programable read-only memory
PTH plated-through holes
PUT programable unijunction transistor
RALU register and arithmetic/logic unit
RAM random-access memory
RIM read-in mode
RMM read-mostly mode
ROM read-only memory
RTL resistor-transistor logic
R/W read/write
SBS silicon bilateral switch
SC semiconductor
SCA subchannel adapter
SCR silicon controlled rectifier
SDLC synchronous data-link control
S/H sample and hold
SIP single in-line package
SOS silicon-on-sapphire
SSI small-scale integration
SUS silicon unilateral switch
TBMT transmitter buffer empty
TTL transistor-transistor logic
T^2L transistor-transistor logic
TTY teletypewriter
TWT traveling-wave tube
UART universal asynchronous receiver/transmitter
URCLK universal receiver clock
Usart universal synchronous/asynchronous receiver/transmitter
USRT universal synchronous receiver/transmitter
UTCLK universal transmitter clock
UUT unit under test
VCO voltage-controlled oscillator
VIL vertical injection logic
VTR video-tape recorder
XOR exclusive-OR gate □

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.

Engineer's newsletter

How to make light work of optical coupling

Interested in looking into fiber-optic data links? Making good couplings to plastic optical fibers is much easier than you might think. And now all the components of a complete system—fibers, connectors, light-emitting-diodes and detectors—are available inexpensively.

Du Pont engineer Tom Balkenol has coupled his company's CrefonR 1040 cable both to LEDs (Fairchild's FLV 104) and to photodetector-amplifier combination ICs (Bell & Howell's 529-2-5) with a minimum attenuation of optical power. Here's the procedure:

Drill a 52-mil hole (#55 drill) into the center of the LED's epoxy lens, coming as close as possible to the chip. **Fill the hole with any epoxy containing 100% solids** (no solvent should be used). The epoxy should be carefully mixed and applied with a syringe to avoid trapping air bubbles.

Next strip off a short length of the polyethylene jacket from the fiber and cut the end with a razor blade. Then bring the cut end close to a hot soldering iron to melt the surface and produce a smooth, slightly curved surface. Insert the finished end into the epoxy-filled hole and let the adhesives set up. Then cut the fiber to a convenient length (2 to 6 in.) and attach it to the cable via a connector.

A length of fiber cable—say 50 meters—can be coupled to that connector and the output end coupled to a variety of detectors.

Why not write your own ticket to the 8080 library?

If you're looking at the 8080 microprocessor system, you might save some money developing your software by joining the Intel users' library. It now contains over 200 user-developed programs ranging from the very complex—like developing universal logic subroutines—to the very simple, like a binary-to-BCD converter. Two other libraries also exist for the 8008 and 4040 systems. It costs $100 to join, and new programs are sent monthly. But **you can get in free by sharing a good program with the library.** Intel Corp., Users Library, Microcomputer Systems, 3065 Bowers Ave., Santa Clara, Calif. 95051.

Unemployment getting worse?

Despite the improvement in electronics business the number of engineers out of work appears to be growing. An analysis of engineering employment, based on a 21-month prediction model developed by Robert Rivers, president of Aircom, Union, N.H., shows that **unemployment has risen sharply this year from 2.9% to almost 4.2% as of April 1.** Even the Bureau of Labor Statistics reports the same trend—its statistics have engineering unemployment for the last quarter of 1975 rising from 2.5% to 2.85%. The Rivers model showed a 0.5% decline in unemployment during the middle six months of 1975, but a sharp reversal thereafter.

Understanding the fast Fourier transform

Using Fourier theory to analyze the frequency-domain response of systems yields helpful information, but requires tedious calculations and understanding of complex mathematics. The fast Fourier transform, or FFT, **a computer program that simplifies the process,** is the subject of a 131-page book by Robert Ramirez of Tektronix Inc. It's available from Tektronix field offices for $25. **—Stephen E. Scrupski**

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Display	LED	LED	Nixie	Binary
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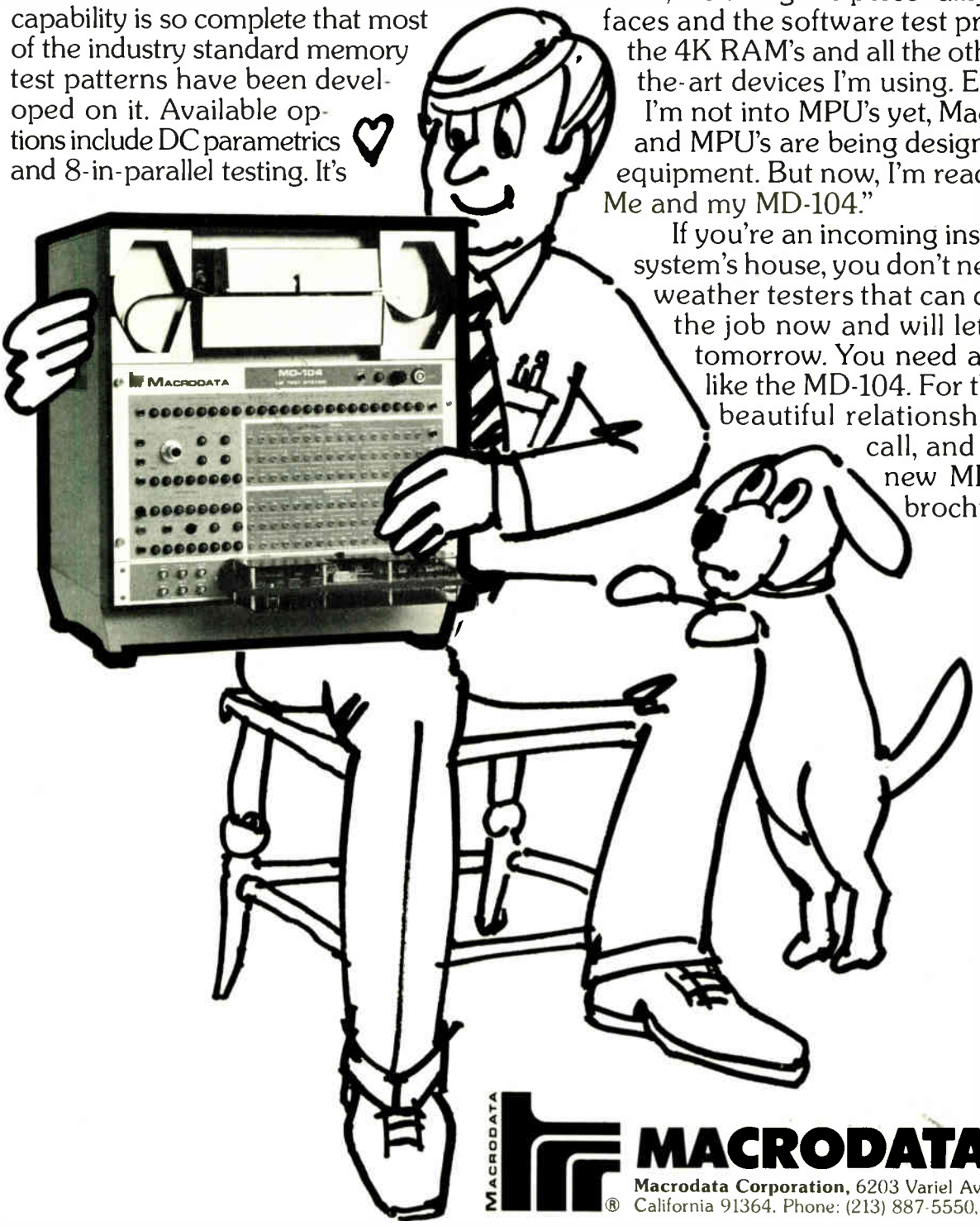

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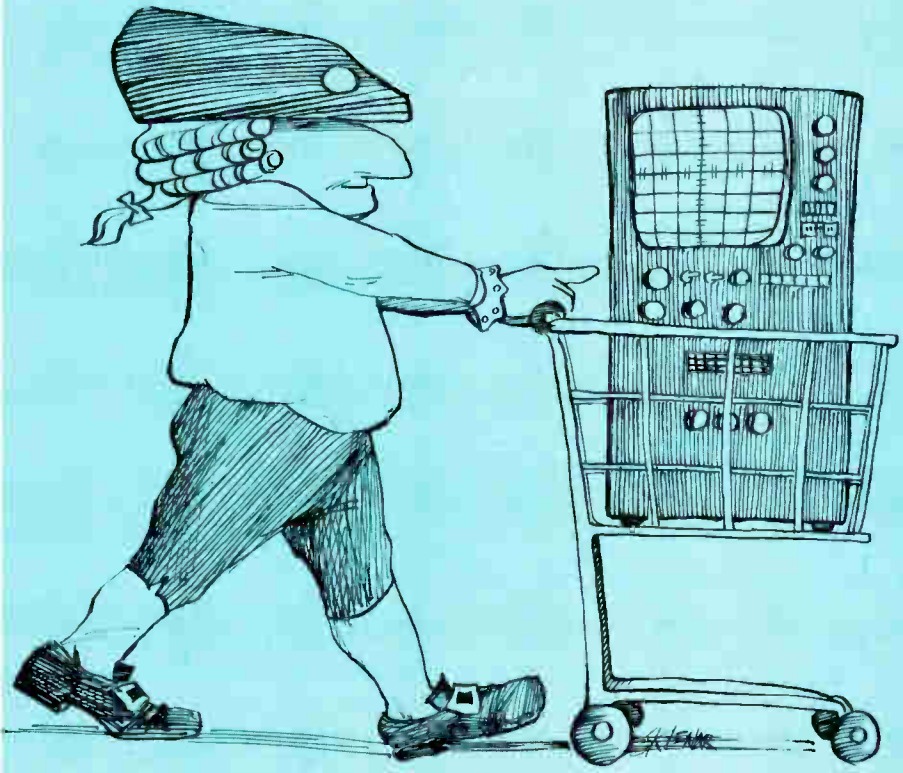
Electro76: new applications sprout



When visitors enter the Hynes Auditorium at the Prudential Center in Boston for Electro/76, May 11-14, they will view the most variegated assemblage of products seen at IEEE's eastern shows in recent years. Emphasis will be, of course, on microprocessors and on 'smart' instruments and terminals—but particularly on new applications of these innovative technologies in the traditional jobs of measuring, controlling, and communicating. The following pages are a preview of some of the more significant products to be unveiled at Electro/76.

Bit patterns can trigger logic analyzers

Logic analyzers have many advantages over oscilloscopes for troubleshooting digital circuits. Perhaps none is more important than the capability to trigger the display on a preset binary word, rather than only a single event.

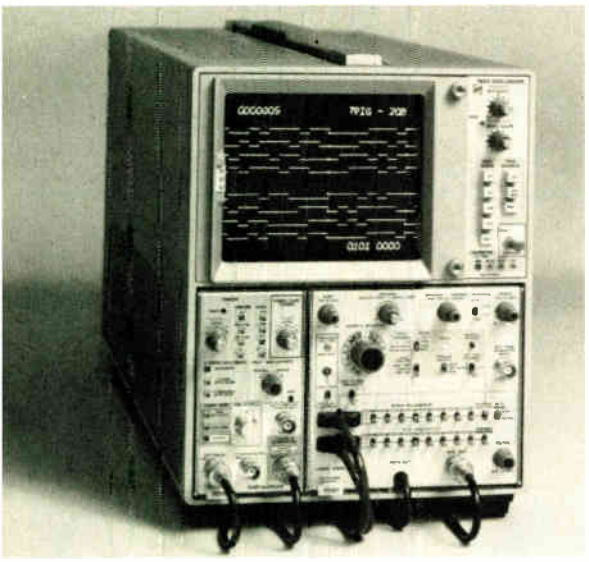
Bit-pattern triggering has been available on a number of logic analyzers, but not on Tektronix' earlier entry in the market, the model LA501 [*Electronics*, Sept. 18, 1975, p. 88]. But Tektronix has recently introduced two products that include pattern-recognition triggering. One, the model WR501 word recognizer and delay, is a plug-in for the firm's TM500 series and can add delay-by-events or -words triggering, as well as bit-pattern triggering, to the similarly configured model LA501. The other, designated model 7D01, is a logic-timing analyzer that plugs into a Tektronix 7000-series oscilloscope mainframe.

The 7D01, priced at $3,195, can capture and display data from 16 input channels with a sampling rate of 20 megahertz and storage of 254 bits per channel, eight channels at 50 MHz and 508 bits per channel, or four channels at 100 MHz and 1,016 bits per channel. It can synchronize sampling with an external clock at speeds to 50 MHz for four or eight channels or 20 MHz for 16 channels.

When used with a 7000-series mainframe that can accept four plug-in units, the 7D01 can provide a logic-timing diagram while real-time vertical and time-base plug-ins produce real-time displays. A three-plug-in mainframe, the $1,800 model 7603, is shown on p. 122.

With the 7D01 plug-in, the cathode-ray tube can display events that occur before, around, or after a trigger signal.

The logic state of interest can be programed into the logic analyzer through the unit's 16-bit word recognizer. The user can then have the trigger signal generated asynchronously whenever the trigger word occurs, or synchronously, so that recognized words between clock pulses are ignored. To minimize the possibility of false triggering, the word recognizer has an operator-adjustable filter that requires the rec-



ognized word to remain true for a minimum length of time between 5 nanoseconds and 300 ns before a trigger pulse is generated. Triggering can also be controlled through two qualifier inputs that must operate before the word recognizer comes into play.

The 7D01 can impress two cursors onto the display. One indicates the trigger position. The second, a movable cursor, simplifies timing comparisons between channels.

When the movable cursor is set to a given clock position, the data word at that point is read out as 1s and 0s on the CRT. Up to 16 bits can be read out, and they can be formatted in 3- or 4-bit groups. The location of the trigger and the number of sample intervals between the trigger and the cursor are also read out on the CRT screen.

The WR501 word recognizer and delay adds some of these features to the $3,250 LA501 logic analyzer. Priced at $1,500, the WR501 takes up a single plug-in slot in any TM500-series instrument mainframe. Tektronix offers a combination of the LA501 and WR501, designated LA501W, for $4,450. Delivery is 25 weeks for the WR501 and 10 weeks for the 7D01.

Interface with WR501 is via two nine-channel active probes. The inputs may either be the same as those for the logic analyzer, or an independent set of 16 lines. Separate threshold controls for each probe simplify testing mixed-logic circuits.

The WR501 contains a digital delay unit that can hold off analyzer operation by up to 99,999 recognized words or by up to 99,999 events such as clock pulses.

Tektronix Inc., P. O. Box 500, Beaverton, Ore. 97077 [341]

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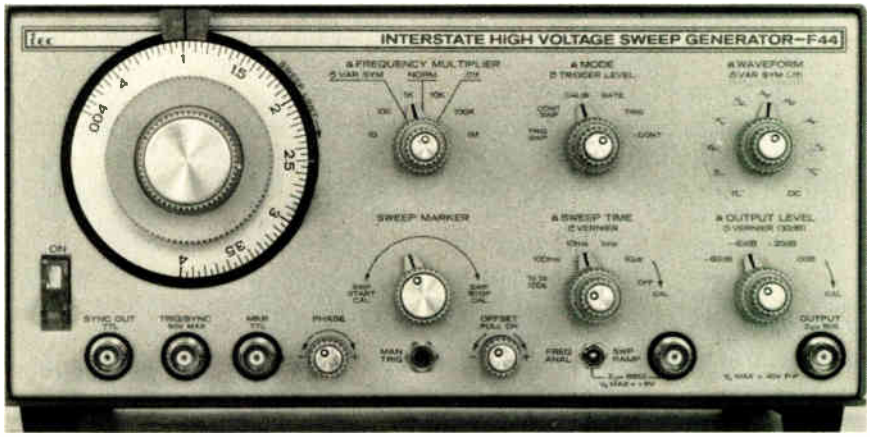
Function generators put out 40 V

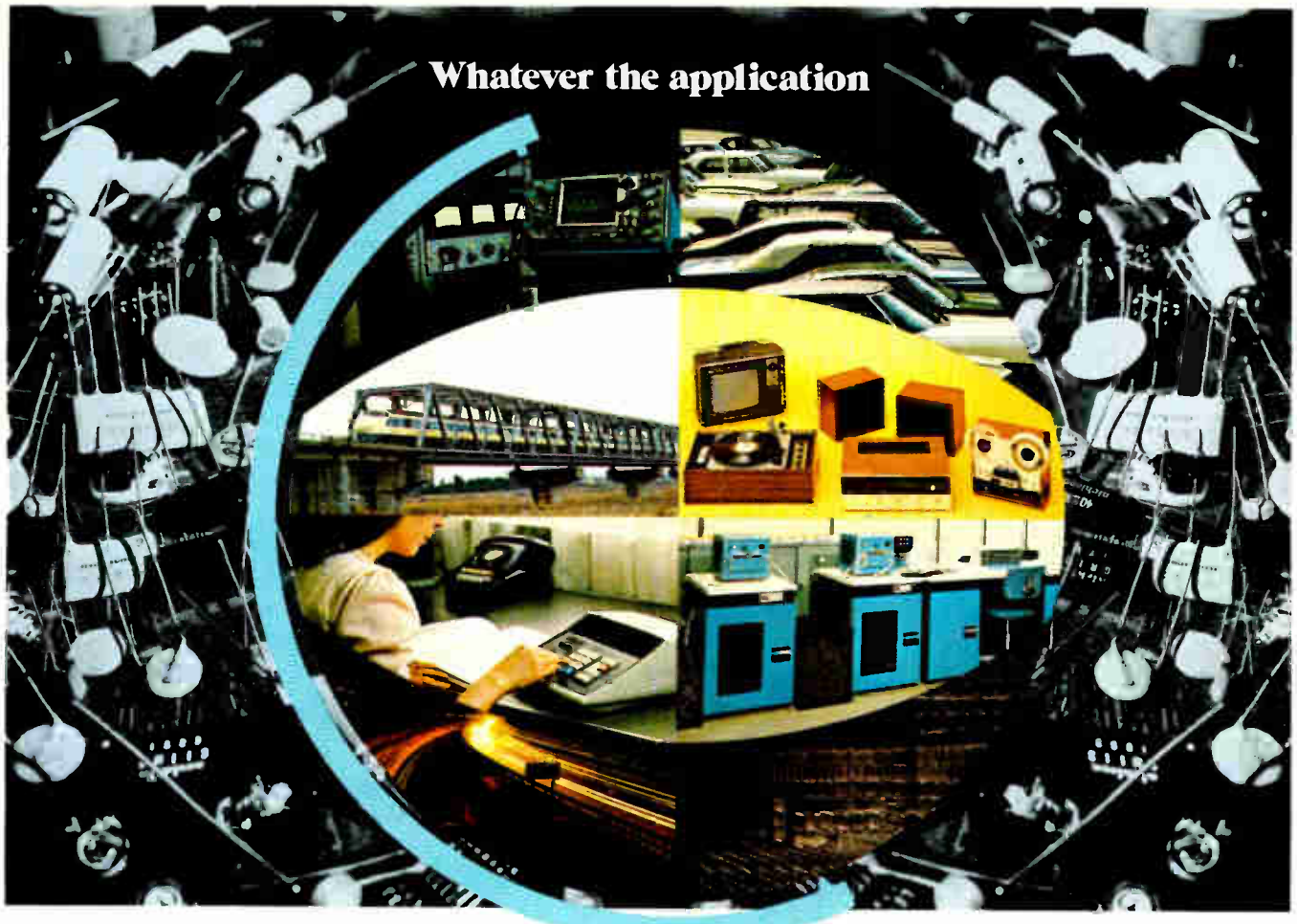
In response to what it anticipates is a budding market for function generators with outputs higher than 20 volts open-circuit, Interstate Electronics Corp. has developed two 40-V models. "Our market research showed that users would like the higher voltages," explains Robert Visser, marketing manager of the products division. He expects the 40-V generators initially to be used for driving a large number of devices in education applications and then in audio-testing. He also notes the trend toward higher-voltage complementary-MOS circuitry for industrial applications. Interstate's market studies concluded that 90% of all generator needs could be met by the 40-V (20-V into 50 Ω) units, in contrast to only 50% by the 20-V models.

Designated the series 40, the two generators produce waveforms from 0.004 hertz to 4 megahertz. At $595, the model F44 provides linear-sweep capability. For $675, the model F47 adds logarithmic/linear sweeps and operator-selectable single frequencies between the start- and stop-sweep frequency settings.

Both generators have the frequency-marker function, which Visser says previously has been available only on more expensive high-frequency sweep generators for calibration at 100 MHz and higher. The marker shows the operator precisely at what frequency an aberration occurs in a swept waveform of a device under test. The marker setting then provides a dc-level change for viewing, and a vernier control shifts the change point to coincide with the frequency, which can be read on a counter.

Each model produces 11 different waveforms, including bipolar and unipolar, positive and negative, and pulses as short as 120 nanoseconds—all with offset control. The model F47 includes a fully controllable 11-point single-frequency selector so that the user can initiate single, non-swept outputs at evenly or logarithmically spaced points without running through the entire preset frequency range. Since applications typically involve step-by-step quality assurance or production testing, the capability to easily select a num-





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ber of frequencies for checking response curves is a big advantage, Visser says.

The internal sweep generator, which is independent of the main generator, can produce continuous and triggered linear ramps. Sweep time is adjustable from 10 microseconds to 100 seconds.

Interstate Electronics Corp., Dept. 7000, 707 E. Vermont, P.O. Box 3117, Anaheim, Calif. 92803. Phone (714) 549-8282 [342]

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Sample-hold amplifiers aimed at industrial uses

To a significant extent, recent decreases in the size and price of data-acquisition subsystems can be attributed to developments in hybrid circuits. The latest is a medium-speed sample-and-hold amplifier that comes complete with an integral holding capacitor and laser trimming to 12-bit accuracy for $34 each in small quantities. The SHC80 has an acquisition time (to 0.01%) of 10 microseconds for a 10-volt step; for 20-v, the time is 12 μs. Throughput offset is a maximum of 2 millivolts, but can be trimmed to zero with an external potentiometer. Droop rate is a maximum of 0.5 mv per second at room temperature but may double for every 10°C increase in temperature.

Because of its low cost and ability to provide 12-bit performance without external trimming, the SHC80 is suitable for reducing aperture time and eliminating conversion noise in a wide variety of industrial applications. For applications for which the 0° to 70°C operating range of the standard SHC80KP is not sufficient, there is the SHC80BM. This latter unit operates from −25° to 85°C and sells for $43 in singles.

Both units have input impedances of 100 megohms shunted by 5 picofarads, and both can be controlled by transistor-transistor-logic or complementary-metal-oxide-semiconductor levels. Bias current for the analog input is 400 nanoamperes. Designed to handle input voltages from −10 volts to +20 v, the SHC80 can safely take up to ±15 v. Its gain drift is no more than 3 ppm of 20 v/°C.

Available from stock to four weeks, the SHC80 is housed in a 14-pin dual in-line package.

Burr-Brown Research Corp., International Airport Industrial Park, Box 11400, Tucson, Ariz. 85734. Phone Joe Santen at (602) 294-1431 [343]

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Digital thermometers offer 16 ranges

Designed to meet varying needs within a single system, Fluke's 2160A and 2170A series of digital thermometers are available with single-point, multi-point, and multi-type thermocouple inputs, with resolutions of 1° for the 60 series and 0.2° for the 70 series.

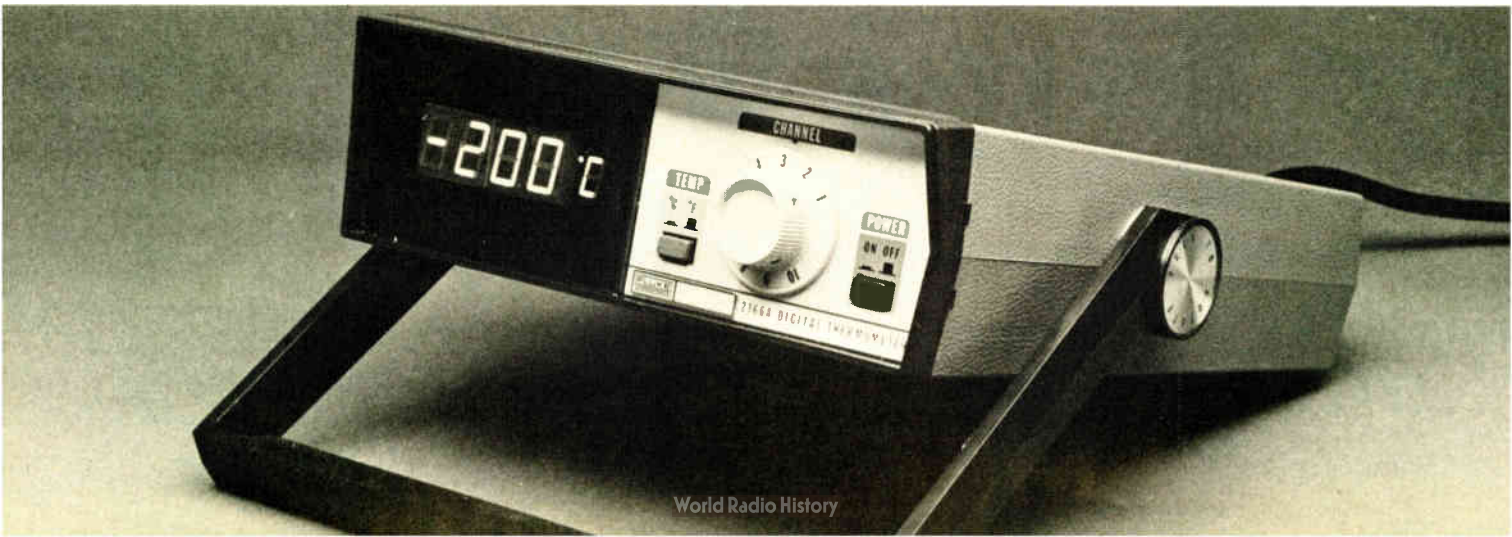
The thermometers are available as bench units or in a panel mount that conforms with DIN standards.

The thermometers can measure temperatures from −200 to +2327°C (+3999°F). Sixteen temperature ranges are available, with temperature-scale selection (°C or °F) through front-panel access to a jumper plug on panel units or by front-panel push buttons on bench models. Prices start at $299.

Optional drop-in battery packs are available for bench models. All units have outputs for digital printers, computers, or analog strip-chart recorders.

The model 2160A, priced at $299, is a panel-mounted, single-point unit with a 4-digit display. It accepts thermocouple types J, K, T, E, R, S, C, or B. The model 2165A, priced at $350, is a bench-top unit; the model 2166A is a bench model, multi-point unit with switch selection of up to 10 thermocouple inputs. The model 2168A is a bench model, multi-type thermometer with switch selection of up to eight thermocouple types.

The model 2170A, priced at $425, is a panel-mounted 4-digit thermometer. It accepts thermocouple types J, K, T, and E. Maximum range is 1,000°. The 2175A is a



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Graphics $2995

bench version, as is the 2176A, which provides front-panel switch selection of up to 10 thermocouple inputs. Delivery is from stock.
John Fluke Mfg. Co. Inc., P.O. Box 43210, Mountlake Terrace, Wash. 98043 [344]

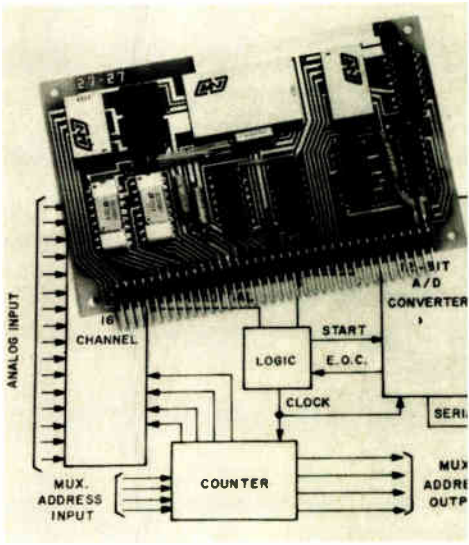
Data systems are rugged

Data-acquisition systems are finding their way into applications that need ruggedness, such as data-logging in pipeline and seismic systems. In response to this requirement, Micro Networks Corp. has developed a 16-channel system in two versions—the MN7002 covering 0 to 70°C, and the MN70002H, which handles the full military range from −55 to +125°C.

Both units offer 16 single-ended or eight differential channels, expandable as an option to 256 single-ended channels. Maximum linearity for the military model is ±½ least significant bit and for the MN 7002 ±1 LSB from 0° to 70°C—both worst-case ratings. Both units offer 12-bit resolution, and their input voltage ranges are −10 to +10 V. Both have tri-state outputs.

Robert Jay, president, points out that no adjustments are required for the units, either upon receipt or in field calibration, because Micro Networks laser-trims the analog-to-digital and digital-to-analog portions of the system at the factory to the user's specifications.

Acquisition time is typically 13 microseconds for both units, and they can cycle through all 16 input channels 2,500 times a second. Both systems can be mounted to a motherboard at right angles.



Jay notes that the units hold their linearity with temperature and function in extreme temperatures because thin-film hybrid circuitry is used throughout, and the units are hermetically sealed.

The MN7002 sells for $495 in quantities of one to 24, and the MN7002H is priced at $895 for the same quantities.
Micro Networks Corp., 324 Clark St., Worcester, Mass. 01606. Phone (617) 852-5400 [345]

LSI upgrades instrument family

A single large-scale integrated circuit provides higher performance and reliability than the thousands of discrete components it replaces in a family of eight digital instruments introduced by the Data Tech division of Penril Corp. Capabilities not previously in their price range are provided by the four frequency counters, three universal timer/counters, and an automatic modulation meter.

All eight models have a time-base stability of ±3 parts in 10^7 per month and rfi-shielded metal cases for protection in electrically noisy environments. A two-year warranty on all eight instruments is made possible by the reliability inherent in the LSI chip. The chip provides input and output gating, clocking, decade counting, time-base, and associated logic circuits.

All four frequency counters, from

introducing

THE NEW WESTON AUTORANGING PORTABLE DMM

The best buy ever in a portable digital multimeter

ONLY $195

Performance, quality, reliability and price. The new Weston Model 6000 is a total value package and the best buy ever in a portable digital multimeter. Just check these performance and convenience features.

Autoranging-plus factor in a portable

The simplicity, speed and accuracy of automatic ranging is a big advantage in a low cost portable digital multimeter. And in the Model 6000, it's available for the five standard measurement functions . . . AC/DC Volts, AC/DC Amps, Resistance . . in 26 broad ranges. . with full overload protection. Zero adjustment for all ranges is built-in . . automatically.

A bonus feature is a 10 Amp AC/DC current range . . . not usually available in digital instruments. And a special "Hold" input jack provides a convenient memory retention capability for remote measurements.

Superior performance in a portable

Even in a low priced portable, Weston quality proves itself. The high performance capability of the Model 6000 is typified by an accuracy of 0.35%, with resolution of 100 μv, 1 μa and 0.1 ohm.

Large, easy-to-read-anywhere display

Even in bright sunlight, it's easy to read the large 0.5" high LCD 3½ digit display. Alternate blinking of the LCD's provides an over-range indication that prevents erroneous readings. And minus polarity is measured and displayed automatically without reversing leads.

Low power operation

Power source for the Model 6000 is two inexpensive, easily available 9V transistor batteries. Long battery life is assured by special circuits designed by Weston for low power drain. And when the batteries do run low, the LCD display blinks to tell you.

Small and lightweight . . . but rugged

The Model 6000 portable is small in size and weighs less than two pounds. The rugged glass-filled Lexan® case can withstand tough treatment. A combination carry handle/display cover/tilt stand makes it convenient and practical for field or bench use.

® Trademark, General Electric Co.

Weston service back-up

The Model 6000 is backed-up with the Weston total service commitment. Complete full year warranty, with service available at any of Weston's domestic or foreign service centers. Another plus factor for a low-priced portable DMM.

The new Weston Model 6000 Autoranging Portable DMM doesn't scrimp on performance, quality or reliability . . . it just brings them to you at a better price.

MODEL 6000
A field type multimeter with bench instrument performance

See the Model 6000 at any Weston Distributor. Or, write direct to Weston for additional information.

Weston Instruments, Inc., 614 Frelinghuysen Ave., Newark, NJ 07114

Canada: 1480 Dundas Highway, Mississauga, Ontario
Europe: Ingolstadter Str. 57a 8 Munchen 46, W. Germany

WESTON® WESTON Schlumberger

Circle 127 on reader service card

New products

the seven-digit model 111, which operates at 120 megahertz, to the nine-digit model 117 at 560 MHz, have automatic gain control for simple measurement of complex or noisy waveforms. Each possesses 10-millivolt sensitivity and overload protection to 250 volts rms. Options are a time base to ±5 parts in 10^{10} stability (also offered on the timer models) and a frequency multiplier for fast, low-frequency, high-resolution operation.

Time-interval averaging in each of the three universal counter-timers yields resolutions up to 100 picoseconds. All models have 10-millivolt sensitivity, overload protection to 250 volts rms, variable dc offset, and a full complement of triggering controls with scope monitors. Models 101 and 103, rated at 50 megahertz, and model 105, at 200 MHz, measure frequency, single or multiple periods and their ratio, and single- or dual-channel time intervals.

The model 209 modulation meter permits completely automatic a-m and fm modulation measurements that are accurate to within 3% over a 1.5-gigahertz frequency range. The meter adjusts input level, locks onto the frequency, and displays the percentage of modulation.

Prices for frequency counters start at $350 each for the 120-MHz model 111 and go to $1,250 for the top of the line, the model 117. For the universal counter-timers, prices range from $675 to $850. The model 209 modulation meters sells for $1,225. Options for all models include a battery pack for portable operation, carrying case, and rack-mount kit.

Data Tech Division, Penril Corp., 2700 Fairview St., Santa Ana, Calif. 92704. Phone (714) 546-7160 [346]

ELECTRO76 ELECTRO76 ELECTRO76 ELECTRO76 ELECTRO76 ELECTRO76 ELECTRO76 ELECTRO76

D-a module gives 'true' 14 bits

In data converters, resolution and accuracy do not always correspond, particularly when resolution is 12 bits or higher. However, Dynamic Measurements Corp. is now offering a modular digital-to-analog converter whose resolution is 14 bits, with the corresponding maximum error of ±0.006% of full-scale range, ±0.5 least significant bit.

This so-called "true" 14-bit module, the model 2470, is small, too—it measures only 2 by 2 by 0.4 inches. It is a current-output device intended for high-speed high-resolution displays in commercial applications. Operating temperature range is 0°C to 70°C.

Settling time to 0.006% is 500 nanoseconds typically, 700 ns maximum. Dynamic Measurements achieves this response by using a fast-settling internal reference. The user can select any of five standard output ranges, which are programed with internal resistor networks by interconnecting external pins.

The new converter offers a maximum gain stability of ±7 ppm/°C. It is compatible with both transistor-transistor and diode-transistor logic devices. Output coding can be either complementary binary (unipolar) or complementary offset binary (bipolar). Full-scale output for the unipolar range is 0 to 2 milliamperes, and for the bipolar output range, −1 to +1 mA.

In small quantities, the model 2470 is priced at $325 each. Delivery time is within two weeks.

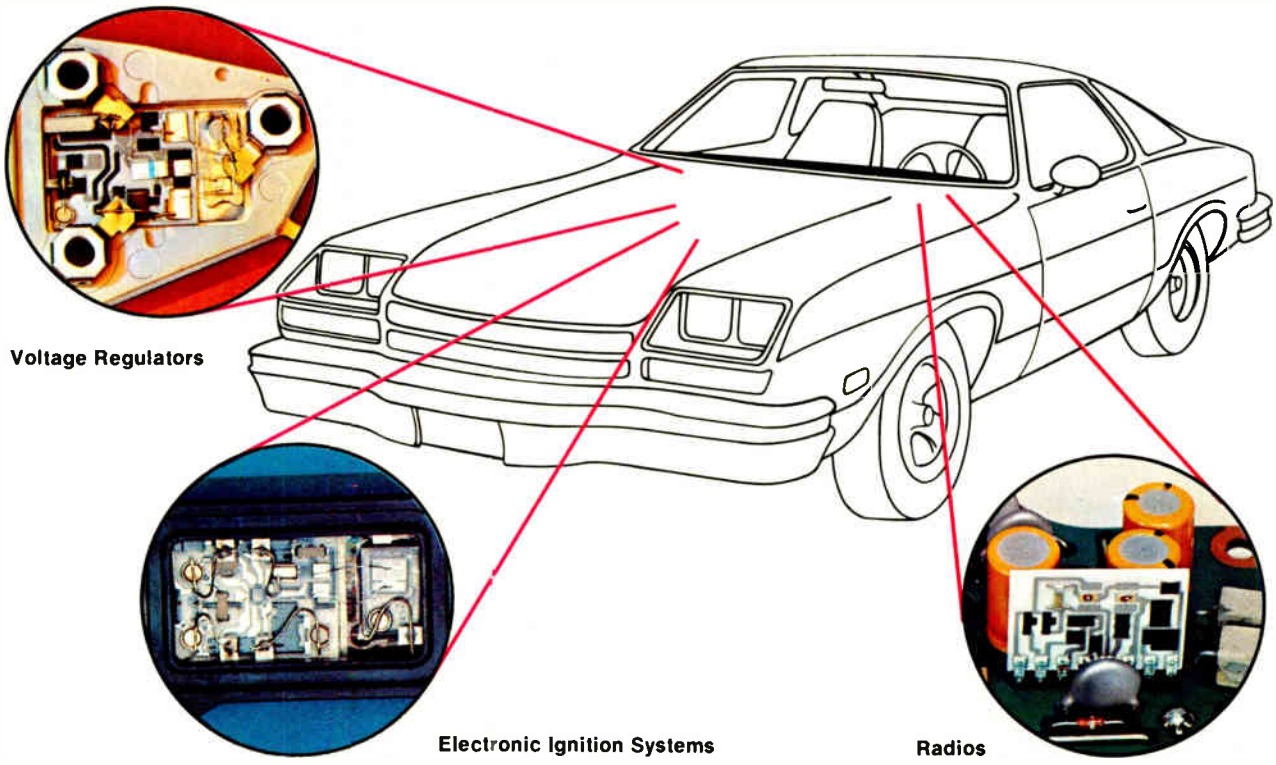
Dynamic Measurements Corp., 6 Lowell Ave., Winchester, Mass. 01890. Phone (617) 729-7870 [347]

ELECTRO76 ELECTRO76 ELECTRO76 ELECTRO76 ELECTRO76 ELECTRO76 ELECTRO76 ELECTRO76

Amplifier puts out 75 watts

Laboratory-type instrumentation amplifiers sometimes offer high-power or high-voltage outputs, but few can deliver both, along with a wideband capability. But Krohn-Hite Corp.'s model 7500 is doing

BME™ Capacitors- Proven Reliability For Automotive Applications



USCC/Centralab, the major supplier of monolithic ceramic capacitors to the largest manufacturers of automotive hybrid electronics. The automotive environment can be considered the ultimate proving ground for component reliability. Under-the-hood systems provide a hostile environment where moisture, temperature extremes, shock and vibration are constant. It is a tremendous challenge to supply a component economical enough for an automotive application which can stand up to their rigorous specifications.

And Centralab is there, providing over 3.9 million BME-Chip™ Capacitors which are in 2.25 million domestic cars and light trucks. Over 11 billion unit life hours in ignition systems, voltage regulators and radios, without a single known failure. That's reliability!

Compare your requirements with those of the automotive industry. We're sure you'll choose BME™ Capacitors . . . reliability and availability at a low cost.

Please write on company letterhead for complete technical test reports.

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For Free sample circle 129

just that with its up to 75 watts of continuous power (150 W with direct current), plus its 125 volts rms from dc to 100 kilohertz, 95 V at 500 kHz, and 45 V at 1 megahertz.

The variable-output dc-offset control permits use of the 7500 as an auxiliary power supply within the specified voltage and current limits because of the direct-coupled output and high power capability. With no input signal applied, the dc offset is adjustable from 0 to ±200 V, open circuit.

In addition, the 7500 is a direct-coupled amplifier, using cascaded power transistors instead of a conventional transformer in the output stage to achieve direct output coupling as well as the high power and voltage capability. The output transistors are protected from short circuits or other abnormal conditions on the amplifier's output by means of a modified fold-back current-limiting technique. That design permits the limiting current to vary as a function of output voltage, load, and frequency.

Krohn-Hite officials also say that the amplifier's low distortion—less than 0.1% total harmonic distortion at full power output from dc to 10 kHz—combined with the wideband performance and adjustable gain, add to its attraction. The fixed voltage gain, which is noninverting, can be selected for a gain of either 20 decibels (gain of 10) or 40 dB (100). Voltage gain is also continuously adjustable from 0 to 40 dB.

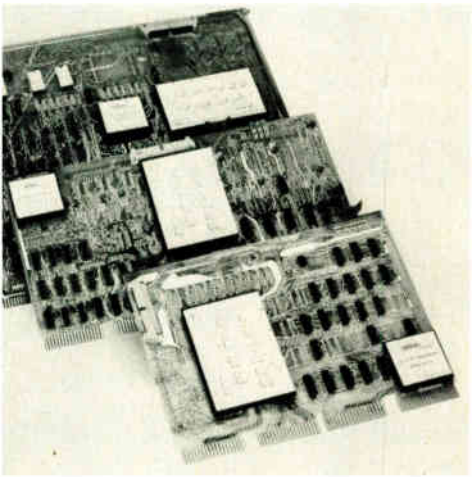
Price of the 7500 is $1,500.

Krohn-Hite Corp., Avon Industrial Park, Bodwell St., Avon, Mass. 02332. Phone (617) 580-1660 [348]

Data-acquisition systems stress economy

In data-acquisition systems for the extremely cost-conscious industrial marketplace, economy is perhaps even more important than it is in other areas of electronics. One good way to cut costs in this area is to buy no more performance than you need. To make this easier, Adac is introducing its Economy Series of computer-compatible data-acquisition and control systems. Similar to the company's earlier units, except for a throughput rate of 35 kilohertz instead of 100 kHz, the series is offered in versions that are compatible electrically, mechanically, and in software with the Nova series and the Eclipse computers made by Data General Corp., Southboro, Mass., and with the PDP-11 series and the PDP-8E, F, M, and A computers made by Digital Equipment Corp., Maynard, Mass.

The basic system, which provides



12-bit performance for 16 single-ended or eight differential input channels, sells for $1,295. Up to 64 single-ended (32 differential) channels can be provided at a cost of $100 for each block of 16. A programable-gain option adds $150 to the system price. Other options include direct-memory access and 12-bit digital-to-analog converters for control.

The Economy Series is rounded out by four control-only systems that include from one to four d-a converters but drop the input multiplexer, analog-to-digital converter, and sample-and-hold amplifier of the data-acquisition system. Pricing on these units ranges from $550 to $995. All units in the line include the bus interface circuitry needed for each computer.

Adac Corp., 118 Cummings Park, Woburn, Mass. 01801. Phone A. L. Grant at (617) 935-6668 [349]

MNOS memory is fast

Compatible with TTL and C-MOS families, a 1,024-bit MNOS (metal nitride oxide semiconductor) memory is fully decoded and nonvolatile.

Developed by Nitron, a division of the McDonnell Douglas Corp., the memory is designated the NCM7050. Unlike the earlier NCM7010, which was designed for low power rather than speed, the 7050 achieves speeds comparable with many MOS memories. It has a chip-access delay time of 500 nanoseconds, a read-cycle time of 4 microseconds, and a write time of 1.5 to 2 milliseconds, says Richard Sirocka, new product planning manager at Nitron.

The memory array is organized in 64 rows or blocks by 16 columns, and the blocks are divided into 4 words of 4 bits each. The block gate driver selected by the block address decoder and programed by the mode decoder provides the memory cell drive for read/write and erase. Entire blocks are transferred between the memory and an internal latch during read and write, and entire blocks are cleared during erase.

The 7050 is similar in structure to a conventional nitride-passivated

New products

p-MOS transistor except that the oxide layer is very thin, thus offering true nonvolatility in that—once the threshold is set—data is stored without further consumption of power, the readout is essentially nondestructive, and the data may be electrically reset. The 160-by-160-mil chip in a 24-pin dual in-line package dissipates 500 to 700 milliwatts.

Aimed at such applications as nonvolatile-memory calculators, code translation, preset frequency tuning, repertory dialers, backup memories, remote-reading utility meters, machine controls, and point-of-sale terminals, the NCM7050 is priced at $20 each. Volume pricing on the nonvolatile memory has not yet been set.

McDonnell Douglas Corp., Nitron Division, 10420 Bubb Rd., Cupertino, Calif. 95014 [350]

ELECTRO76 ELECTRO76 ELECTRO76 ELECTRO76

Full coverage

Responding to the demand for a-m and fm signal generators to cover a range wide enough to eliminate the need for more than one instrument to cover the broadcast bands, Boonton Electronics has extended the range of its models 102A and 102B, reducing the lowest carrier frequency from 4.3 megahertz to 450 kilohertz.

In the new models 102C and 102D, residual fm at 500 megahertz is typically 10 hertz over a 0.03-to-3-kHz bandwidth, and the single-sideband noise floor is less than 135 decibels/Hz.

The model 102D is priced at $4,295, and the model 102C, which is the same generator without phase-lock capability, is $3,575.

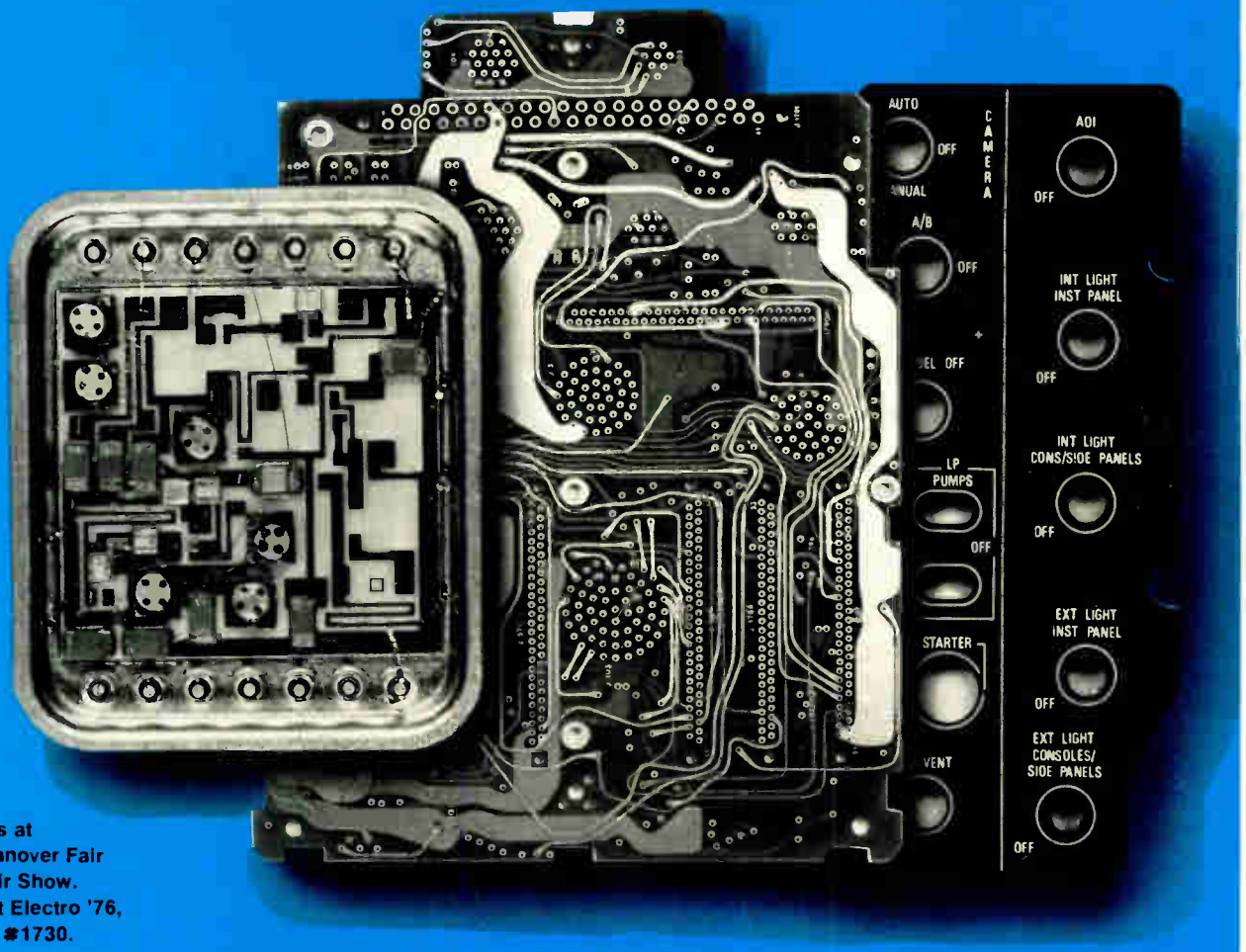
The 102D has a separate crystal reference for phase-lock operation so that the frequency can be varied by a vernier control, and the changing carrier frequency is displayed to the full 100-Hz resolution of the instrument.

Frequency-deviation range is 300 kHz at any carrier frequency.

Boonton Electronics Corp., Route 287 at Smith Road, Parsippany, N.J. 07054 [362]

From Israel Aircraft Industries.

Elta Electronics wants your business.



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We'll give you the same reliability, value and service on small and medium quantities as we do on large ones.

Elta specializes in advanced military and industrial electronics on a competitive turn-around basis. Whatever your circuit technology requirements—hybrid, state-of-the-art thin and thick film modules—we can design, produce and package components to your exact specifications.

Transformer or filter problems? Elta can solve them. We manufacture precision magnetic elements with a variety of applications, to U.S. and NATO MIL specs.

Elta is also a leader in the design and utilization of multi-layer printed circuit boards and edge lit panels. Tell us what you need, when you need it. Elta delivers.

If you're seeking a reliable source to produce high quality microelectronics —on time, within budget, in virtually any quantity—contact Elta. We want your business. And we'll keep our promise.

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Problem

Interacting low-frequency filter adjustments.

Solution

HP's 3580A Spectrum Analyzer.

Benefit

Time saved, tuning simplified.

It's a typical problem. Your finished prototype usually contains multiple adjustments—which means you use a lot of time tuning your filter for top performance.

If you're designing filters to operate in the 5Hz to 50kHz range, you now can stop using so much time, stop being bothered by interactive adjustments. Our 3580A combines a built-in tracking oscillator, wide dynamic range, and digital storage to help speed and simplify every step of your next filter design. Follow this typical example and learn how the 3580A can help.

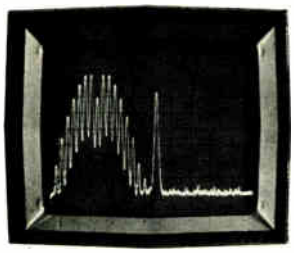
Step 1 With the 3580A, observe your spectrum and determine which frequency components to pass, which to attenuate. Decide the best type of filter to get the performance you need. Design your filter.

Step 2 Once you've selected your components and breadboarded a prototype, you can analyze your filter's performance with the 3580A. Its 80 db dynamic range gives you a clear view of everything taking place so you know exactly how your prototype is performing. Now with the tracking oscillator driving your filter, you can trim component values to optimize filter performance. Note how the tracking oscillator lets you observe the influence of each adjustment on filter performance—how it reduces the frustration you experienced before with interactive adjustments.

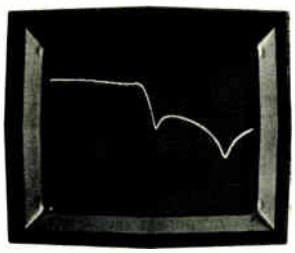
Step 3 Package and build your first production filter. Use the 3580A's digital storage to superimpose both waveforms for simultaneous viewing—a big advantage of the 3580A. Now set up and store the response of a good production filter and simply compare other production units against the good one, making adjustments as needed. All of the capabilities in one instrument gives you extra value in your filter design and production. It's priced at $4485*. Your local HP field engineer can give you all the details. Or write for our 8-page technical data sheet.

*Domestic U.S.A. price only.

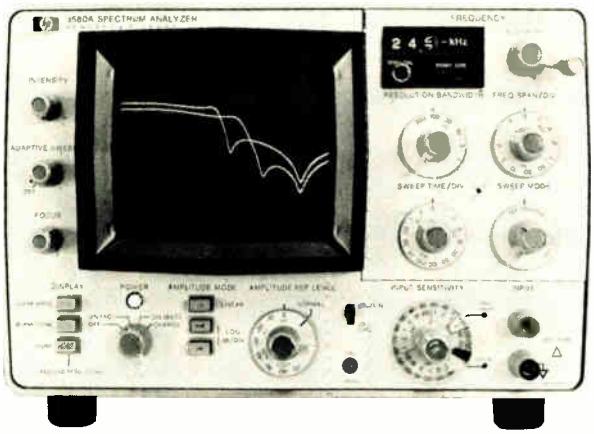
Step 1.
Analyze your spectrum.



Step 2.
Adjust your prototype's response.



Step 3.
Compare all production filters with the stored standard. Note the analog look that you get with HP's digital display.



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096/43

Computer controls IC 'wet cycles'

In wafer fabrication, master controller with microcomputer directs coating and developing processes, wafer transport, protective devices

by Bernard Cole, San Francisco bureau manager

Automation has taken over most of the steps involved in the manufacture of integrated circuits. One significant exception has been the "wet portion" of wafer fabrication—specifically the scrubbing, coating, developing, dehydration/bake, soft-bake, and hard-bake processes. At last, those have been brought under direct computer control in a system developed by GCA Corp.'s Sunnyvale, Calif., division.

When the modular system, called Wafertrac, is combined with new automatic wafer-transport modules that, among other things, allow movement around corners, the user can configure the assembly to fit virtually any space in his factory, says William Loveless, marketing vice president. The entire family can be adjusted to process wafers from 2 to 5 inches in diameter, according to the company.

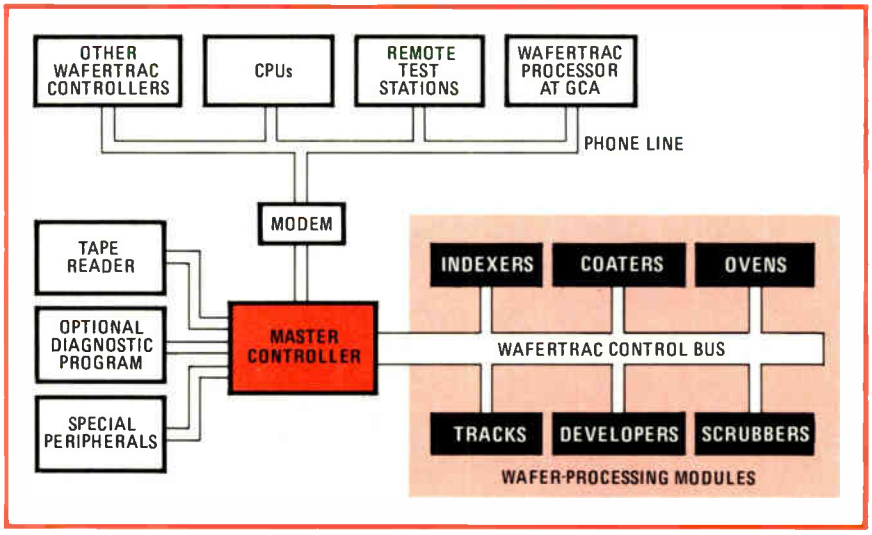
Key to the system is the model 9503 master controller that contains an 8-bit n-channel metal-oxide-semiconductor microcomputer and 16,384 words of random-access and programable read-only memory. The controller, which can control up to 256 peripheral modules, monitors and displays process parameters for smooth continuous operation; controls wafer transport, including track-to-track transfer; computes and displays batch statistics; selects and controls dispenser for coat, develop, dope, and scrub cycles; controls spin-cycle times, spin rate, and acceleration; controls bake time and temperature; and generates automatic alarms and lockouts to protect wafers in process.

With the microprocessor-controlled alphanumeric and simplified keyboard, says Loveless, an operator can easily set up customized, ready-to-use process programs that enable independent control of intermixed batches in a wide variety of configurations in single- and multitrack-system applications.

For production processing, the operator merely loads the program from a punched tape or selects the program from the memory, loads the wafer carriers and depresses RUN on the keyboard. The module location of wafers and the actual process parameters can be instantly displayed on the CRT. The modules, which can be arranged in a variety of configurations to include up to 256 peripherals, are the series 9400 automatic transport modules, the series 9300 automatic infrared ovens, the series 9200 automatic-indexers, and the series 9100 automatic spin processors.

Operating with GCA's high-speed wafer transport, which has precision air bearings, the series 9400 standardized 9-by-9-in. bidirectional track modules are designed for automatic transport between indexers and process modules. The track sections, which can be installed end-to-end in any orientation, are operated with program commands given to adjacent indexers and process modules. These commands turn on the pneumatic supply only when needed. Wafer sensors provide positive feedback control to ensure that a wafer has been sent before additional processing steps are performed.

Each series 9300 oven module can be independently controlled to allow different bake cycles to be run simultaneously on adjacent tracks. A ±3°C temperature profile is programable from 50°C to 300°C in 1°C increments. The bake time is programable from 100 to 1000 seconds in 5-s increments. The module provides outputs for ENTER/DON'T-ENTER indications and for monitoring the oven temperature and belt



speed. In the event the temperature gets too high, internal sensors actuate software override to turn off power to the heating element, empty the oven, and prevent entry of additional wafers. The belt area in each oven module is enclosed and continuously purged with nitrogen, controlled by a flow-meter and filtered to maintain a Class 100 environment.

The series 9200 is a family of standardized 9-by-9-in. single-track modules for program-controlled sending, receiving, and in-line buffer storage. Each can be software-controlled as a sender, receiver, or in-line last-in, first-out, buffer. Significantly, says Loveless, a number of buffers can be sequentially connected to store large numbers of wafers at the input or output of the system. "The user is no longer confined to processing in 20- or 25-wafer batches," he says.

Choice of combinations. The series 9100 automatic spin processors which coat, develop, scrub, and dope, can be equipped with up to eight dispensers. Combinations range from four photoresist pumps and four aspirators to two photoresist pumps and six aspirators, the company says.

A special brush assembly is mounted on the head for scrubbing and a dedicated head assembly is available to protect against boron and arsenic in doping applications. Each module in a system has its own PROM so that it can be programed for stand-alone operation or with other modules without the master controller.

Prices of the Wafertrac range from $10,000 for a minimum stand-alone system that includes a spinner, a single-track transport module, a sender, a receiver, and a PROM programer, to $52,000 for a four-track system that has four spinners, four senders, four receivers, eight track-transport modules, and a master controller.

Production models will be ready in July, and delivery time will be 90 days.

GCA Corporation. Sunnyvale Division, 1050 Kifer Rd., Sunnyvale, Calif. 94086 [340]

High-Resolution CRT-To-Film Printer:

CELCO MASTERPRINTER is a high resolution CRT-To-Film Precision Computer-accessed system utilizing digitized data from CELCO MASTERSCAN to produce production fonts.

MASTERPRINTER features automatic computer-control of CRT focus, optical focusing, lens selection and film positioning. High accuracy is obtained over 10" x 10" step and repeat X-Y tables. Automatic self-calibration and automatic exposure compensates for CRT aging, lens-selection and writing rate.

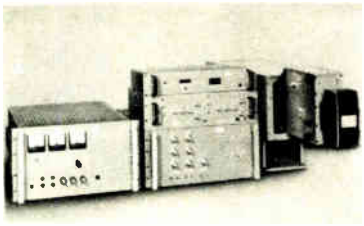
NEW 20, 35, & 60 volt X-Y Deflection Amplifiers.

Featuring NEW small-size and light weight, CELCO high-power X-Y Deflection Amplifiers provide 12 amps and 16 amps peak-to-peak and are designed for the highest accuracy and maximum stability applications, such as CRT Film Recorders and Flying Spot Scanners, Electron Beam Recording Equipment, Integrated Circuit Mask Generation, and Electron Beam Substrate Preparation.

Bandwidth for the MDA & MRDA 20 volt and 60 volt Amplifiers is greater than 2.5 MHz, and less than 300ns small signal step response with 10uH Yoke. The MDA & MRDA 35 volt Amplifier Bandwidth is greater than 2.5 MHz, and less than 350 ns small signal step response with 10uH Yoke.

Electrical specifications for the new CELCO Amplifiers also include 0.01% Linearity; Temperature Drift of less than 20uA/°C; Short Term Drift is less than 0.1mA, and Long Term Drift is less than 0.5mA.

The CELCO MRDA series of 20 volt, 35 volt, and 60 volt, 12 and 16 amp Amplifiers are offered with Regulated Quadru-Power Supplies, and are rack-mountable in standard 19" relay racks. Availability: 90 days.



Record on 70mm Film from 4600 Line CRT.

The CELCO DSC-III Photo Recorder provides new flexibility for satellite "Quick-Look" monitors, medical research, data reduction, and any application where a 0.0006" CRT light source (3" x 3" raster) can be used to advantage. Digitized photos, letter masters, X-rays, and data obtained in biological experiments can be operated on with CELCO's DSC-III 70mm Photo Recorder.

The CELCO DSC-III is fully integrated to accept digital and/or analogue inputs. All the necessary power supplies, electronics, and logic are included to operate this self-contained system.

The CELCO digitally controlled camera includes transport drive, lens, shutter and photomultiplier assembly which can be directly interfaced to TTL control lines from a computer. Film transport speeds are available from one second per frame, and faster. Features of the transport interfacing include pre-select for number of exposures, film advance, exposure counting, and single-frame exposure. Unique camera optics of the camera accomodate a variety of film transports and magazines.

CELCO's RG-116 Precision Dual Ramp Generator provides convenient selection of a wide range of recording or film reading applications.
Options include: Linearity to 0.05%, short term stability to 0.001%, long term stability to 0.0005%, MTF on film plane, metering, shades of grey required, brightness monitor, brightness limiting, loss of raster or scanner protection, film transport speeds, special interfacing, special lenses, video requirements, and CELCO software.

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Celco

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Unique Large-Format Scanner:

MASTERSCAN from CELCO, now makes it posible to scan and digitize Large-format data and images (14 inches x 14 inches) for many different applications, such as X-Ray Scanning, Enhancement, Storage and Printing for Hospitals and Medical Centers; Clothing Pattern Digitization and Printing for numerical control production; or MASTERSCAN can be designed to digitize data at high-speed and high resolution to fit a customer's particular data requirements.

The MASTERSCAN System pictured is CELCO's unique solution for automating the production of Master Fonts for a manufacturer of Computer Typesetting Equipment.
Scanning a 16 million point area, MASTERSCAN calibrates itself and reduces an artwork master 14" x 14" to a digital record in 16 seconds.

Depending on your precision requirements, your MASTERSCAN System can be designed to produce 512, 1024, 2048, or 4096 line rasters on the CRT face. With 2048 line raster, the System provides 4096 resolvable dots per line.

CELCO Immersion Optics Assemblies

CELCO announces production of their newest line of Deflection Yokes for Image Dissector, Vidicon, Silicon Storage, SIT, and SEC tubes.

DQV series Yoke: designed for use with 2¼" diameter Image Dissector Tubes for Photo Typesetting, Digitizing, and Imaging applications where high resolution and linearity are of primary importance.

BQV series Vidicon Tube Assembly: for 1" neck diameter Round Mount, and TV Vidicons, the BQV is designed to minimize beam landing error.

CQV series High resolution Silicon Target Storage Tube Coil Assembly: for 1" neck diameters combine extreme field uniformity and high resolution design.

Power circuits go monolithic

Low-cost, self-contained, integrated regulators, both switching and shunt types, simplify power-supply design for a variety of applications

by Larry Armstrong, Midwest bureau manager

Designers of avionics gear and battery-operated and portable equipment have had to use switching voltage regulators in power supplies to meet size, weight, and efficiency requirements. But existing regulator circuits have been too expensive for low-power commercial designs. Now, Texas Instruments has succeeded—using ion implantation and its resulting smaller geometries—in putting most of the components for a switching voltage regulator onto a single silicon bipolar chip [*Electronics*, April 15, p. 25].

The device, called the TL497, is designed to operate at power-transfer efficiencies of 60 to 80%. On the chip are a precision 1.22-volt reference, a reference amplifier, frequency-controllable duty cycle oscillator, a short-circuit sense amplifier, a commutating diode, and a power-transistor switch. It will handle a maximum switching current of 500 milliamperes, with an output voltage capability of up to 35 v. Input voltage can range from just under 5 v to 40 v.

To provide the inductive characteristics necessary for the commutating action of a switching voltage regulator, the power-supply designer must add an external coil and a timing capacitor to set the basic frequency of the chip's internal oscillator. With a 500-microhenry inductor and a 300-picofarad capacitor, the regulator provides a typical line regulation of 0.2% and typical load regulation of 0.4%, says Dale Pippinger, manager of linear integrated circuit applications and market deveopment at TI, Dallas.

Also necessary are three resistors—one to set the short-circuit input limit and two to establish a feedback level for the output voltage. "And as with any voltage regulator, most people use a filter capacitor on the output," he says.

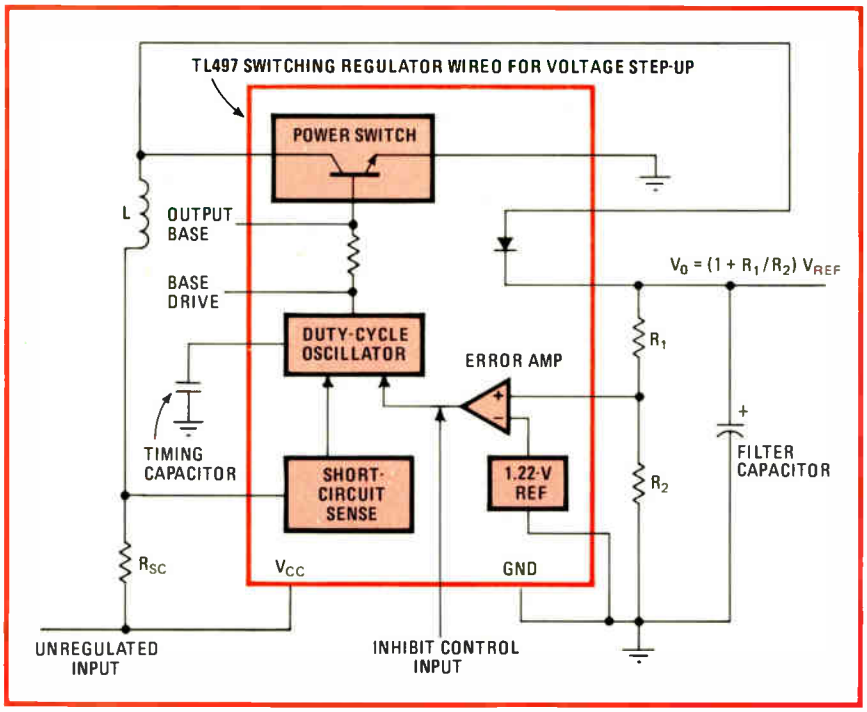
The TL497 is housed in a 14-pin dual in-line plastic package and will operate from 0° to 70°C without heat-sinking. In plastic, the part sells for $2.18 in 100-lots.

The firm also has designed a three-terminal adjustable shunt regulator that can be used to provide a precision voltage reference. Operating voltages can be set, with two external resistors, from 2.75 v to 30 v, and the device will supply from 600 microamperes to 100 milliamperes.

The TL430 can be used like a temperature-compensated zener diode, Pippinger says, and is stable over temperatures to within 0.005%/°C. Unlike zeners, however, the unit has a very low on-resistance, typically 1.5 ohms.

In a three-lead TO-92 plastic package, the device will dissipate 775 milliwatts. The TL430 is aimed at markets that haven't used temperature-compensated references for cost reasons—for example, television varactor tuning systems or digital voltmeters and counters with built-in references. It is now available at 73 cents in quantities of 100 to 999 or $1.24 each for single units.

Texas Instruments Inc., P.O. Box 5012, Dallas, Texas 75222. For further information on the switching regulator, circle 339 on the reader service card; for shunt regulator, circle 361.



New from Centralab...

CERBON™ TRIMMER RESISTORS

Affordable Stability... 300% More Stable Than Carbon... at a Carbon Trimmer Price!

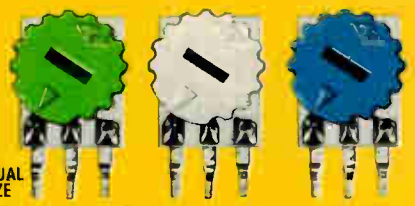
Why pay more? With Centralab's new *CERBON* trimmers you get stability approaching cermet and at carbon prices ...As little as 28¢ in distributor 1,000 quantities; as low as 10¢ in high volume orders.

The secret of *CERBON* superior performance? A totally new thick film resistor element, which combines both potentiometer and conventional thick film technologies, *plus* a heat stable ceramic substrate, *plus* a dual-tine contact spring, *plus* "Fluxgard" protection from dust and wave soldering contaminants. In short, a totally balanced electromechanical system.

Look at these benefits:
• TCR less than −400 ppm/°C. • CRV less than 2% of maximum resistance. • Rotational life exceeds 500 cycles. • Adjustability (typical)—0.05% of total voltage. • High overload capability—1 watt at 25°C ambient for 1,000 hours exhibits less than 2% cumulative resistance change. • Maximum stability in humid environment — Resistors exposed to an atmosphere of 40°C at 95% relative humidity for 300 hours return within four hours to +2.5% of their initial readings.

CERBON trimmers are offered in a resistance range of 1 K ohm to 1 megohm with a choice of standard PC terminal configurations. They fit universally accepted circuit board mounting patterns. And they're ready now for fast delivery in any quantity.

Write for complete technical data on Centralab's new *CERBON* trimmer resistors. Or call (915) 799-3961 for a free evaluation sample. Move up to *CERBON* and save!



ACTUAL SIZE

Knob colors available in white, blue, red and green for ease in assembly operations

CENTRALAB
Electronics Division
GLOBE-UNION INC.
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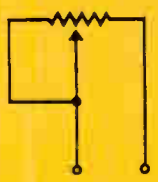
EL PASO, TEXAS 79915

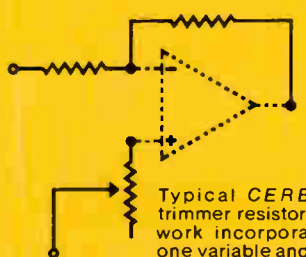
AVAILABLE CIRCUIT OPTIONS

Thanks to their ceramic substrate, Centralab *CERBON* trimmers permit a variety of screen printed circuit options. Here are three typical circuits:



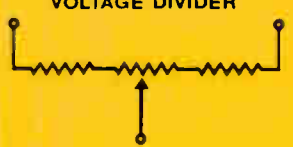
TERMINAL SHORTING
One of five electrical termination options available.

OPERATIONAL AMPLIFIER NETWORK



Typical *CERBON* trimmer resistor network incorporating one variable and two fixed resistors on dual substrate configuration.

VOLTAGE DIVIDER



Fixed and variable resistors can be ratio matched for precise values and to insure temperature tracking. Eliminates need for costly discrete resistor selection.

Circle 139 on reader service card

Communications

National invades phone market

First entries of company in telecommunications field are dual-tone receiver cards

Gearing up for a big push into the telecommunications marketplace, National Semiconductor Corp. is planning to introduce a family of seven or eight devices over the next year.

First of these to be in volume production will be the TRC-1 and TRC-2 dual-tone multifrequency (DTMF) Touch-Tone receiver cards, designed to receive dual-tone signals and generate a 2 of 7 (TRC-1) or a 2 of 8 (TRC-2) logic output indicating the presence of valid tones.

Functions included on the card are dial-tone reject filters, low-band and high-band splitters, high-band "talk-off" automatic gain control and tone detectors. Outputs are TTL levels which may be pulled up externally for other logic families. Timing and decoding logic are available as an option.

A key strategy in this, as in other new markets, says Dean Coleman, telecommunications product manager, is pricing. Using its low cost C-MOS technology and its computerized active-filter designing capabilities, National expects to be able to sell devices for much less than the $250 to $500 it costs telephone companies to make their own cards.

Unlike some manufacturers, who use digital filtering techniques on a portion of their systems to lower the costs, says Coleman, National uses an all-analog active-filter approach. "The drawback to the digital back-end approach is that it produces an error rate not acceptable for central-office-quality DTMF systems."

National's TRC-1 (or TRC-2) consists of two 4.5-by-6-inch cards containing 14 C-MOS hybrids, with an average of two active filters and two comparators per hybrid. A novel feature, useful in testing and debugging a system, are on-card LED indicators to let the user know a valid signal is coming through.

Available now, the TRC-1 and TRC-2 will be sold as fully tested boards or components, meeting all Western Electric specifications, says Coleman.

Other telecommunication products to come, he says, will include a one-chip C-MOS DTMF oscillator/generator, a one-chip C-MOS dial pulse generator, three single-chip trunk and carrier line compandors and a single-channel pulse-code-modulated coder/decoder.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif 95051 [401]

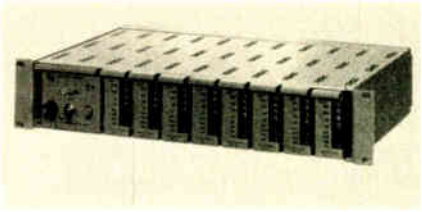
Microprocessor system works with IBM computers

The Pix II intelligent data-communications system is a modular, microprocessor-controlled family designed to provide a variety of communications services to users of IBM System/360 and 370 computers. Able to operate at five data rates from 4,800 bits per second to 56,000 b/s, the Pix II system employs a synchronous-data-link-control (SDLC) protocol and can operate over a full range of communications facilities including dial-up lines (both half- and full-duplex), leased private lines, wide-band lines, digital networks, and satellite links. The system contains all necessary error-control, synchronization, and line-control procedures; hence, there is no need for IBM RJE hardware or software. It is offered in a variety of rental, lease, and purchase plans. For a typical data-communications system, two-year rental prices, including high-speed modems and maintenance costs, start at $1,600 a month.

Paradyne Corp., 8550 Ulmerton Rd., Largo, Fla. 33540. Phone Robert Budenstein at (813) 536-4771 Ext. 249 [403]

System detects failures on four-wire lines

The model 140 Verify-Off-Hook (VOH) unit is designed to prevent false seizures caused by line or equipment failures in four-wire telephone circuits. The unit verifies normal signaling by an exchange of signals similar to those used in "wink-start" trunks. Only after the signal is verified is the circuit cut through to the far end. The units include a provision for energizing an alarm.



The VOH unit is housed on a single printed-circuit card which is mounted in a slide assembly that measures 3.5 inches high. Designed to operate from a 48-volt dc station battery, the unit can be powered by an optional supply that converts ac voltages between 105 and 130 V to 48 V dc.

TM Systems Inc., 25 Allen St., Bridgeport, Conn., 06604. Phone Mr. S. Feldman at (203) 366-4571 [404]

Television camera operates in extreme environments

Suitable for use in nuclear reactors and other hostile environments, the model 1600 HT television camera

Analog Devices introduces less of a DPM.

When we designed our new line of second generation digital panel meters, we had a clear objective in mind.

Give our customers less of everything. Less of everything they don't want in DPMs, and more of what they need.

Less confusion.

Like less confusion finding the exact DPM they require. With six different second generation DPMs (three +5VDC logic-powered and three AC line-powered) we have the biggest selection available. And each of them benefits from advanced MOS/LSI circuitry, 3½, 4½ or 4¾ digit large LED displays, a full week of failure-free, power cycled burn-in, lower power consumption and lower cost.

Less components.

But let's not talk in generalities. Let's talk specific Analog Devices DPMs where less is a plus. Take our 3½ digit 5VDC Model AD2021 for example. Through the use of MOS/LSI circuitry, we've been able to cut the number of components in it by 42%. And in doing so, chopped power consumption by 42%. Decreased the number of interconnections adding to reliability. Reduced its size to 3"W x 1.8"H x 1.25"D. And dropped its weight to 4 ounces. That's why logic power is your logical choice for compact instrumentation. Our line-powered version, AD2016, offers similar advantages, in its industry-accepted AC-powered package.

Less difficult to read.

Digital panel meters should be easy to read. Get a glimpse of our logic-powered 4¾ digit AD2028 and line-powered AD-2025. Like our other second generation Analog Devices DPMs, they have displays featuring big, high-intensity "light-pipe" LEDs almost twice the size of earlier ones.

Less cost.

With so much that's improved, you'd expect to pay more for our latest DPMs. Surprisingly, that's not the case. Our logic-powered 4½ digit Model AD2027 and line-powered Model AD2024, for instance, are priced 40% lower than their first generation predecessors.

Less is more.

When is less more? When you specify Analog Devices new line of second generation digital panel meters. The real company for precision measurement and control. For complete facts, get the Designers Guide to DPMs. Analog Devices, P.O. Box 280, Norwood, Mass. 02062.

ANALOG DEVICES

The real DPM company.

East Coast: (617) 329-4700, Midwest: (312) 894-3300, West Coast: (213) 595-1783, Texas: (214) 231-5094. Belgium: 03 38 27 07, Denmark: 97 95 99, England: 01/94 10 46 6, France: 686-77 60. Germany: 089/53 03 19, Japan: 03/26 36 82 6, Netherlands: 076-122555 and representatives around the world.

Circle 141 on reader service card

New products

can operate over the temperature range from −55°C to 80°C and can tolerate 10^8 roentgens of gamma radiation. The camera has a resolution of 800 lines and a 1-decibel bandwidth of 15 megahertz. It is made entirely of MIL-E-5400 components and uses a printed-circuit deflection yoke to achieve a combination of light weight, small size, and ruggedness. The 1600 HT is 12 inches long, 2.25 in. in diameter, and weighs less than four pounds. It draws 600 milliamperes from a 13-V dc supply.

Edo Western Corp., 2645 South 300 West, Salt Lake City, Utah 84115. Phone Keith Thomas at (801) 486-7481 [405]

Audio synthesizer has two outputs

Designed for telecommunications applications, the model 401 frequency synthesizer has two output ports: one is capable of driving loads from 900 ohms to 40,000 ohms at fixed, switch-selectable levels from −40 dBm to +9.9 dBm accurate to within 0.1 dB. The other is calibrated to deliver the same levels to a 600-ohm load with a maximum error of 0.2 dB. The unit covers the frequency range from 100 hertz to 9999.9 Hz in 0.1-Hz steps.

Bowmar/ALI Inc., 531 Main St., Acton, Mass. 01720. Phone (617) 263-8365 [407]

Acoustic coupler operates at 300 bauds

Able to operate in the originate mode at data rates in excess of 300 bauds, the model FM300 acoustic

OMI is where answers in metal finishing are nailed down.

Metal finishers have been bringing us their tough ones for years. Fine. We've got the answers.

For example:

A manufacturer of hydraulic cylinders was producing precision parts faster than existing plating facilities could handle them. OMI installed its Udylite Ultrachrome™ ACS process and production capability jumped 70% with no sacrifice in quality.

The world's largest coil-coating line must process more than a mile of strip at a speed of 600 fpm. Its designers looked to OMI for the super line's complete wet section—Parker cleaning and prepaint-treating chemicals and control equipment. They got it.

Dissatisfied with cost and production levels for critical gold plating processes, a maker of telecommunications devices switched to a new Sel-Rex process. Plating time was cut in half...gold consumption was reduced by 15%. And the resulting boost in production allowed for a 50% saving in labor cost alone.

Need a better answer...a better way to increase the capability and profitability of your operation? Chances are OMI can help. Ask for our brochure "The World of OMI," write:

Oxy Metal Industries Corporation, 21441 Hoover Rd., Warren, Michigan 48089.

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Circle 143 on reader service card

coupler is intended for use on the dial-up network. The unit has a sensitivity of –40 dBm in the acoustic mode. It can also be hardwired into the telephone network through a data-access arrangement, which improves sensitivity to –46 dBm. Compatible with Western Electric 103 series data sets, the model FM300 is capable of simultaneous operation with 20-milliampere teletypewriters and with devices that conform to EIA standard RS-232-B. The frequency-shift keyed coupler operates in both half and full duplex modes. The coupler sells for $310 in small quantities.

Multi-Tech Systems Inc., 3406 University Ave. S.E., Minneapolis, Minn. 55414. Phone (612) 331-5000 [406]

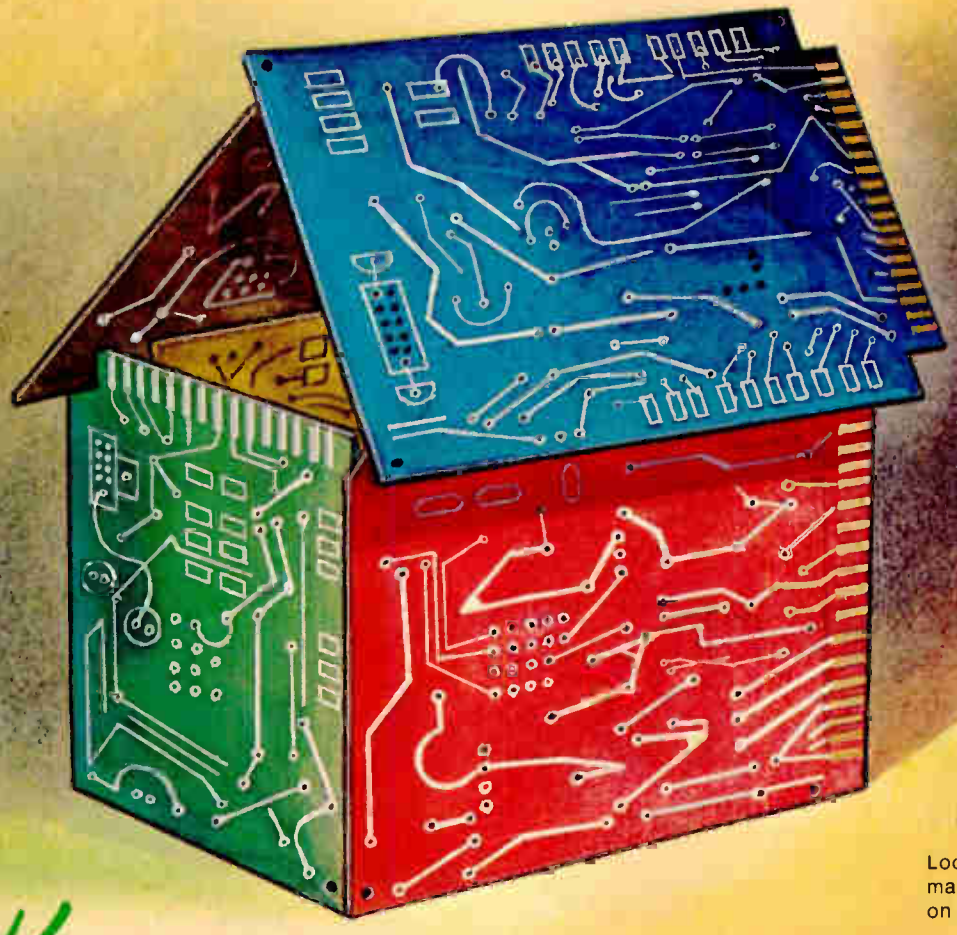
TOPICS

Communications

Infotron Systems Corp., Pennsauken, N. J., has introduced a Dataguard option for its Timeline 180 and 240 time-division multiplexers. The $320 option detects, corrects, and reports many of the common errors generated on the high-speed link between multiplexers. . . . **Lear Siegler Inc., Anaheim, Calif.,** has announced an option for its ADM-3 video terminal that greatly simplifies the initialization message to and from the terminal. The option allows a 32-character message to be sent from the terminal at the touch of a single key. . . . **RFL Industries Inc., Boonton, N. J.,** is offering variable-frequency telemetry systems with accuracies of 0.04% and 0.12%. This way, the company claims, users need only pay for the accuracy they need. The series 6405 systems work in the frequency band from 5 hertz to 40 Hz. . . . **Paradyne Corp., Largo, Fla.,** is selling its 9,600 b/s modems at reduced prices through May 13. Until then, the LSI-96, which usually sells for $4,500 will be offered for $3,500, and the M-96, which normally is priced at $6,500, will go for $4,500.

One of the most overworked words in the printed circuit board business is "quality." At Kalmus & Associates, we don't talk much about quality, we just build it into every one of our precision printed circuit boards. ▪ If you're a user of PCB's, give us a try. We'll produce circuit boards that meet your specifications to the letter; that are delivered on schedule; that will reduce your production problems to a minimum. ▪ For more information on the "quality house" in PCB's, send for our new catalog.

The House That Quality Built

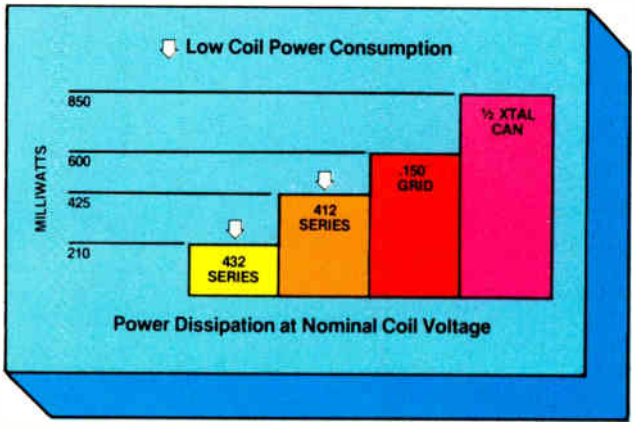


Look for this mark of quality on Kalmus circuitry

KALMUS & ASSOCIATES, INC.
2424 South 25th Avenue, Broadview, Illinois 60153 ▪ Phone: 312-343-7004

TO-5 RELAY UPDATE:

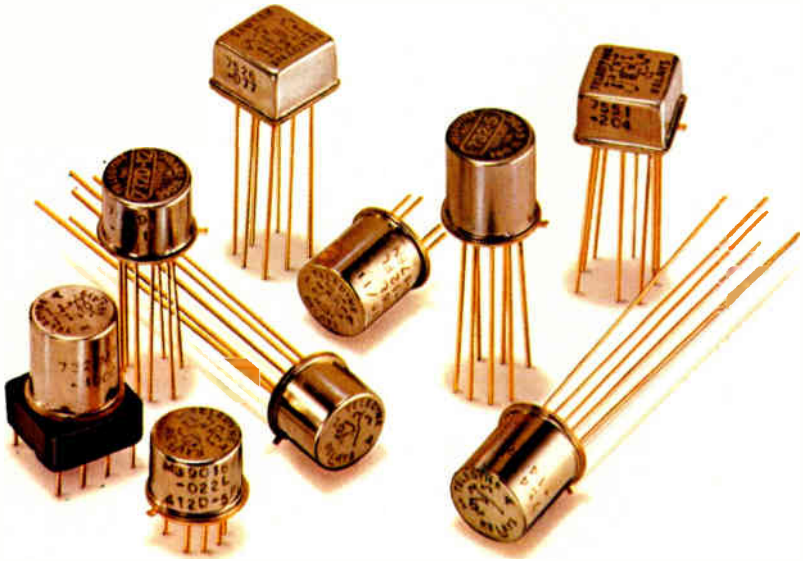
Solve your energy crisis with TO-5 relays



Subminiaturization and pc board compatibility — two obvious advantages of Teledyne TO-5 relays. But there's another outstanding advantage: low coil power consumption. This feature is best illustrated in the above graph which shows our TO-5 relay power savings compared to other miniature relays. The Teledyne 412 Series dissipates about 30% less power than the .150" grid relay, and 50% less than the ½ crystal can. Our sensitive 432 Series is 65% less than the .150" grid. And 75% less than the ½ crystal can.

This means you can save over 6 watts in a typical system using, let's say, ten TO-5 relays. In the end, you gain significant advantages in terms of thermal and power supply considerations that can help prevent an "energy crisis" in your system.

Our complete line of TO-5 relays includes military and commercial/industrial types, with virtually all military versions qualified to established reliability MIL specs. For complete data, contact Teledyne Relays — the people who pioneered the TO-5 relay.



- **Hybrid "T" Series**
  SPDT & DPDT types with internal transistor driver and suppression diode
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  Military and commercial/industrial versions with internal suppression and steering diodes
- **Magiatch Series**
  SPDT, DPDT, and 4PST magnetic latching types
- **Centigrid® Series**
  World's smallest relay — only .225" (5.72mm) high x .370" (9.40mm) square
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  Screened versions for space flight applications (NASA qualified)
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Semiconductors

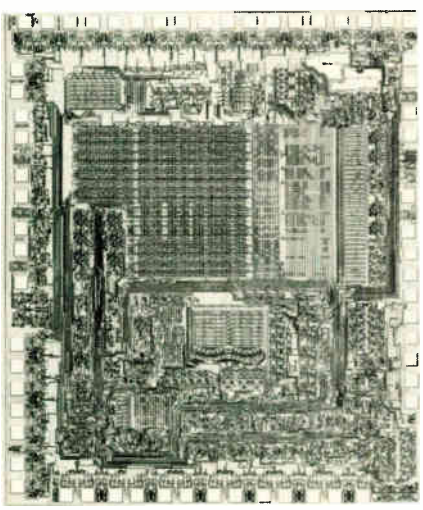
Watch chip is programable

IC uses microprocessor techniques for flexibility, shorter development time

Microprocessor techniques are now being applied to watch chips. Intel will be in volume production soon with a C-MOS integrated circuit that uses a special purpose, display- and timing-oriented microprocessor architecture.

Using on-chip random-access and read-only memory as well as complementary-metal-oxide-semiconductor programed logic arrays, says Tony Livingstone, international marketing manager, it will be possible to mask-program in the factory 4-, 6-, or 8-digit displays, up to eight timing functions, as well as a choice of several segment styles and alphanumerics. In addition, he says, it will also be possible to a limited degree to program pin-outs to simulate any particular configuration a watch-module maker might want for his special purposes.

"This chip is our response to a rapidly differentiating market as far as features are concerned" says Livingstone, "and the need on the part of watch and watch module makers to reduce the development time on particular timepiece products. The number of combinations that our customers were asking for were almost without limit.



"And since the trend in LSI logic is to programable devices whereby a fixed set of hardware is reconfigured to fit a number of different applications by means of ROM, RAM and PLA, we asked ourselves why microprocessor techniques couldn't be applied also to watch chips." The result is this 164-by-197-mil watch chip with the equivalent of 5,000 to 6,000 transistors, operational from a 1.5 volt battery and with a basic cycle time of 125 microseconds. "What we've come up with is a watch circuit that is about as flexible as one can imagine," he says.

The basic mechanisms by which the Intel engineers achieved this flexibility is a 130-bit RAM storage array used in conjunction with a 768-bit PLA and associated address decoder instead of conventional counters to supply the basic timing information. An additional 512 bits of ROM control the display sequence and another 368 bits of ROM are dedicated to the segment font. Time-set is controlled by 424 bits of programed logic array.

All data, says Livingstone, is handled internally on a 4-bit wide bus. Externally, because there are no convenient means of multiplexing liquid crystal displays externally, this is handled on a one-driver-per-segment basis. But internally, multiplexing is used, with signals fed out through the read-only-memory decoder into the LCD drivers, where the information is latched and updated continuously.

Also on-chip is a 32-kilohertz oscillator, including an on-chip capacitor, a feedback resistor and a series resistor, with the only off-chip components being an external crystal and a trimmer capacitor.

Fabricated using standard silicon-gate C-MOS, the chip is in a 60-pin package.

Pricing depends on the number of features required.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051 [411]

Gate-turn-off SCRs have high gains

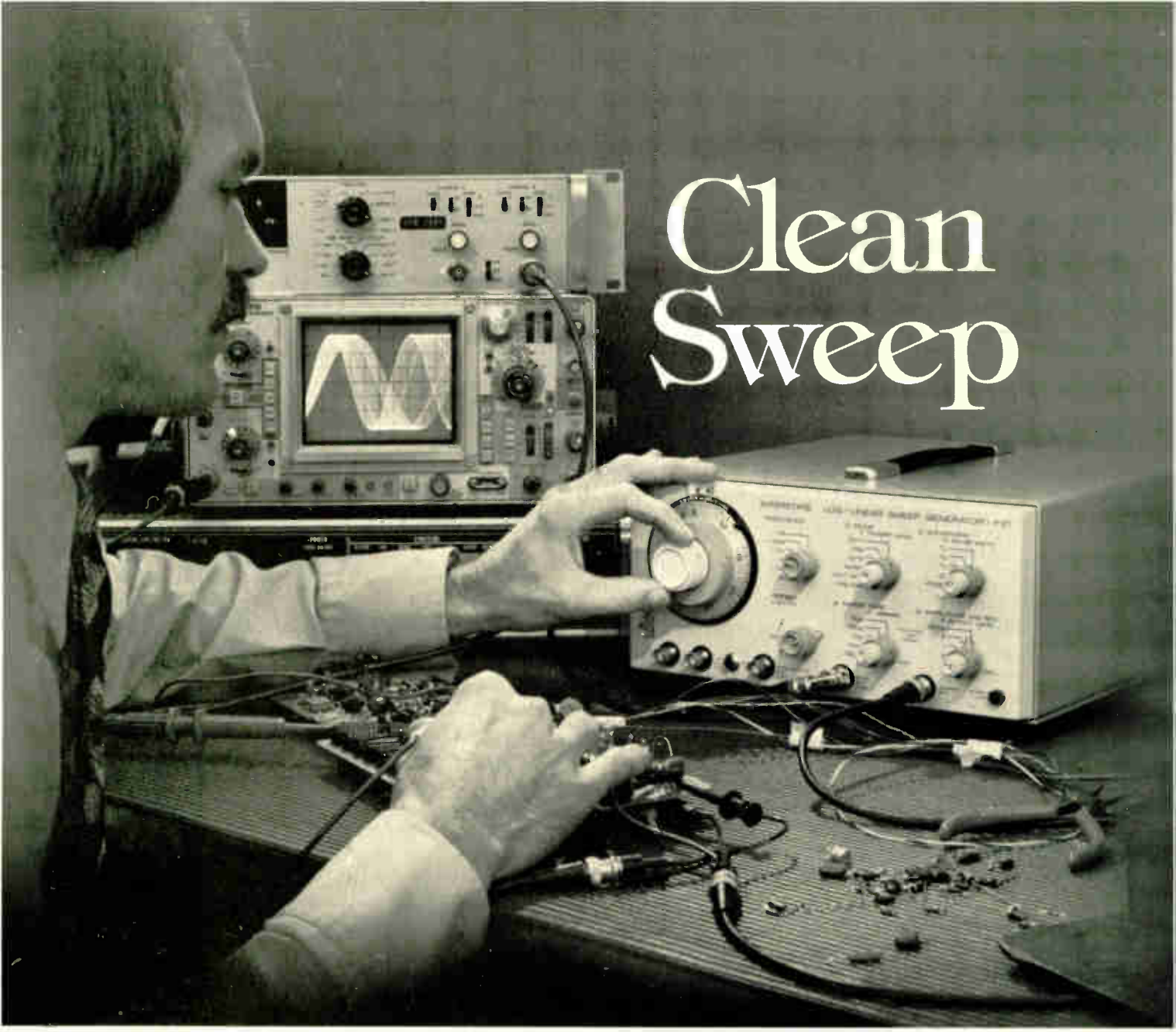
A line of gate-turn-off SCRs intended for use in medium-power switching applications differs from other available devices in that it offers turn-off gains on the order of 1,000. A turn-off trigger current of about 4 milliamperes can turn off an anode current of 4 amperes. Furthermore, the required trigger voltage is only about 1 or 2 volts. Available in both hermetic (TO-66) and plastic (TO-202) packages, the devices have a continuous-current rating of 4 A and a peak-current rating of 8 A. They are offered with six voltage ratings: 50, 100, 150, 200, 300, and 400 V. The device numbers range from the UGT405 through UGT440 with a P suffix to indicate a plastic package. Typical turn-on time is 200 nanoseconds and typical turn-off time is 800 ns. In lots of 1,000, the hermetic units sell for from $2.40 to $3.65 each, and the plastic ones are priced from $1.24 to $1.82.

Delivery time for the SCRs is three to four weeks.

Unitrode Corp., 580 Pleasant St., Watertown, Mass. 02172. Phone Vinnie Savoie at (617) 926-0404 [413]

1,024-bit n-MOS static RAM has 70-nanosecond cycle

Designed as replacements for high-speed bipolar random-access memories, the model 2115 and 2125 are low-voltage silicon-gate n-channel static MOS devices with 70-nanosecond access and cycle times. The 1,024-bit RAMs require only a single 5-volt power supply and dissipate a maximum of 656 milliwatts. The memories are interchangeable with Fairchild's popular 93415 and 93425 bipolar RAMs. Six versions of each memory are offered: the standard 2115/2125 has a maximum access time of 95 ns, the 2115-2 and 2125-2 have 70-ns access times, and the 2115L and 2125L are low-power devices with a maximum current of



F37 Log/Lin Sweep Function Generator

Precision Performance. F37's frequency setability is more accurate to begin with, because you can set your desired frequency with one fully calibrated coarse/fine control. The fine-tune vernier is centered on the dial so the output frequency meets accuracy specs wherever the vernier is set. And for easy and accurate sweep limit settings, you just swing the sweep limit cursor around.

Top Sweep Capability. Inside the F37's sturdy metal case is all the capability you need for sweep function generator applications — triggered sweep and burst modes, log/linear selection, and two separate plotter drive signals, for example. F37 sweep time is ten times faster, too, than competitive models — all the way from 10 picosecs to 100 seconds.

You can count on F37's smooth performance and superior operating features because quality engineering and years of instrumentation experience are built into every Interstate Electronics unit.

F37 — the best sweep function generator you can buy for $795.

Interstate's SERIES 30 offers you a complete, economically priced line of quality-built function generators. Write for our SERIES 30 datapack.

Circle 148 on reader service card

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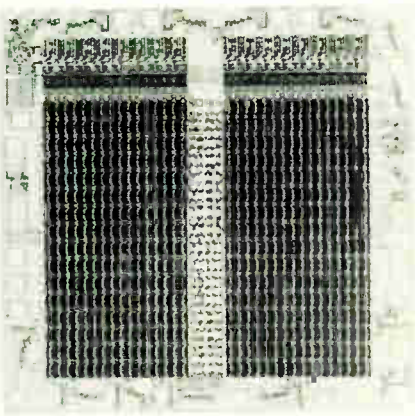

65 milliamperes (compared with 100 mA for the standard units and 125 mA for the fast ones) and access times of 95 ns. Each version of each unit is available in both plastic and hermetic 16-pin dual in-line packages. The 2115 differs from the 2125 in that the former has open-collector outputs while the latter's outputs are tri-state. The RAMs in quantity are priced from 100 to 999 ranges from $12.70 to $19.80, depending upon model and package. Delivery is from stock.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95050. Phone (408) 246-7501 [414]

Three-state bus transceiver designed for M6800 MPU

A Schottky TTL quad three-state bus transceiver which contains four 48-milliampere inverting drivers and four 20-mA inverting receivers is designed to expand the data-bus capacity of microprocessor systems built around the Motorola M6800 microprocessor unit and similar MOS MPUs. The device's inputs are protected with Schottky-barrier diode clamps to suppress undershoot voltages, and both inputs and outputs are protected against short circuits. Low input currents make the transceiver compatible with MOS systems, the company says. Housed in a 16-pin dual in-line package, the M6880/MC8T26 sells for $3.95 in ceramic and $2.95 in plastic; both prices are for quantities of 100.

Technical Information Center, Motorola Inc., Semiconductor Products Division, P.O. Box 20924, Phoenix, Ariz. 85036 [415]

ICs trigger thyristors at zero-voltage points

To eliminate transient load-current pulses and their concomitant radio-frequency interference, three integrated circuits are designed to provide trigger pulses for thyristors only at the zero-voltage points in the supply-voltage cycle. The SL447, SL448, and SL449 devices, which are second sources for the RCA CA3058, CA3059, and CA3079, are designed for easy integration into a system. Each has a

stabilized internal supply and a high-output gate-pulse driver, and each can operate over a wide range of voltage and frequency—20 to 300 volts and 10 to 1,000 hertz. Prices for the zero-voltage switches start at $2.96 in hundreds.

Plessey Semiconductors, 1674 McGaw Ave., Santa Ana, Calif. 92705. Phone Dennis Chant at (714) 540-9979 [416]

MOV transient suppressors protect solid-state relays

The series 970 line of metal-oxide-varistor transient suppressors has been specifically designed to protect Teledyne solid-state relays and input/output converters. The devices can, of course, also be used as general-purpose transient suppressors. The MOV devices are offered in two models. The 970-1 is rated at 5 joules for operation up to 140 V rms, and the 970-2 at 10 joules for operation up to 250 V rms. The devices sell for $1.45 each in thousands.

Teledyne Relays, 3155 West El Segundo Blvd., Hawthorne, Calif. 90250. Phone Don Stalker at (213) 973-4545 [419]

TOPICS

Semiconductors

Advanced Micro Devices Inc., Sunnyvale, Calif., has added 16 memory and line-interfacing circuits to its bipolar logic and interface product line. The second-source products include memory-sense amplifiers, line receivers, line drivers, and a core-memory driver. . . . **Texas Instruments Inc., Dallas,** is offering seven of its linear circuits, which previously were available only in TO-99 metal cans, in eight-pin DIPs. Included are op amps, a timer, a comparator, and peripheral drivers. . . . A final data bulletin and a new application note on the MW7001ID n-MOS static 1-kilobit RAM are available from **RCA Solid State Division, Somerville, N. J.** Refer to data bulletin File No. 839 and application note ICAN-6401.

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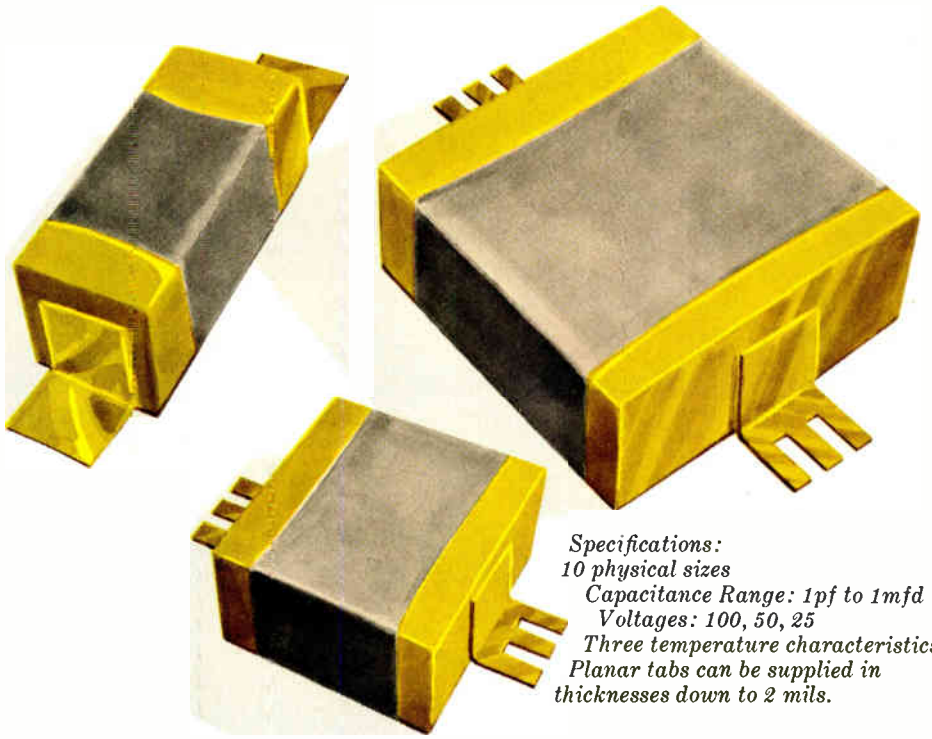

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Subassemblies

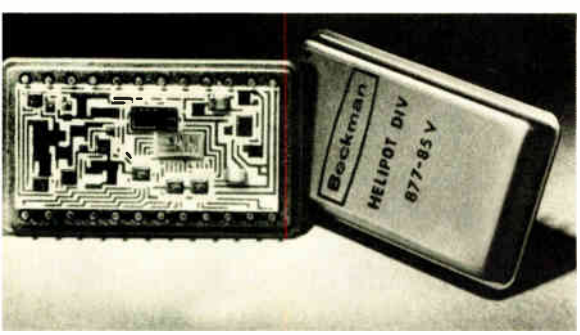
Beckman joins hybrid scuffle

Initial thin-film data converters include economy units

It looks like the current low prices for self-contained 12-bit hybrid data converters are here to stay—for quite a while, at least. The latest company to commit itself to the low-end prices [*Electronics*, April 15, 1976, p. 35] is the Helipot division of Beckman Instruments, long a supplier of thick-film hybrids. Introducing a family of standard thin-film hybrids are four self-contained 12-bit converters, including a digital-to-analog device for $20 (in 100-unit lots) and an analog-to-digital device that sells for $40 (in 100-unit lots).

The new family is intended to serve commercial, industrial, and military markets with standard products that are self-contained, as well as highly flexible, says Lyle Pitroff, product marketing manager. "Emphasis has been placed on consistent price-to-performance mix to meet the requirements of widely differing markets and applications," he adds. The first four members of the family are two d-a units and two a-d units, all aimed at high-volume commercial and rugged industrial markets.

Both d-a converters are 12 bit binary units, accurate to within 0.5 least-significant bit (LSB) and having a typical setting time of 3 microseconds. They are compatible with transistor-transistor logic and provide external connection options for bipolar and unipolar outputs of 2.5, 5, and 10 volts full scale. Current-output versions are also available, the company points out.



The $20 model 877-80, can operate over the temperature range of 0°C to 70°C. It is housed in a 24-pin glass dual-in-line package. The higher-performance model 877-85 offers a wider operating range—from -25°C to +85°C. Priced at $60 each in quantities of 100, it comes in a 24-pin metal DIP. This model can also be screened to MIL-STD-883A for even broader temperature performance—up to +125°C.

Designed as companions to the d-a converters, the two 12-bit a-d devices are TTL-compatible successive-approximation units exhibiting a conversion time of less than 25 μs. Over the temperature range of 0°C to 70°C, the $40 model 873-78 has a conversion accuracy within ±0.5 LSB, plus a quantizing error of ±0.5 LSB. Full-scale voltage ranges are 10 V unipolar and 5 or 10 V bipolar, and the package is a 24-pin glass DIP.

The model 873-88 a-d converter offers the same specifications as the model 873-78, but over the range of -25°C to +85°C. Housed in a 24-pin metal DIP, it sells for $120 each in quantities of 100. This model is also available screened to MIL-STD-883 for operation from -55°C to +125°C.

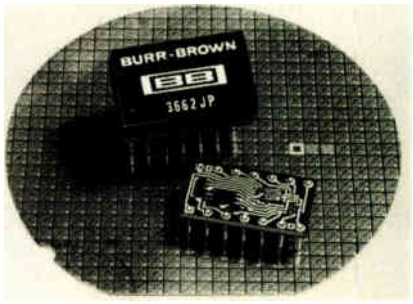
Within the next six months, Beckman plans to introduce full military versions of these initial models. Soon to follow will be a pair of multiplying complementary metal-oxide semiconductor d-a converters designed for use with microprocessors.

They will be 12-bit devices with double-buffered inputs, in commercial and military versions. Other product plans include additional microprocessor-compatible C-MOS converters.

Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, Calif. 92624 Phone (714) 871-4848 [381]

Instrumentation amplifier has low drift and low price

The 3662 instrumentation amplifier is a hybrid circuit that offers performance approaching that of modular units at less than half the cost. It is offered in two versions: the 3662 JP has a maximum gain nonlinearity of 0.1%, an input offset-voltage drift of less than 6 microvolts/°C at a gain of 1,000, and a small-quantity price of $15. The

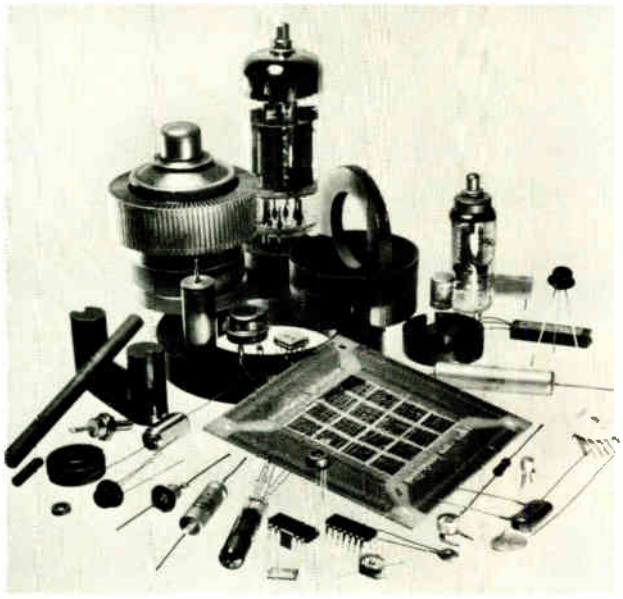


3662 KP has a maximum nonlinearity of 0.05%, a maximum drift of 2.5 μV/°C at a gain of 1,000, and sells for $23 in small quantities. Both units have typical common-mode input impedances of 2×10^{10} ohms shunted by 3 picofarads. All required resistors, except the gain-setting resistor, are included in the 14-pin dual in-line package, which measures 0.80 by 0.50 by 0.25 in. In hundreds, the JP version sells for $9.75 and the KP for $14.95.

Burr-Brown, International Airport Industrial Park, Tucson, Ariz. 85734. Phone Dennis Haynes at (602) 294-1431 [383]

Highly linear deglitcher has 15-ns acquisition time

Discontinuities in the output of a digital-to-analog converter, often called glitches, are a common and important problem in the application of fast converters. The DGM-1040 and DGM-1080 are modular units designed to reduce these glitches to an acceptable level and, more importantly, to make the am-



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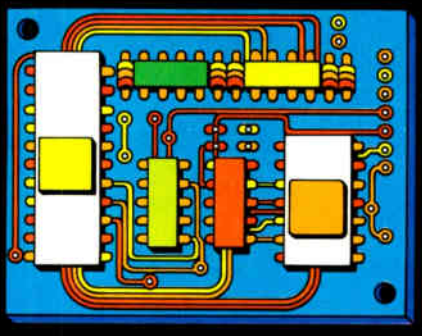

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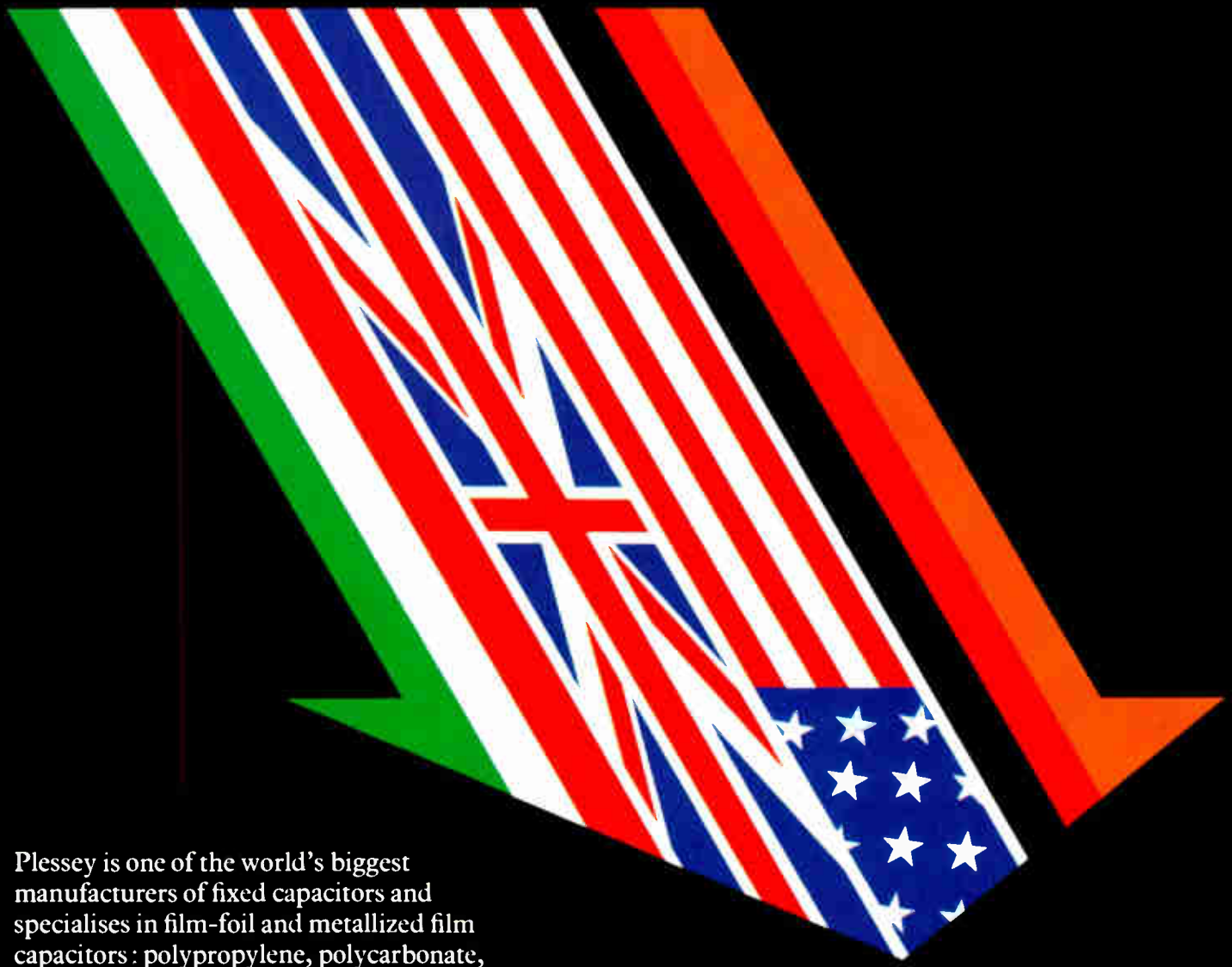

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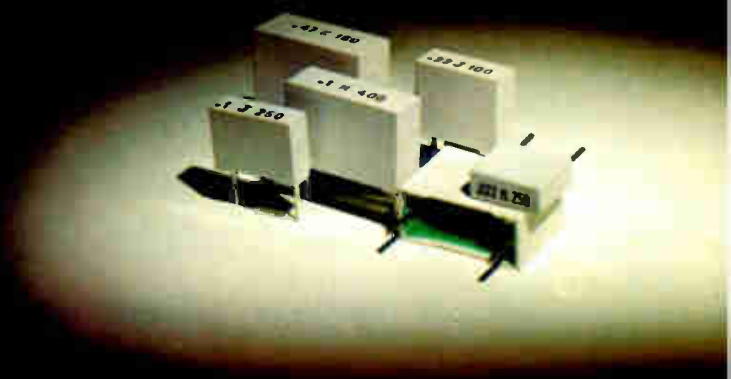

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Circle 154 on reader service card

New products

plitude of the residual glitch independent of the bit transition at the input of the d-a converter. The DGM-1040 has an acquisition time of 15 nanoseconds, a maximum sample rate of 30 megahertz, a droop rate of 8 millivolts per microsecond, and a residual glitch of 30 millivolts. The DGM-1080 has an acquisition time of 74 ns, a maximum sample rate of 11 MHz, a droop rate of 1 mV/μs, and a residual glitch of 20 mV. Both units can be used to eliminate most of the nonlinear effects of glitches in such applications as TV signal reproduction, waveform generation, and the generation of CRT displays. The deglitchers, which have a small-quantity price of $279, are available from stock in small quantities.

Computer Labs Inc., 505 Edwardia Dr., Greensboro, N. C. 27409. Phone Ed Graves at (919) 292-6427 [384]

12-bit a-d converter has 2-μs conversion time

A successive-approximation analog-to-digital converter, the model ADC-EH12B3, performs 12-bit conversions in only 2 microseconds. Built around a single bipolar MSI successive-approximation programer/register, the converter is housed in a standard low-profile module with dimensions of 4-by-2-by-0.4 inches. Power consumption is 2.3 watts. Intended for use in fast-scanning data-acquisition systems, pulse-code-modulation systems, and in the analysis of fast pulses, the

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DEPOSITION EQUIPMENT
Applied Materials F3 Poly Silicon Reactor; AMS 2660 Pyroglass; AMS 2660 Pyrox; AMN 730 Si_3N_4 Reactor; AMS 2000 Continuous Silox Unit; AMN 730 Polysilicon Reactor and Scrubber AMT; Leitz Orthoplan Microscope; M.I. Superscrubber; Fluoroware Spin Dryers; Laminar Flow Hoods and Etch Stations.

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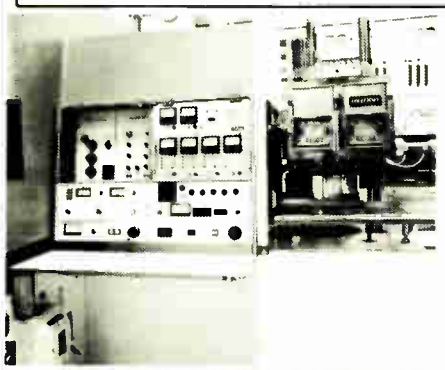

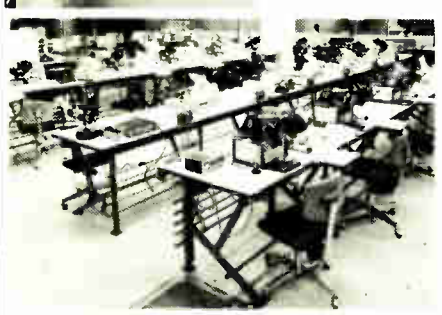

DEPOSITION SYSTEMS: (4) Semi Metals Epi Reactors; (2) Applied Materials AMN 730; (2) AMS 2640; (3) AMS 2600; AMN 720, AMV 800.

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FURNACE SYSTEMS: (12) Brute Thermcos 367B-1 with Gas Systems and Laminar Load Stations; (1) Spartan 200.

(31) PROBER SYSTEMS: Electroglass 900 and 1034X Pacific Western, CE5 and SP1.

(50) WIRE BONDERS: West Bond T.C. 7700 Series; Unitek T.C. Models 8-146-04, 06; G.T.I. Ultrasonic Model 2000; West Bond Ultrasonic Model 7400; Miscellaneous Bonders: Donovan, Tanaka, K&S.

(20) DIE BONDERS: Unitek Mod. 8-148-01, 02, 03, 04, 05; Miscellaneous Models: Laurier, K&S, West Bond.

(20) FINAL TEST HANDLERS: I.P.T. Handlers, Model 801; CHS Model 4000; Diacon TO Handlers; Daymarc TO Handlers; Delta TO Model 8824, 8825; Delta Supercharger 8072; T.A.C. Handler.

COMPUTER SYSTEMS: Teradyne J259 & J277; (1) Fairchild 400 and (2) Fairchild 5000's; Tektronix S-3130 Switching System; Adar Doctor 32-II; Miscellaneous Tape Readers & Punches, Teletypes, PDP 8E, I, L, Versatec Printer; Miscellaneous Hewlett-Packard Equipment; Datagen Nova 1220, Cassette Deck; Teradyne T/S 241.

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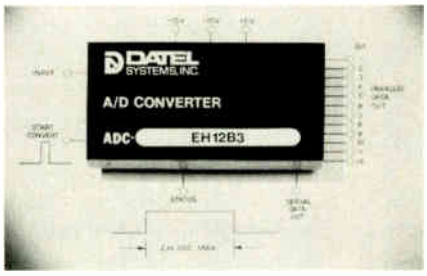


converter has an input impedance of 1.5 kilohms, an input-voltage range of either 0 to 10 volts or −5 to +5 V, and TTL-compatible serial and parallel outputs. A temperature coefficient of differential nonlinearity of less than 3 ppm/°C ensures monotonicity over the unit's operating temperature range of 0°C to 70°C. Priced at $299 each in small quantities, the ADC-EH12B3 is available from stock to four weeks.

Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021. Phone Eugene Zuch at (617) 828-8000 [387]

TOPICS

Subassemblies

Analog Devices Inc., Norwood, Mass., which introduced a family of voltage-to-frequency converters last November [*Electronics*, Nov. 13, 1975, p. 185] has slashed prices of the line by as much as 26.4%. . . . **Adtech Power Inc., Anaheim, Calif.,** has cut prices on its APS series Black Beauty power supplies by 5% while increasing the temperature at which full output power can be obtained. . . . **Analogic Corp., Wakefield, Mass.,** is selling pre-aged, stabilized 12-bit digital-to-analog converters. The MN563 and MN562 are aged and tested before shipping to ensure that the initial, relatively large change in value of the units' laser-trimmed thin-film resistors occurs before the converters reach the user . . . A 20-kilohertz switching power supply, producing 5 volts at 25 amperes, is packaged in a unit only 1.7 inches high. The total package operates at 1.3 watts per cubic inch due to its high efficiency, says the maker, **RO Associates of Menlo Park, Calif.**

Instruments

Versatile probe is inexpensive

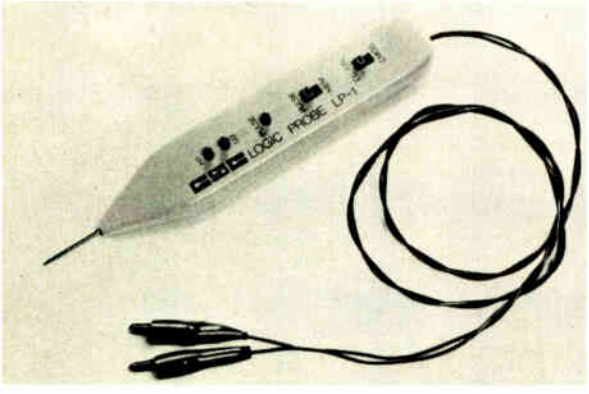
Logic unit tests TTL and C-MOS, detects 50-ns pulses, costs $44.95

It is a common practice in modern system design to combine two logic types on a single board. Transistor-transistor logic is often used where speed is essential, and complementary-metal-oxide-semiconductor logic elsewhere because of its low power consumption. A particularly useful logic probe should be capable of handling both TTL and C-MOS levels.

Such a probe is the LP-1. Priced at only $44.95—less than probes that can handle only one logic family—the multifunction instrument has a two-position switch for selecting either C-MOS logic thresholds or those suitable for TTL and DTL circuits.

Three light-emitting diodes display signal activity at the node under test. HI (logic 1) and LO (logic 0) lamps indicate static and slowly changing levels while a PULSE lamp blinks to indicate logic transitions. A pulse-stretching circuit causes the PULSE lamp to blink at a 3-hertz rate to indicate the presence of a pulse train. Pulses as narrow as 50 nanoseconds can be stretched for easy observation.

An unusual feature of the LP-1 is its ability to indicate highly unsymmetrical pulse trains. If a pulse train has a duty cycle of 30% or less, both the blinking PULSE lamp and the LO lamp are activated. For duty cycles of 70% or more, the PULSE lamp and the HI lamp are turned on. For observing single-shot events or those with very low repetition rates, a memory switch allows the PULSE lamp to stay lit after it detects a single transition.



A high, 100-kilohm, input resistance for both the TTL/DTL and C-MOS modes virtually eliminates loading problems in the application of the LP-1. And the loading is independent of the logic state of the node under test.

Housed in a tough, molded plastic case not much bigger than a fountain pen, the probe is made rugged by strain-relieved power leads and electronic overvoltage and reverse-polarity protection.

Continental Specialties Corp., 44 Kendall St., Box 1942, New Haven, Conn. 06509. Phone (203) 624-3103 [351]

Scope alternately shows main and delayed sweeps

When the beginning of an oscilloscope's trace is controlled by the main time base and the balance by the delayed-sweep time base, a lot of information can be packed onto the scope screen. The model PM3625E from Philips makes this information both more accurate and more nearly complete.

The conventional mixed sweep has disadvantages. It isn't always possible to get as much of the delayed-time-base signal onto the scope display as the user would like. Also, measurements made at the switch-over point between the two sweeps aren't as accurate as is desirable because of the time it takes to make the change and because of nonlinearity in the delayed time base.

Philips' PM3265E oscilloscope, which will be shown at Electro/76, overcomes these problems by alternately displaying the main and delayed sweeps for each of its two inputs. Similar to the firm's model 3265, the 3265E deletes the multiplying and probe power features of the earlier unit and, at $2,295, is priced more than 25% lower.

A dual-trace portable scope, the PM3265E has a sensitivity of 5 millivolts per division to its full bandwidth of 150 megahertz. Like other Philips scopes, it uses a direct-conversion power supply so that it can operate from power sources of 90 to 270 volts, ac or dc, without tap-switching. The power supply also keeps the unit's weight down to 21 pounds and power consumption down to 55 watts.

Philips Test & Measuring Instruments Inc., 400 Crossways Park Dr., Woodbury, N.Y. 11797 [352]

Bench-top tester checks 500 devices an hour

Users of IC bench-top testers are usually more concerned about go/no go results during production inspection than the reasons for a device's failure. With this in mind, Teradyne Inc. has developed the J133D Analogical Circuit Test Instrument, a streamlined version of its predecessor, the J133C. The J133D, which will be introduced at Electro 76, has been optimized for go/no go inspection by removal of the evaluation features from the basic system; evaluation capability is now offered as an option.

Priced at $5,700, the J133D includes free programing cards for testing any of up to 25 different devices. The bench-top tester, which accommodates about 6,000 different devices, can inspect about 500 devices per hour using manual insertion and about 10 times that number with an automatic handler.

The J133D will test TTL, C-MOS, and HTL, as well as more mature logic families such as DTL and RTL. Tristate and open-collector devices, timers, monostable multivibrators, ROMs and RAMs are tested in packages with up to 24 pins.

The streamlined J133D includes only a single lamp to indicate

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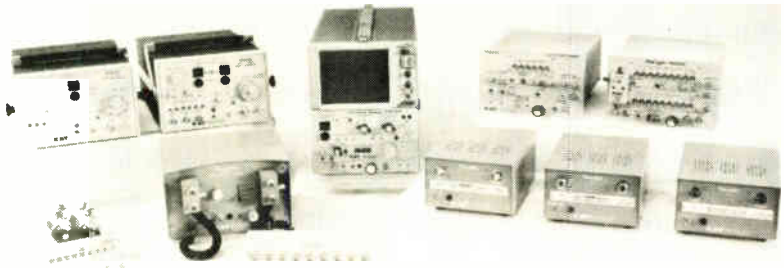

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Pinebrook, N.J. 07058

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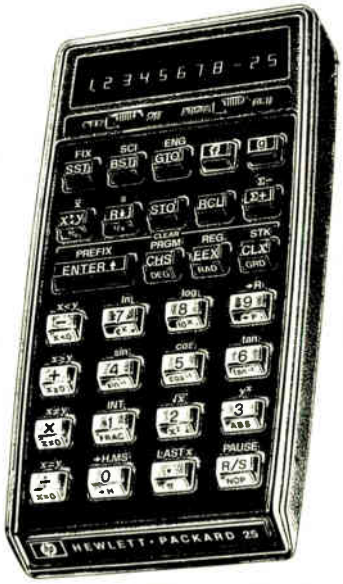

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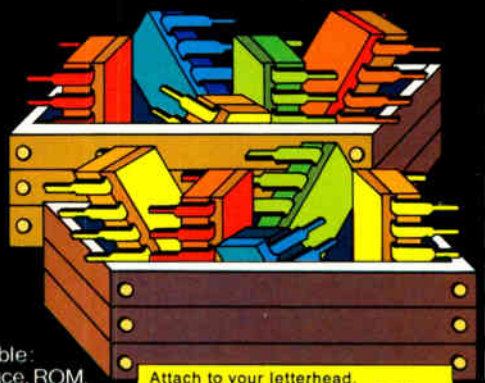

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Circle 195 on reader service card

New products

pass/fail and three reject-cause lamps to identify the major cause of failure. Teradyne says the tester is simple to operate: there are no dials to turn, no buttons to push, no switches to set. The operator merely inserts the devices and watches the pass/fail indicator. Delivery time for the J133D is 12 to 16 weeks.

Teradyne Inc., 183 Essex St., Boston, Mass. 02111. Phone (617) 482-2700 [363]

3½-digit multimeter sells for $99.95

The model MM200 3½-digit (1,999-count) multimeter from the De Forest Electronics subsidiary of Dumont Oscilloscope Laboratories is priced at only $99.95. It is the first in a planned series of non-oscilloscope product ventures from the company [*Electronics*, August 21, 1975, p. 14]. The instrument measures ac and dc voltages with full-scale ranges from

1 to 1,000 volts, ac and dc current with full-scale ranges from 1 to 1,000 milliamperes, and resistance with full-scale ranges from 1 to 10,000 kilohms. Accuracy is within ±(0.5% of reading + 1 digit) on most of the dc voltage and current ranges on ac, ±(1% of reading + 2 digits).

De Forest Electronics, 40 Fairfield Pl., West Caldwell, N. J. 07006 [353]

16-channel logic analyzer handles 25-MHz data rates

The self-contained Vector 1625 logic analyzer is a 16-channel instrument that can handle data rates from 20

hertz to 25 megahertz. A transient detector can catch and display single pulses as narrow as 7 nanoseconds. Capable of handling two logic families at the same time, the 1625 contains a character generator that provides a CRT readout of the settings of all of the instrument's controls along with the logic-state display. Other features include a trigger delay generator and a movable cursor, which together allow the user to look both forward and backward in time from the trigger word. Priced at $4,200, the logic analyzer has a delivery time of 60 days.

Vector Associates Inc., 685 Station Rd., Bellport, N. Y. 11713. Phone (516) 286-9000 [354]

Inexpensive true-rms meter has 1-megahertz bandwidth

Priced at only $345, the 733 series of analog true-rms voltmeters has a fast-responding computational rms converter with maximum error of 0.25%. Passbands extend from 10 hertz to 1 megahertz, and they can handle crest factors as high as 5.5 at full scale. The analog meters have a

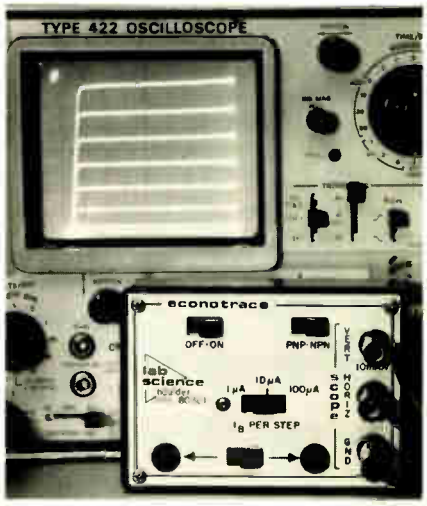
New products

maximum error of 1% of full scale, but better accuracy can be obtained by measuring the converter output with a dc digital voltmeter. The 733 series units have eight ranges, arranged in a 1-3-10-30 sequence. The 733A has full-scale ranges from 100 millivolts to 300 volts and is overload-protected to 500 v peak. The 733B has ranges from 30 mv to 100 v and protection to 250 v. The C version goes from 3 mv to 10 v and has protection up to 50 v. Differential input is available as an option for $10. The meters measure 8 by 3.5 by 7.5 inches and weigh 2.75 pounds. Delivery is from stock to 30 days.

Ufad Corp., 700 36 Street, S.E., Grand Rapids, Mich. 49508. Phone (616) 241-6000 [355]

Compact curve tracer sells for $39.50

Designed to be used with any oscilloscope that has an external horizontal input, the Econotrace semiconductor curve tracer is a small battery-powered device that sells for $39.50 plus $1 for postage and handling. Its C-MOS circuitry draws very little current, so its 9-volt alkaline battery will last more than a year under normal use. Designed primarily to display the characteristics of bipolar transistors, the Econotrace can also be used to test FETs and diodes, limited only by its ±9-v sup-



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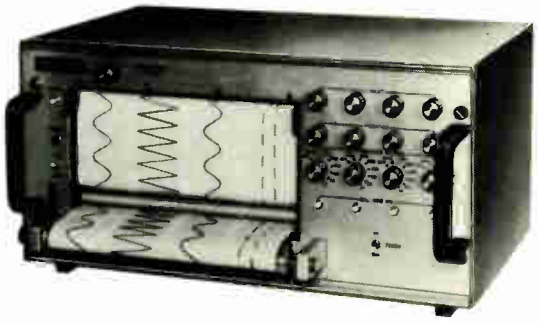

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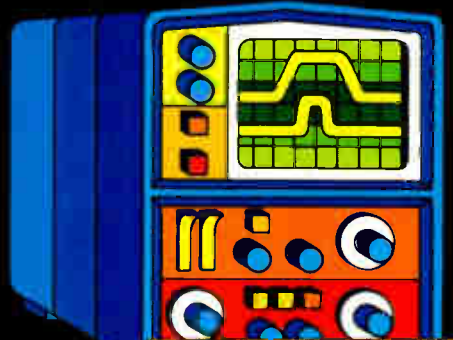

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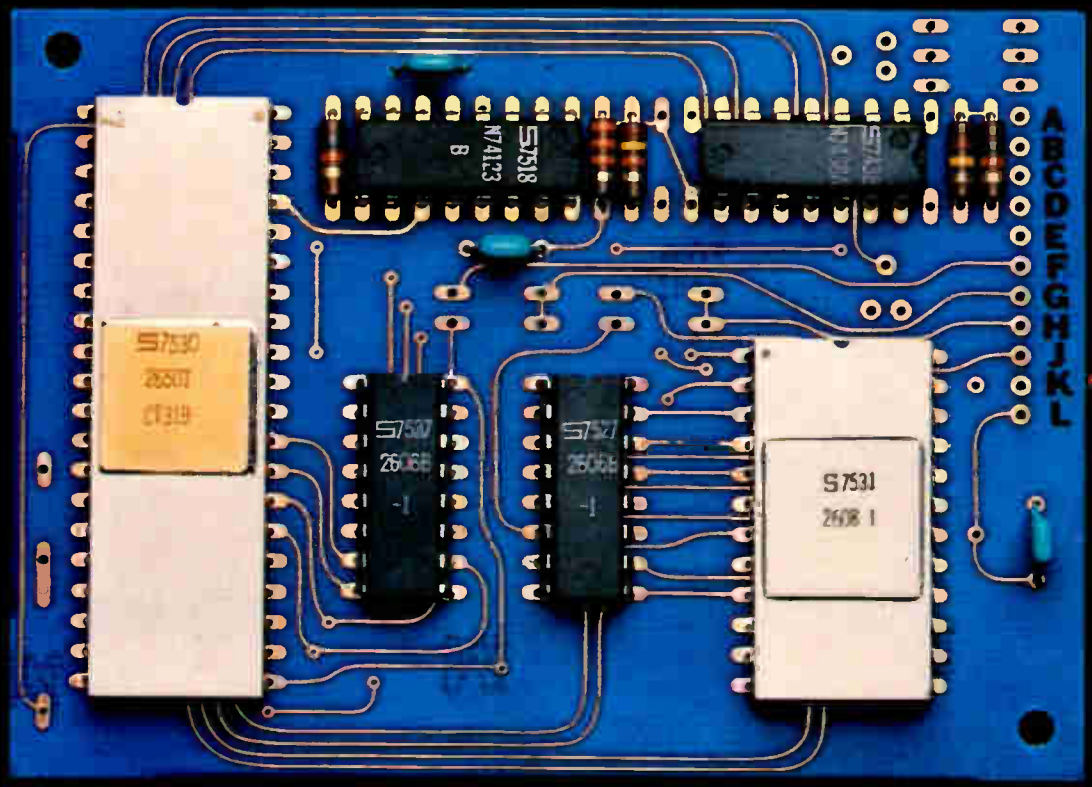

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Flow Chart: How to travel safely and quickly from spec sheet to your μC.

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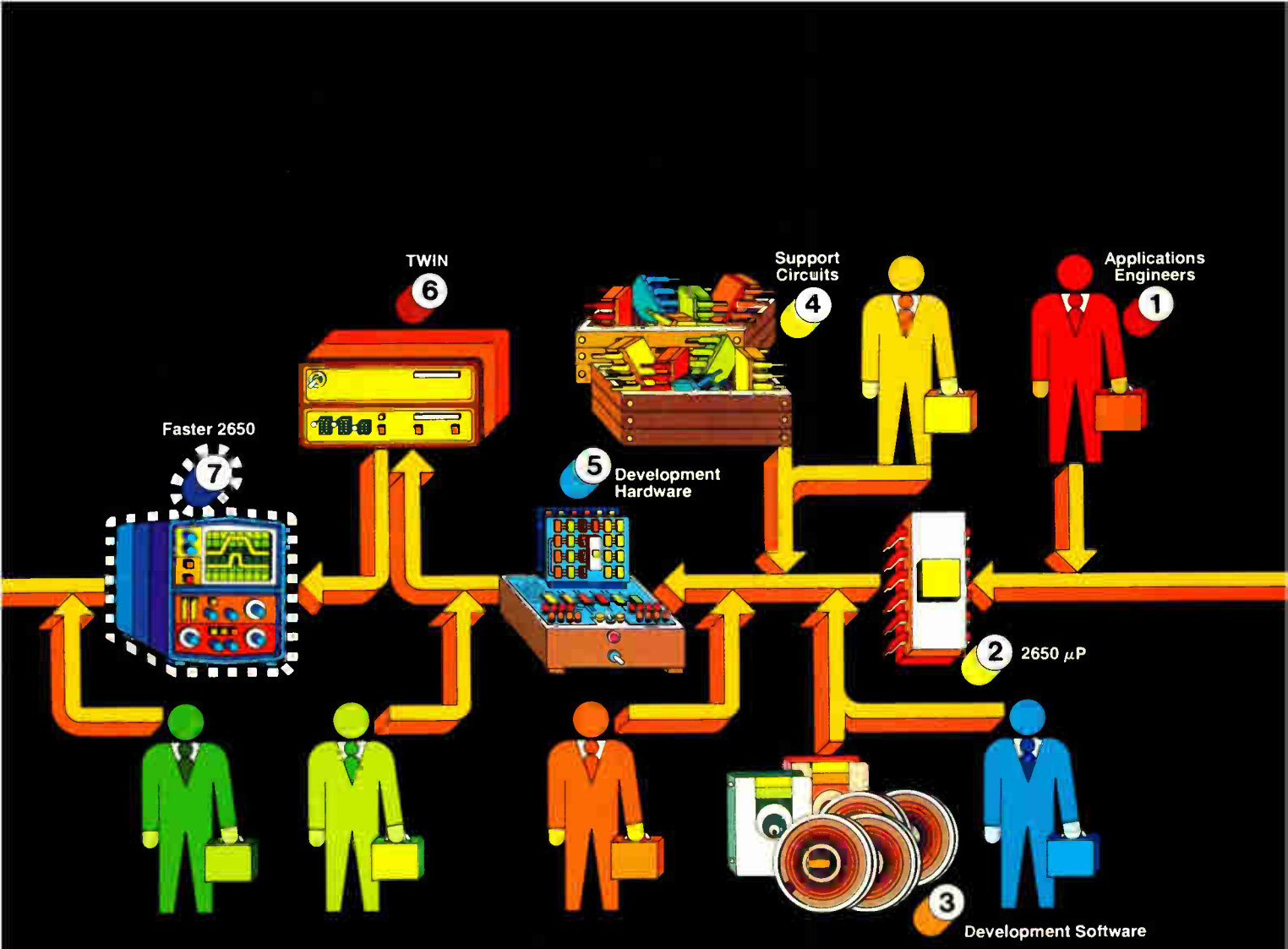
2. Multi-sourced 2650 — available in any quantity from Signetics, at the unprecedented low price of $21.50. Also available from AMS and Philips, and from Signetics' authorized distributors.

3. Development Software — includes the PL μS, an extremely efficient High Level Language (compiler) that reduces programming effort and cuts development time. ANSI standard Fortran IV executes on most machines without alteration. 2650AS1000/1100 Assembler and 2650SM1000/1100 Simulator are available in both 32- and 16-bit, on GE and NCSS time-sharing.

4. Multi-sourced Support Circuits — You'll need MOS and/or Bipolar Memories, Interface and Logic. Signetics has *everything* for a complete system. Back up any item from other sources. Coming soon from Signetics are: Programmable Peripheral Interface and Communications Interface, A-D Converters, Synchronous Data Link Controller, 16k NMOS & Bipolar ROMs, 4k & 8k NMOS EROMs, and 8k Bipolar PROMs.



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ply. In the event of semiconductor breakdown, a built-in 100-ohm resistor limits the current through the device under test to 90 milliamperes. The Econotrace measures 2.875 by 4.00 by 1.875 inches and weighs 14 ounces.

Lab Science, P.O. Box 1972, Boulder, Colo. 80302 [358]

Low-cost logic analyzer handles eight channels

The WCT8 logic analyzer is an inexpensive eight-channel instrument that serves both as an 8-bit word recognizer for the triggering of other instruments and as a logic analyzer. After recognizing the 8-bit trigger word set up by means of its front-panel slide switches, the unit can delay from 0 to 999 clock pulses and then put out a trigger pulse and display the states of its inputs on an array of eight light-emitting diodes. The unit can operate at clock rates up to at least 15 megahertz. Measuring 4.5 by 9.0 by 11.0 inches, the WCT8 sells for $265.

Computel Engineering and Manufacturing Co., 29501 Greenfield Rd., Suite 110, Southfield, Mich. 48076. Phone (313) 559-9577 [359]

TOPICS

Instruments

3M Co., St. Paul, Minn., has introduced its Scotch brand 890 high-resolution instrumentation tape for recording critical analog signals. The tape is claimed to be ultra-smooth and to have superior short-wavelength response. . . . **Hewlett-Packard Co., Palo Alto, Calif.,** has made available four options for its 8015A pulse generator. They are power-supply tracking, external access to the linear output amplifiers, a third TTL output, and remote control. . . . **Tektronix Inc., Beaverton, Ore.,** has announced its C-5A low-cost oscilloscope camera. The unit sells for $200 without graticule flash, and $235 with it.

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New literature

Butterworth filters. An application report, "Phase Response Characteristics of a Butterworth Filter" provides a basic understanding of the phase-versus-frequency response of a Butterworth filter without using complex circuit equations. Intended for those not familiar with filter-design theory, the report includes examples of calculations of gain and phase shift for high-pass, low-pass, band-pass, and band-reject filters. The report is available from Krohn-Hite Corp., Avon Industrial Park, Avon, Mass. 02322. Circle 421 on reader service card.

Preconditioning ICs. A four-page brochure from Electronic Test Center, 2031 East Cerritos Ave., Anaheim, Calif. 82806, explains the importance of conditioning integrated circuits before testing them. It also makes a case for testing by an independent laboratory rather than in-house screening. [422]

Solenoids. Prefaced by a technical discussion of solenoids in general, a 62-page catalog gives details on 26 solenoid models. The "Solenoid Engineering Manual" is liberally illustrated with photographs, performance curves, and tables of specifications. Bulletin 1846 can be obtained from Deltrol Controls, 2745 S. 19 St., Milwaukee, Wis. 53215 [423]

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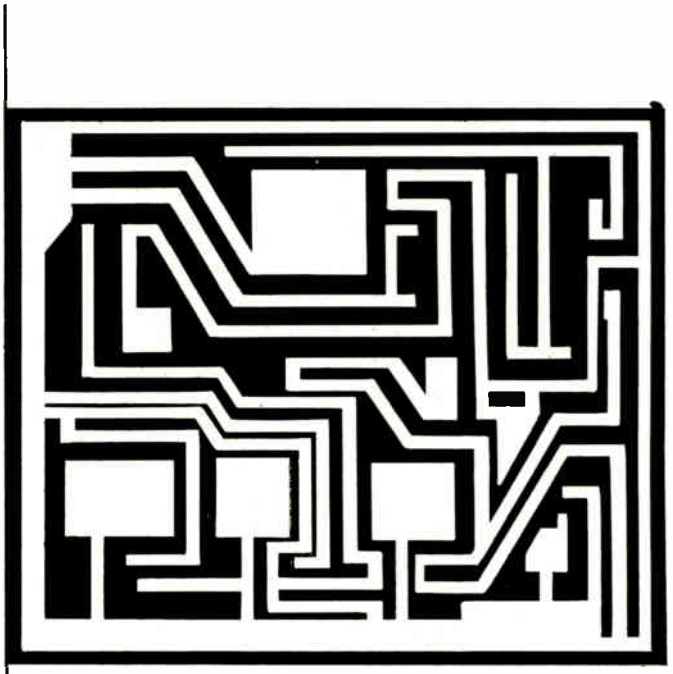

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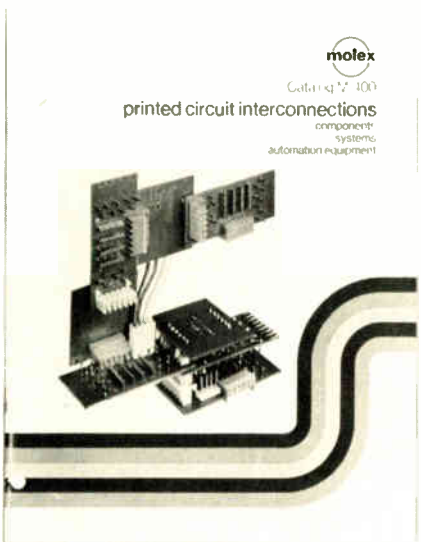
New literature

seventh edition of the Directory of Science Resources for Maryland is a 230-page book that gives details on companies, universities, government facilities, and professional organizations in Maryland. Copies can be purchased for $3 (plus 4% sales tax if delivered in Maryland) from the Maryland Department of Economic and Community Development, 2525 Riva Rd., Annapolis, Md. 21401.

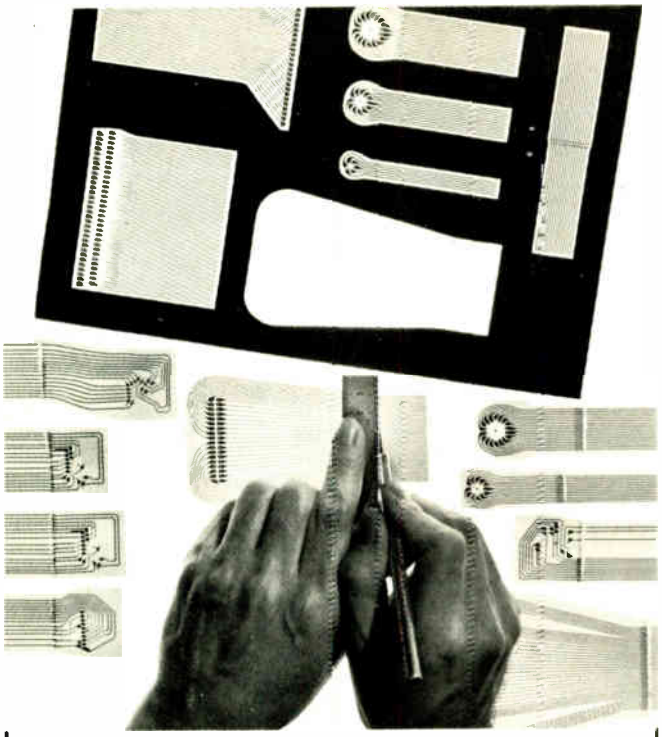
Pc interconnections. Sockets, connectors, and interconnection systems are described in a 64-page



catalog from Molex Inc., 2222 Wellington Court, Lisle, Ill. 60532 [425]

Discrete semiconductors. A 112-page "Discrete Semiconductor Guide" contains technical specifications on Intersil's line of field-effect transistors, dual FETs, and dual bipolar transistors. Intersil Inc., 10900 North Tantau Ave., Cupertino, Calif. 95014 [426]

Ceramic capacitors. A Kemet ceramic-capacitor catalog which includes MIL-C-20 ultra-stable capacitors, Z5U general-purpose units, X7R stable devices, and NPO capacitors, covers units with capacitances from 1.0 picofarad to 6.8 microfarads. Union Carbide Corp., Components Dept., P. O. Box 5928, Greenville, S. C. 29606 [427]



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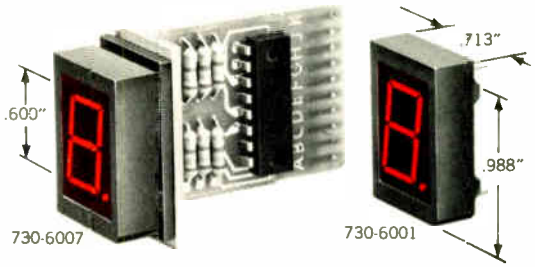

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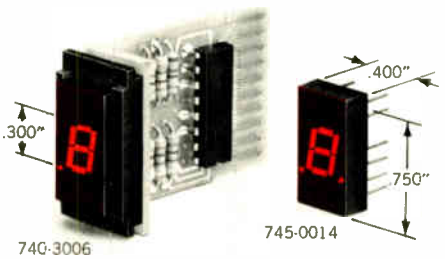

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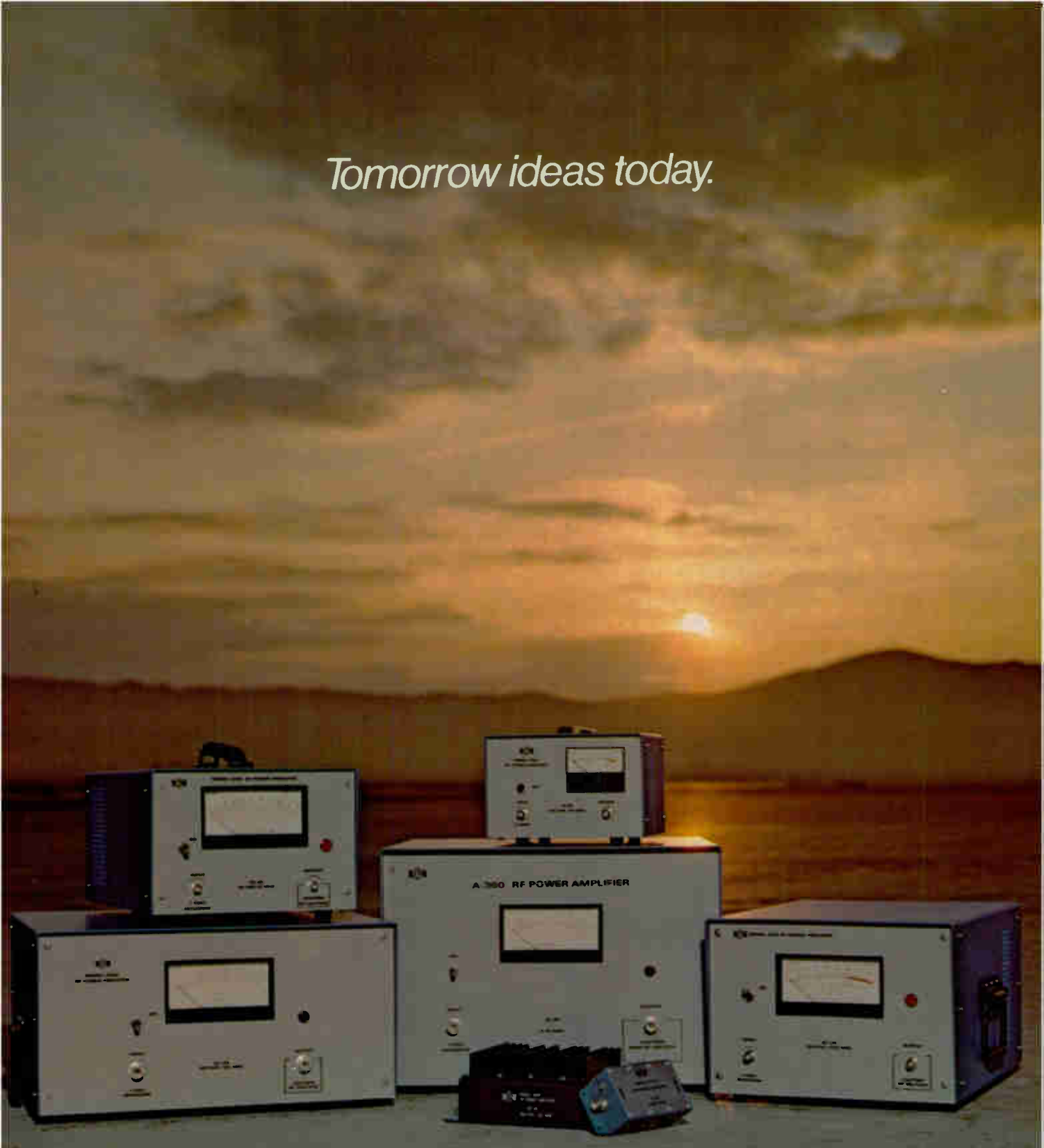

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