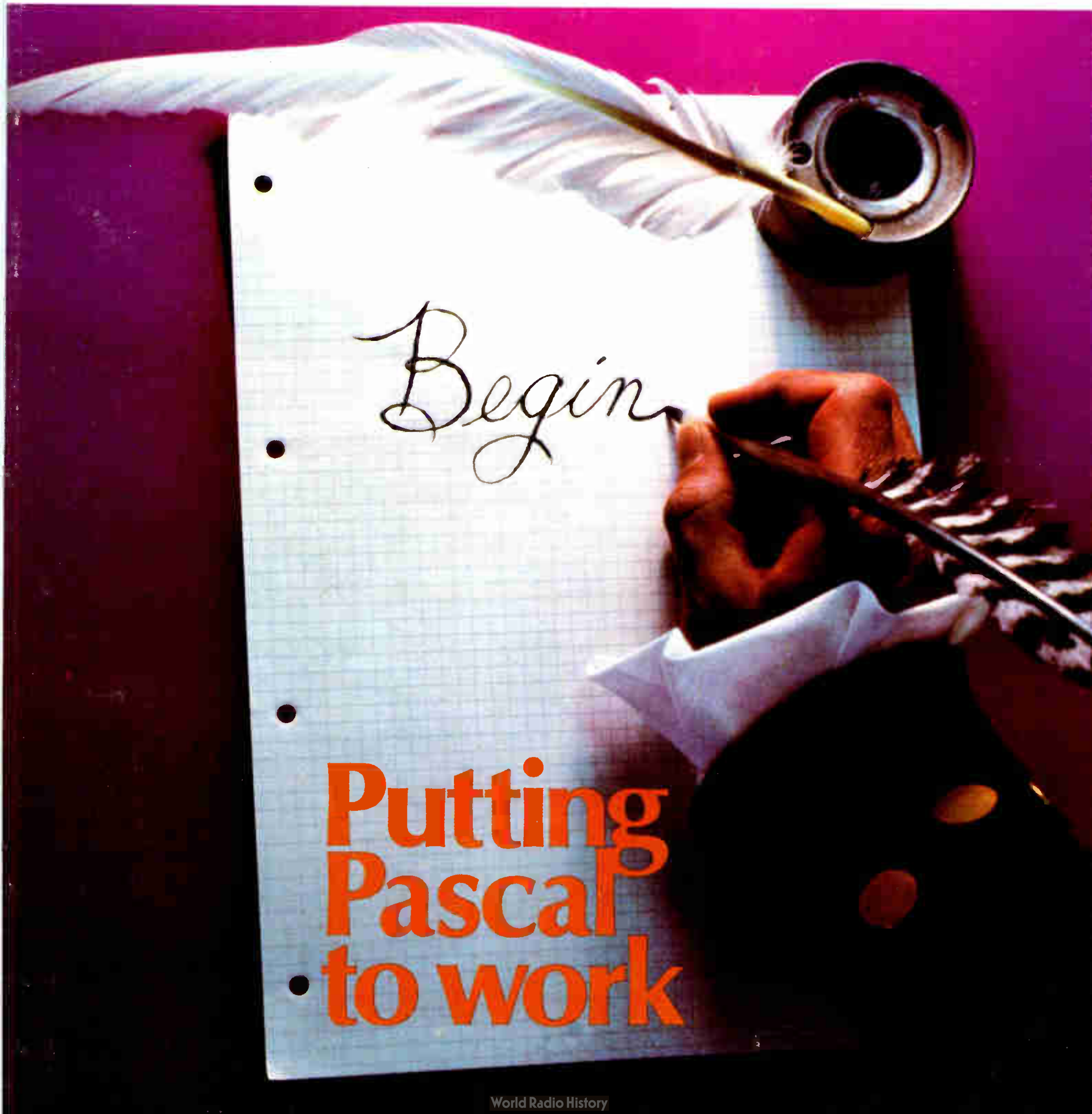
JUNE 7, 1979

A NEW WAVE OF PERSONAL COMPUTERS COMING/87

50 YEARS
FOUR DOLLARS A McGRAW-HILL PUBLICATION

Electronics®



Bourns SIP Trimmers Come in Small Packages...

And save you valuable space.

Model 20 SIP trimmers save you precious PC board space, yet don't cost a fortune. Only .785" X .185" X .079" in size, the Model 20 SIP trimmer occupies just 25% of the board space used by comparable DIP configurations and 50% of that used by conventional ¼-inch rectangular trimmers. The low board profile of .185-inches and .100-inch spacing are ideal for meeting all of your high density PC board trimmer needs.

Priced at only 75¢* in 1,000 to 4,999 quantities, Model 20 SIP trimmers are available in 18 standard resistance values ranging from 10 ohms to 5 megohms. Options of either hand or machine insertion, plus compatibility with automatic test equipment add up to more cost savings yet.

There's no sacrifice in performance either. Sealed to withstand industrial cleaning processes, Model 20 SIP trimmers have a low tempco of 100 ppm/°C over −55°C to +125°C temperature range. Power rating is 0.50 watts at 70°C. The stable cermet element offers infinite resolution. The wiper assembly idles at both ends of travel, eliminating damage from forced adjustment.

Put these little jewels to work for you. Dramatic space savings, the ring of Bourns quality, and sparkling performance, too. Contact your local Bourns representative for evaluation samples or send today for complete details. Or, see EEM directory, Volume 2, pages 3804, 3805.

TRIMPOT PRODUCTS DIVISION, BOURNS, INC., 1200 Columbia Avenue, Riverside, CA 92507. Phone: 714 781-5050. TWX: 910 332-1252.

European Headquarters: Bourns AG, Zugerstrasse 74 6340 Baar, Switzerland. Phone: 042 33 33 33. Telex: 78722.

*Domestic U.S.A. price only

BOURNS®

For Immediate Application—Circle 120 For Future Application—Circle 220

Why settle for an ordinary switch...

when you can have a LOLLAPALOOSA!

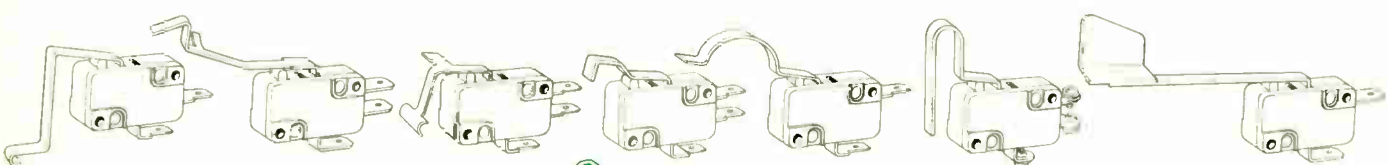
Our basic miniature snap action precision switch (up above) is the standard of the industry. 34,816 variations make it the standard of the switching world.

Example: Our miniature comes in 17 standard actuators... *plus* 43 more special forms and shapes already tooled (like the examples down below)... *plus* Cherry will produce any design your application needs. The standard actuators *alone* range from as high as 400 grams operating force at 15 amps to an operating force as low as 2 grams at 3 amps.

Example: Our miniature comes in your choice of five (count them!) five ratings—from 0.1 amp gold crosspoint contacts... to a full 15 amps. With 3, 5 and 10 amps in between.

Then there's our choice of terminals: screw, solder or QC. And, our choice of circuitry: SPDT, SPST/NO or SPST/NC. Add it all up and you'll come to three conclusions:

1. This is the most versatile miniature switch you can spec—34,816 times over.
2. Only Cherry—with 25 years of snap switch experience—could offer such a lollapaloosa at the right price.. with the right delivery dates.
3. **You need our complete catalog... and free sample switch. Just call... write... or TWX... say "Lollapaloosa!"... and we'll send you both. Free. No strings.**



CHERRY® PRECISION SWITCHES

CHERRY ELECTRICAL PRODUCTS CORP. 3608 Sunset Avenue, Waukegan IL 60085—312/689-7700—TWX 912/235-1572

Circle 1 on reader service card

Here's how you can be fully computerized for so much less than you thought

BUSINESS — EDUCATION — ENGINEERING — MANUFACTURING

We are pleased to announce the first professional time-sharing system in the microcomputer field.

Naturally, it's from Cromemco.

This new multi-user system will do all of the tasks you usually associate with much more expensive time-sharing computers. Yet it's priced at an almost unbelievably low figure.

Look at these features:

- **You can have up to 7 terminals plus a fast, 132-column line printer**
- **You can have a large system RAM memory that's expandable to ½ megabyte using the Bank Select feature**
- **Each user has an independent bank of RAM**
- **You can have floppy disk storage of up to 1 megabyte**
- **You have confidentiality between most stations**
- **And, make no mistake, the system is fast and powerful. You'll want to try its fast execution time yourself.**

PROGRAMMERS LOVE OUR BASIC

This new system is based on Cromemco's well-known System Three Computer and our new Multi-User BASIC software package.

Programmers tell us that Cromemco Multi-User BASIC is the best in the field. Here are some of its attractions:

- **You can use long variable names and labels up to 31 characters long — names like "material on order" or "calculate speed reduction."**
- **You get many unusual and helpful commands that simplify programs and execution — commands such as PROTECT, LIST VARIABLES, NOLIST, and many more.**
- **No round-off error in financial work (because our BASIC uses binary-coded decimal rather than binary operation). And we've still been able to make it FAST.**
- **Terminals and printer are interrupt-driven — no additional overhead until key is pressed.**
- **The conveniences in this Multi-User BASIC make it much easier to write your own application software.**
- **A line editor simplifies changes.**

BENCHMARK IT — NOW

In the final analysis, the thing to do is see this beautiful new system at your dealer. See its rugged professional quality. Evaluate it. Benchmark it for speed with your own routine (you'll be agreeably surprised, we guarantee you).

Find out, too, about Cromemco's reputation for quality and engineering.

Look into it now because you can have the capabilities of a fully computerized operation much quicker and for much less than you ever thought.

Cromemco
incorporated
Microcomputer Systems
280 BERNARDO AVE., MOUNTAIN VIEW, CA 94040 • (415) 964-7400

Circle 2 on reader service card

Electronics
The International Magazine of Electronics Technology

Vol. 52, No. 12 • June 7, 1979

Highlights

Cover: Pascal starts work, 111
Having graduated from academia with honors in comprehensibility and ease of maintenance, Pascal is busy acquiring industrial expertise. Part 1 of this two-part article tells how the high-level language has been adapted by Texas Instruments to handle multiprocessing and to aid the programmer still more. Part 2 (p. 117) describes the microprocessor version of TI Pascal.

Cover is by Art Director Fred Sklenar and Microsystems & Software Editor John G. Posa.

AEG-Telefunken specializes at home, 96
The West German semiconductor company is recentering its domestic operations around the components markets in solar technology, thermal imaging, and optoelectronics. For instance, it plans to be mass-producing a 1-watt terrestrial solar cell for 50 cents by 1985.

Why CCDs can't shake the RAM pursuit, 122
The processing advances that help charge-coupled-device memories also keep random-access memories only a step behind them in density. And in most applications, random access to data is both faster and more convenient than serial access.

How to design bipolar V-f converters, 139
Voltage-to-frequency converters that can accept bipolar inputs have many uses in data acquisition and control.

. . . and in the next issue
Special report on data encryption . . . the design innovations behind a 1-gigahertz oscilloscope . . . building and using a microcode down-loader.

Electronics

Publisher's letter

What hath Niklaus Wirth wrought? His computer language, Pascal, is moving rapidly into the limelight among users. But long before the language's current heyday, among the first of Pascal's supporters was Texas Instruments.

At TI the decision makers who focused the company on Pascal were Roger Bate, head of the Advanced Software Technology department, and Doug Johnson, currently integrated software support systems manager. Their two-part cover article (pp. 111, 117) describes in detail its advantages and applications in minicomputers and microprocessors.

But being among the first had its risks. "When we started, it was not clear that Pascal would become popular," Bate recalls. "But we liked what we saw and took the plunge. That decision looks correct now."

"It takes several years for a computer language to work its way into a society," comments Johnson. "Fortran has been around for 20 years, Cobol for 10. A standard Pascal will eventually evolve, though implementation may vary."

Bate and Johnson have worked together for some 15 years. Graduates of West Point, they both spent several years on the aeronautical engineering faculty of the Air Force Academy. They were reunited in 1976 after Bate had retired from the military and formed the software department at TI. Heading the team there that prepared the language were George Ligler and Joe Cointment. Even Wirth got into the act to review TI's effort.

The Advanced Software Development department in TI's Equipment Group is by no means the only concentration of computer-language people at the company. "TI has been building up a staff of software engineers for some time," Johnson points out. "We have also converted hardware designers as more and more of them are moving from the use of discrete logic in hardwired form to program logic on a microprocessor."

Incidently, the cover prepared by art director Fred Sklenar shows authentic 18th-century objects. The jacket and pewter inkwell in the picture came from the extensive collection of Colonial Americana owned by our direct marketing operations manager, Tom Howland.

June 7, 1979 Volume 52, Number 12 101,109 copies of this issue printed

Electronics (ISSN 0013-5070). Published every other Thursday by McGraw-Hill, Inc. Founder: James H. McGraw 1860-1948. Publication office 1221 Avenue of the Americas, N.Y., N.Y. 10020; second class postage paid at New York, N.Y. and additional mailing offices.

Executive, editorial, circulation and advertising addresses: Electronics, McGraw-Hill Building, 1221 Avenue of the Americas, New York, N.Y. 10020. Telephone (212) 997-1221. Teletype 12-7960 TWX 710-581-4879. Cable address: M C G R A W H I L L N E W Y O R K.

Subscriptions limited to professional persons with active responsibility in electronics technology. No subscriptions accepted without complete identification of subscriber name, title or job function, company or organization, and product manufactured or services performed. Based on information supplied, the publisher reserves the right to reject non-qualified requests. Subscription rates: in the United States and possessions $17 one year, $29 two years, $43 three years; company addressed and company libraries $23 one year, $41 two years, $58 three years; APO/FPO addressed $35 one year only; Canada and Mexico $19 one year, $32 two years, $47 three years; Europe $46 one year, $78 two years, $110 three years; Japan, Israel and Brazil $70 one year, $115 two years, $165 three years; Australia and New Zealand $95 one year, $170 two years, $240 three years, including air freight; all other countries $50 one year, $85 two years, $125 three years. Limited quota of subscriptions available at higher-than-basic rate for persons allied to field served. Check with publisher for these rates. Single copies: $4.00. Please allow four to eight weeks for shipment.

Officers of McGraw-Hill Publications Company: Gordon L. Jones, President; Group Vice-Presidents: Daniel A. McMillan, James E. Boddorf, Senior Vice-Presidents: Russell F. Anderson; Ralph R. Schulz, Editorial; Vice-Presidents James E. Hackett, Controller; Thomas H. King, Manufacturing; Robert L. Leyburn, Circulation; John W. Patten, Sales; Edward E. Schirmer, International.

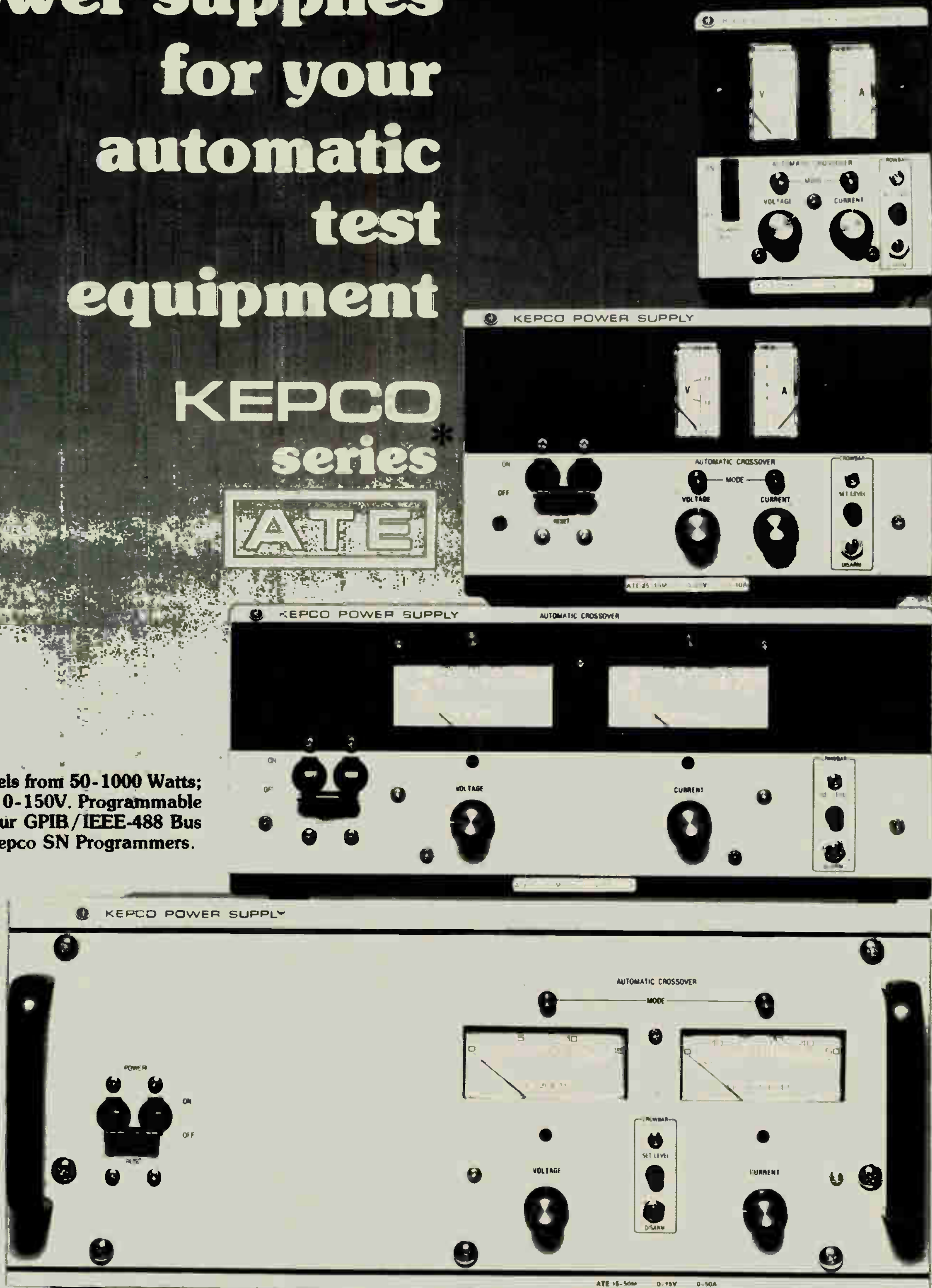
Officers of the Corporation: Harold W. McGraw, Jr., President, Chief Executive Officer, and Chairman of the Board; Robert N. Landes, Senior Vice President and Secretary; Ralph J. Webb, Treasurer.

Subscribers: The publisher, upon written request to our New York office from any subscriber, agrees to refund that part of the subscription price applying to copies not yet mailed. Please send change-of-address notices or complaints to Fulfillment Manager; subscription orders to Circulation Manager, Electronics, at address below. Change-of-address notices should provide old as well as new address, including zip codes. Attach address label from recent issue. Allow one month for change to become effective. Subscriber Service: call (609) 448-8110, 9 a.m. to 4 p.m. EST.

Postmaster: Please send form 3579 to Fulfillment Manager, Electronics, P.O. Box 430, Hightstown, N.J. 08520.

power supplies for your automatic test equipment

KEPCO series* ATE



*38 Models from 50-1000 Watts; 0-6V to 0-150V. Programmable from your GPIB/IEEE-488 Bus using Kepco SN Programmers.

KEPCO® For complete specifications, write Dept. CJF-14.

KEPCO, INC. • 131-38 SANFORD AVENUE • FLUSHING, N.Y. 11352 U.S.A. • (212) 461-7000 • TWX #710-582-2631 • Cable: KEPCOPOWER NEWYORK

Circle 5 on reader service card

Readers' comments

Mark this

To the Editor: The diagram in your article "Tunnel diodes flying high" in the April 26 issue, p. 81, uses the word Kovar as if it were in the public domain. This is not the case. Kovar is a registered trademark of Carpenter Technology Corp. and any use of that name should credit the ownership to Carpenter.

D. K. Rothermel
Carpenter Technology Corp.
Reading, Pa.

Let's hear it for ECL

To the Editor: Your article "The race heats up in fast static RAMs" [April 26, p. 125] reveals what I perceive to be an oversight on the part of many random-access memory suppliers—namely, many of us designers now use emitter-coupled logic. As the article points out, 10-nanosecond scratchpads and 20-ns caches are available. I do need and use these devices, but within an ECL environment not all memory requires the blazing speed and consequent blazing heat they provide.

Since committing to ECL for a new product four years ago, I have waited in vain for an ECL-compatible RAM family in the 50-to-100-ns range for instruction files and also for compatible 4-K and 16-K bulk memory chips.

I submit that the main reason these needs of mainframe and specialized processor systems remain unfilled is not basically technical or even a lack of awareness that such a market exists, but rather the fact that no supplier wants to take the chance of being first.

ECL systems are indeed here! Let's see who has the courage to recognize it.

Clyde A. Boenke
Ann Arbor, Mich.

Call to action

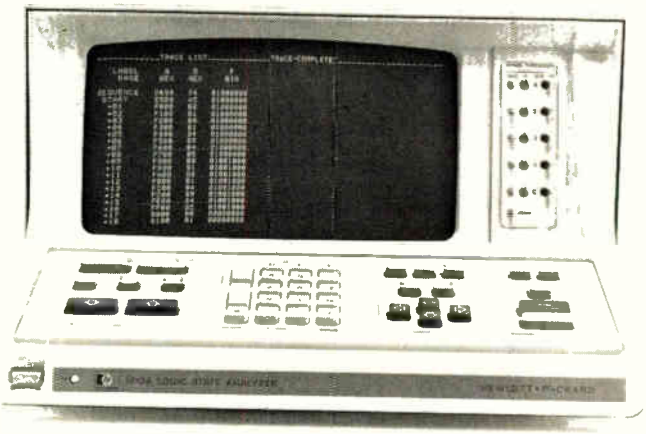
To the Editor: Ray Connolly makes some important points about solar-power satellites in his Washington Commentary of April 26 [p. 56], but it is a mistake to depict White House and congressional leaders as timid. What they are is caught in the middle, and we are the ones who

Relax!

We can get HP's 1610A Logic State Analyzer on its way to you in minutes.

Whether your requirement is for a week, a month, a year or longer, there's one way to get HP's 1610A logic state analyzer without waiting. Rent it from Leasametric.

Instantly, our nationwide on-line computerized inventory system will check our dozens of regional inventory centers to pinpoint the unit closest to you. Within minutes, your order will be processed and moving on its way. In most cases, your analyzer will be in your hands in less than 24 hours.



Need other test equipment? Don't waste time and energy calling everyone in the book. One phone call to Leasametric is the fast, simple way to end your equipment worries and start relaxing. And, rental means more than immediate possession. It's the one effective way to get the new equipment you need without going back to management for more money. There's no major capital investment with a Leasametric rental.

Leasametric, of course, means more than general-purpose test equipment. We stock the latest terminals, acoustic couplers, modems, development systems, and communications test equipment . . . just about anything you might conceivably need. Our growing inventory includes over 23,000 items from 500 of the top electronic manufacturers— including almost the entire HP catalog.

Need it now? Why wait? To order, or for our latest rental catalog, pick up the phone and call one of the relaxing, nationwide numbers shown below. They're toll free. Or call your local Leasametric office. There's one in every major city.

Rent it and relax.

In the West
Call 800-227-0280
In California, call (415) 574-4441

In the Central U.S.
Call 800-323-2513
In Illinois, call (312) 595-2700

In the East
Call 800-638-4009
In Maryland, call (301) 948-9700

Leasametric

1164 Triton Drive, Foster City, CA 94404
A Trans Union Company

have put them there.

Nothing is going to be done about solar-power satellites or anything else in our political system until there is broad popular support for it. The only Congressman who might be influenced by the column is Mr. Connolly's own, unless readers take action to call or write their own representatives with reasoned, factual arguments.

If you are serious about solar-power satellites, which you should be, then you should publish articles about the idea and the addresses of the grassroots organizations that are trying to do something about it. Those organizations are:

- Sunsat Energy Council, 600 New Hampshire Ave., N. W., #480, Washington, D. C. 20037
- L-5 Society, 1620 North Park Ave., Tucson, Ariz. 85719

Let's not wait until we are all reduced to barbarism by worldwide economic collapse or thermonuclear war. Solar-power satellites are a feasible alternative that can meet the needs, not only of the United States, but of the world, without the risk of nuclear proliferation.

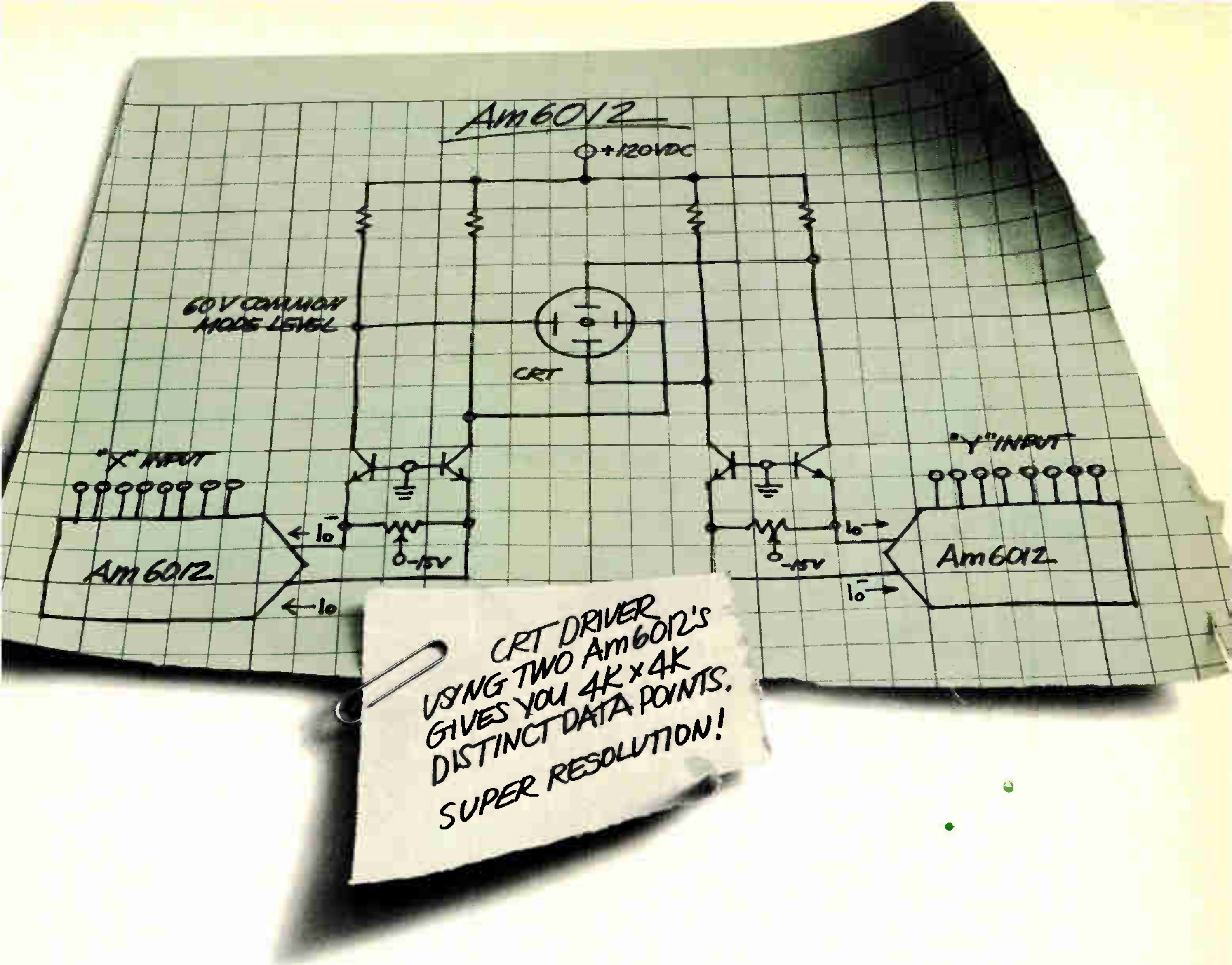
Jon D. Roland
San Antonio, Texas

Emphasis added

To the Editor: There is no doubt that modern electronic technology, particularly in the microprocessor and minicomputer area, can be instrumental in preventing more nuclear accidents. This was well pointed out in your April 12 editorial [p. 24].

Scores of reactors now on the drawing board and scores more of old reactors are prime candidates for improved safety equipment. With this in mind, it is well to note that some of the new technologies, particularly those involving semiconductors, are extremely sensitive to nuclear radiation. Therefore I feel much greater emphasis should have been placed on your comment that "the know-how in radiation hardening acquired from years of fabricating devices for the military would have to be applied."

James R. Weckback
Hopkinton, Mass.



We trimmed the price, not the DAC.

Circle 11 on reader service card

Microwave radiation: winner or sinner?

Microwaves have been generating a lot of news lately. Microwave emissions allow cancer to be detected far more safely than with traditional X-ray diagnosis [*Electronics*, April 12, p. 85]. Microwaves, and radio-frequency energy in general, are proving valuable in cancer treatment through what's called hyperthermia [*Electronics*, April 26, p. 88], and though the technique has not as yet gained wide acceptance for human patients, it is 90% effective at controlling eye cancer in cattle [*Electronics*, May 24, p. 44]. There is also evidence that microwave radiation can be used to alter the effect of some drugs [*Electronics*, April 26, p. 46].

But there is another side to the topic: fear among some citizens that low-level exposure to rf fields is a health hazard. It is unfortunate that when something as important as health is discussed, so much of the basic data should be in doubt, but that's the case with rf effects. There is just no consensus on whether they are harmful or harmless. Each side has its partisans, naturally, and the debate is growing heated. With tempers rising, the argument is becoming tinged with politics as citizens' groups try to ban antenna test ranges and radar systems because of this fear [*Electronics*, April 12, p. 48].

What is needed is basic research—animal studies conducted under controlled conditions. In fact, some researchers say testing ultimately will have to be done on human beings. Such studies should investigate all the variables that now cloud the issue, like energy density, pulse repetition rate and width, and the relationship between wavelength and body length. A good study would also have to last for several generations to spot possible long-term genetic effects. An absolutely unbiased group should undertake the work, and the funding should come from the Government because some feel that industry funding would taint any results.

We may have a handle on some of the results already. John M. Osepchuk, consulting scientist at the Raytheon Co.'s Research division in Waltham, Mass., makes a good case that people are worrying about the wrong waves. He figures that if there is a real risk, it comes from exposure to rf wavelengths about as long as the human body—not the microwaves that are exciting so much controversy. If he is right, there could be trouble, because those 3- to 6-foot waves are the ones used by television and fm-radio stations.

It's obvious that we need data; let us hope the need is obvious enough so that somebody will tackle the job of getting it and clear up the confusion.

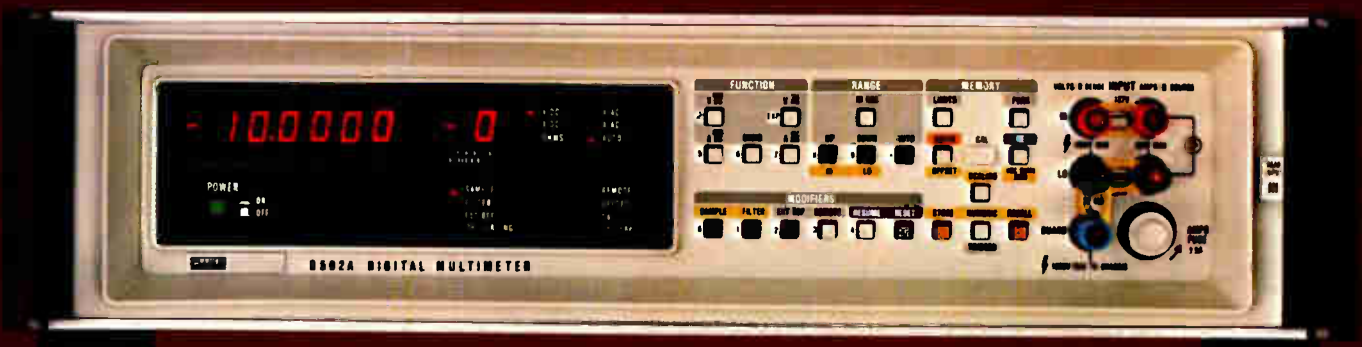
The voice of the recruiter is heard in the land

Now that the dogwoods, azaleas, and roses have bloomed, don't you wish you were young, in love, and a June EE graduate? The market for engineers is so tight that some companies are wining and dining the young grads much the way assistant college football coaches do with outstanding high school football players (see p. 90). And with starting salaries dancing around the $18,000 mark, one engineering professor says of the future: "You can just see the salary levels [for new BSEEs] going up by better than $100 [per month] year by year."

It is truly heartwarming to see the young, well-educated electronics engineer receiving his or her due. But lest we be dazzled by the splendor of industry's courtship dance, now would be a good time to consider all the over-40 EEs out there who are facing obsolescence. Maybe some of the time, money, and effort that's being put into netting those eager and enthusiastic young EEs could have a greater return if invested in the continuing education of older, experienced engineers.

ON THE BENCH, THE MOST ADVANCED DVM.

IN SYSTEMS TOO.



The new 8502A digital voltmeter—the precision DVM just right for both systems *and* bench applications.

It's right because it brings all the power of the 8500A, the world's most advanced system DVM, to the front panel.

"Y=AX+B"

Press SCALING and enter any multiplier to scale volts, ohms or amps to temperature, percent, engineering units, or any scale of convenience. Press OFFSET and add or subtract any numerical value to set your prescaled units to the right reference point.

If you're looking only for a good/bad indication, use LIMITS and key in both high and low tolerance values on any function. After that you'll get a friendly "Hi, Pass or Lo" reading at full accuracy.

The 8502A remembers its highest and lowest readings. Leave it unattended on a stability test, for example, then touch PEAK, HI and LO later to observe the amount of drift that occurred.

Want 6½-digit resolution? Press HI RES and get it on all functions. This lets you utilize the full instrument accuracy —6 ppm on DC volts.

The 8502A is fast—up to 250 readings/second on the bench, 500/second in a system. This speed is put to work to provide noise rejection through digital averaging. Adding analog filtering gives you up to 100 dB NMR.

Calibration memory is a Fluke exclusive that saves time and money. Without removing the voltmeter or taking off covers, simple recalibration is done from the front panel in a few minutes. Lab calibration is recommended only once a year if calibration memory is used.

The five FUNCTION pushbuttons are evidence of another exclusive. Besides volts and ohms, the 8502A can have AC and DC current capability installed, a feature not available in any other precision DVM.

Error E

We even provide diagnostic error codes to keep you out of trouble by identifying programming mistakes and hardware errors.

For systems use, we offer more interface options than anyone: IEEE 488, RS-232 or full parallel. And, a switchable front/rear input option is available.

U.S. base price: $2595.

For more information, contact any one of the more than 100 Fluke offices or representatives, worldwide. In the U.S., CALL (800) 426-0361*, TOLL FREE. Residents of the U.S.A. and all countries outside Europe, contact: John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043, U.S.A. Telex: 32-0013.

In Europe, contact Fluke (Nederland) B.V., P.O. Box 5053, Tilburg, The Netherlands. Telephone: (013) 673973. Telex: 52237.

*Alaska, Hawaii, Washington residents — please call (206) 774-2481.

6104-8002

FLUKE®

For Technical Data Circle #12 on Reader Service Card

For Demonstration Circle #13 on Reader Service Card

People

Fred Blum holds umbrella over Rockwell's R&D

A case of double vision in the process of being cured—that's how the recent reorganization of the research and development operations of Rockwell International's Electronic Devices division may be viewed.

"We've consolidated all advanced electronics R&D under one umbrella," explains Fred A. Blum, newly named division vice president and head of the Electronics Research Center in Anaheim, Calif. For years, the research center and Rockwell's Corporate Science Center at Thousand Oaks, 80 miles to the northwest, shared engineers and scientists (275 at present) who reported to different entities within the division. Developments in advanced materials and devices not only overlapped but often went off on uncoordinated tangents.

"No longer," vows Blum, looking younger than his 39 years. He will relocate to Anaheim from Thousand Oaks, where since 1975 he directed the solid-state electronics department and headed work on semiconductors made of gallium arsenide and related compounds.

Big play. Unlike most R&D directors, who tend to be closemouthed about their plans, Blum discusses his in some detail. He admits to being a gallium-arsenide enthusiast, and this material, overshadowed by silicon and derogatorily called the "eternal material of the future," will get a big play from him. He is certain its practical use is imminent and that it will come into its own around 1985.

Blum hopes to demonstrate GaAs devices, with a basic 5-to-1 speed advantage over silicon, in large-scale integrated circuit (500 to 1,000 gates) within 18 to 24 months. Concurrently, Rockwell will be working on other new devices, he continues. These include a generation of very large-scale integrated n-channel MOS chips and complementary-MOS-on-sapphire circuits set for limited production later this year. In about two years will come a 4-megabit bubble memory.

Imminent. Gallium arsenide's speed advantage will soon be applied, says Blum.

Blum took a classy route to his new post, beginning with a Ph.D. in physics in 1968 from the California Institute of Technology. In between were stops at the Massachusetts Institute of Technology, Hughes Research Laboratories, and Texas Instruments.

He likes his group's new operational structure very much. "Reporting to division president Howard Walrath ties R&D firmly into the business sector now," he says. This corrects an arrangement that sorely hampered Rockwell's application of technology in the past.

Pay heed to human resources, says Electronic Arrays' Wood

Electronic Arrays Inc. is turning out products again, especially its 32-K read-only memories, after a five-month hiatus that followed its merger with Nippon Electric Co. EA was like an airplane in a slow tailspin during the last two years, but now president Charles L. Wood is thinking about the future.

He is most concerned about what he believes will be a crucial factor affecting integrated circuit makers—attracting and keeping employees. "I don't think many other IC managers support a real human resources plan; most just pay it lip service," he says. "The next consolidation of the industry will see a shakeout of less human-resources–oriented companies."

Wood admits that he is more than

Intel Marches On

How we put military equipment manufacturers in command of the latest advances in microelectronics.

Designers of military and high reliability systems can depend on Intel for the latest in LSI technology. We deliver more advanced mil-spec microcomputers and semiconductor memory than anyone.

Here's our strategy. The fiercely competitive pressures of the industrial marketplace have driven us to push for higher and higher performance with greater and greater reliability. Last year alone Intel spent $41 million on research and development. That investment strengthened our decade of leadership in microelectronics. And it enables us to keep our commitment of bringing the world's most advanced LSI microcircuits to the military.

JAN-approved 8080A: leading edge of military LSI

Intel invented the microcomputer, and it's no surprise our 8080A was the first microprocessor to qualify for JAN approval and first for QPL Part I listing (M38510/42001 BQB). Now military designers can also take advantage of Intel's M8085A, military version of the most powerful 8-bit microprocessor ever. Or design with our recently militarized single-chip microcomputer, the M8048.

Intel also delivers the high performance memory you need for advanced military systems. A good example is our M2147, military equivalent of Intel's HMOS* industry standard 4K static RAM. Another is our 16K M2716, the highest density military EPROM on the market.

Enlist our entire family

Intel's military family gives designers a full range of state-of-the-art LSI solutions: RAMs, EPROMs, bipolar PROMs, microcomputers and peripherals. All processed to full Level B requirements of MIL-STD-883B, Method 5004 and quality conformance procedures of Method 5005. And they're all backed by the support and development systems you'd expect from the largest supplier of LSI devices.

Building up for the future

To expand your design capability even further, Intel is currently working with government agencies and military equipment manufacturers to upgrade more devices to military specifications. We stand ready to support your programs with additional JAN-approved components as slash sheets are issued.

For more information on Intel's complete family of military devices contact your local Intel distributor or write Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA 95051. Or call (408) 987-8080.

intel delivers.

Europe: Intel International, Brussels, Belgium. United States and Canadian distributors: Arrow Electronics, Alliance, Almac/Stroum, Component Specialties, Cramer, Hamilton/Avnet, Harvey, Industrial Components, Pioneer, Sheridan, Wyle/Elmar, Wyle/Liberty, L.A. Varah and Zentronics.

*HMOS is a patented Intel process.

Circle No. 15 for Information

People

Concerned. Charles Wood hopes to check employee disaffection early on.

a little influenced by the success Japanese companies have had with human resources programs. The quality of some components manufactured in Japan has been better than comparable parts made in the U. S., and Wood says that is no accident. In his view, workers in Japan feel a greater sense of pride in the finished product than workers here.

"There's a great need for our workers to identify with what they're doing," Wood says, adding that participation in the planning as well as in the operation of manufacturing programs can bring this about.

Growth. Another way is for workers to feel that there is room for career growth. Wood feels that every key manager should prepare at least two people for promotion into the manager's own slot. Also, promotional or other career decisions cannot be left to one supervisor's caprice. Such decisions must be made by two people at least, he says. That way, employees feel less vulnerable to personality conflicts.

Another part of Wood's plan for holding his employees is to interview them 9 to 12 months after hiring. "That is called the 'point of first disillusionment,'" Wood says. By dealing with sources of dissatisfaction, he feels his managers can combat job disaffection.

Wood, who holds a masters degree in business administration, joined Electronic Arrays in 1976 as vice president of finance after five years overseeing operations for Teledyne in Singapore. He became president of EA in 1977 during a period of protracted decline. □

MEASUREMENT COMPUTATION news
product advances from Hewlett-Packard

JUNE 1979

Introducing a versatile new computer, with 449K bytes of power and interactive graphics

HP-IB

HP's new 9800 System 45B computer puts up to 449K bytes of computing power and interactive graphics where they belong: at your desk or work station. With System 45B you and your technical staff can address a problem through the system's keyboard, check the results on the CRT, perform related computations, restate the problem until you reach the best result, then print a hard copy of the solution on the system's built-in thermal printer—all in convenient, uninterrupted progression.

But the System 45B doesn't stop there. With the appropriate HP-created software, it goes on to format your data tables, prepare text and generate charts or graphs. You can do all this and more without complicated programming or combinations of expensive, specialized equipment.

Sound easy? It is. System 45B was designed to be "friendly". It's ready to start solving your problems as soon as you turn it on. It has no complicated start-up procedures, no operating system to load, no compiling to do. And it lets you interact with every step of the problem solving process. "Friendly" also means that the System 45B programming language, HP Enhanced BASIC, is easy to learn and provides a conversational style of prob-

(continued on third page)

Compact and integrated, System 45B combines the necessary ingredients of computing power and versatility to meet your present needs and future growth with an extensive line of plug-in peripherals. Connecting your instrument to this system is as easy as plugging-in the proper interface card and cable assembly.

Now you can learn microprocessors thoroughly, quickly

There's a new fast, interesting way to learn all three aspects of microprocessor systems—hardware, software *and* troubleshooting. It's HP's 5036A Microprocessor Lab—an operating microcomputer in a briefcase with a professionally edited 450-page, 20-lesson course book/lab manual.

You'll find hardware relationships easy to grasp and remember because the 5036A circuit board is laid out just like a microcomputer block diagram.

Enter your programs on the 5036A keyboard. Nine internal programs give interesting examples of programming and hardware principles. You'll clearly see meaningful details of system behavior on the lab's 6-digit alphanumeric display and on the LED's at numerous strategic system locations.

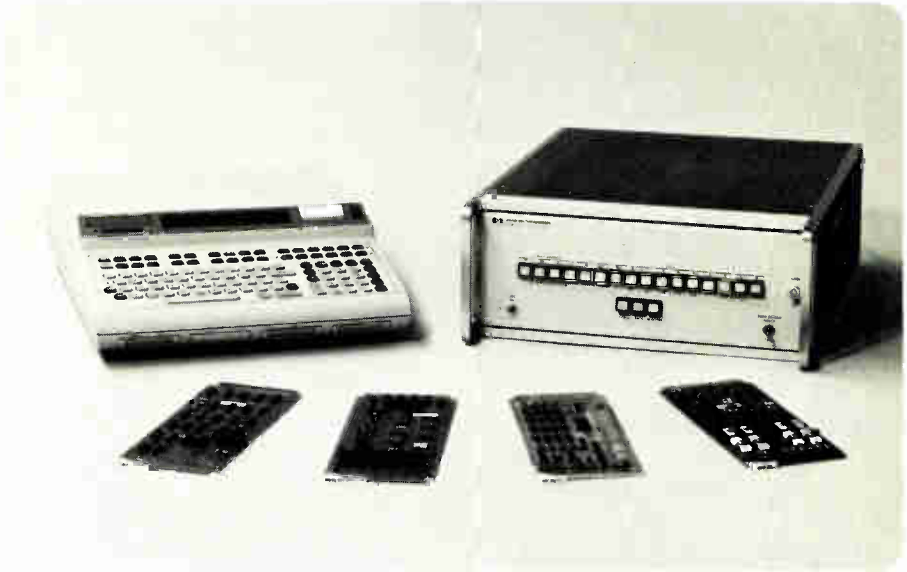
Hardware fault jumpers provide programmed failures, providing you with actual hands-on experience in troubleshooting realistic faults. This further builds circuit knowledge and reinforces troubleshooting techniques useful for all microprocessors.

To learn hardware and programming you need only the HP 5036A. To add troubleshooting requires HP's 5004A Signature Analyzer and 5024A Troubleshooting Kit (HP's 545A Logic Probe, 546A Logic Pulser and 547A Current Tracer)—tools you can use to service products after learning troubleshooting.

Check **C** *on the HP Reply Card for more information.*

Take HP's 50-hour course at your own pace wherever ac power is available. Use it in the classroom, too.

Multiprogrammer enhancements ease building of your own automatic system



Use HP's 6940B Multiprogrammer with its 39 different plug-in functions for interfacing a desktop computer to the equipment you want to automatically control.

Three new plug-in cards team-up with a new software library, a system throughput analysis, and a three day training course to make it even easier to use the HP 6940B Multiprogrammer as the vital link between an HP desktop computer or minicomputer and your test or control process.

Thousands of 6940B Multiprogrammers are now in operation saving time and money in user defined and assembled systems for production testing and control, data acquisition, and process monitoring. Multiprogrammer hardware includes mainframes and a family of 39 plug-in cards providing specialized stimulus, measurement, control and acquisition functions.

New Hardware

New hardware enhancements include these three cards:

1. The 69422A High Speed A/D Voltage Converter Card which transfers up to 20,000 voltage reading/second to the computer with 12-bit resolution and has four full scale ranges from ±0.1 V to ±100 V.
2. The 69423A Low Level A/D and Scanner handles six channels of thermocouples or other low level dc in the ±20 mV range. Temperature readout is directly in degrees since the reference junction is automatically compensated for in software.
3. The 69322A Quad D/A Voltage Converter Card provides four low cost ±10 V programmable outputs with 10-bit resolution.

System Support Aids

New system support aids for the 6940B Multiprogrammer include:

- The 14556A Software Library offering simplified 6940B programming with the 9825A Desktop Computer.
- The 6940B Multiprogrammer System Throughput Analysis contained in publication AN 282-1, An I/O Transfer Timing Analysis.
- The multiprogrammer training course —a three-day, hands-on seminar on designing and programming Desktop Computer/6940B systems.

For more details, check **D** *on the HP Reply Card.*

System 45B, a friendly and powerful problem-solving system that sits on your desk

(continued from first page)
lem solving. The computer operating system can also point out typographical errors as soon as you make them. System 45B indicates why a program didn't work, then helps you locate the problem. It is a computer system that works with you.

Yet with all its friendly attributes, System 45B features enough power and versatility to solve your complex and demanding problems, be they in engineering design and process, in business management, or in scientific fields.

Here are just some of its impressive features:

- **Read/write memory 56K bytes (standard) expandable to 449K bytes. Operating System - 120K bytes (in ROM).** Since the 45B's operating system resides in its own ROM, the entire Read/Write memory, up to 449K bytes, is available for programs and data.
- **Powerful HP Enhanced BASIC.** Despite its simplicity, HP enhanced BASIC is a very capable language even for experienced programmers. With its extensive matrix and array functions, you can perform, with a single instruction, operations that would otherwise require many program lines. It provides powerful features found in FORTRAN and APL to streamline high-order math calculations and other complex data manipulations.
- **Typewriter-like, alphanumeric keyboard.** Input your data on this 128-character ASCII set, color-coded keyboard with 32 definable special function keys and five alternative language character sets.
- **High-resolution, 12-inch CRT display.** See what you're doing on this 80-character, 24-line display that shows you data listings, program segments or graphics images as the work is being performed. Permits text scrolling and editing of data as you put it in.
- **Full graphics capability with built-in thermal line printer.** Capture displays in hard copy form on command. Quiet and fast, 480 lines/minute, the printer can generate customized symbols and logos, in addition to reproducing the CRT display with unprecedented resolution in CRT/printer combination.
- **Two integral tape cartridge drives, each providing 217K byte storage capacity.** One standard, one optional, the two tape drives can both be used for data and programs.

For full information on the System 45B, check **E** *on the HP Reply Card.*

To fully utilize the System 45B capabilities, HP has developed an applications-oriented software library in many general areas including Electrical Engineering, Statistical and Numerical Analysis, Engineering Design, Structural Engineering, Business Management and Medical. Specific EE software covers three areas: Waveform Analysis, A-C Circuit Analysis and Digital Simulation as shown above.

New application note describes RF modulation analyzer

HP-IB

For the first time, modulated RF signals from 150 kHz to 1300 MHz can be fully characterized for frequency, power and AM/FM/ΦM modulation with one instrument. A new name, modulation analyzer, has been used to describe this new product concept and measuring capability.

Application Note 286-1, *Applications and Operation of the HP 8901A Modulation Analyzer*, gives detailed procedures for using the 8901A for such applications as transmitter testing, signal generator calibration, broadcast monitoring, measuring VCO differential linearity, measuring residual FM noise of oscillators, separating residual AM or FM, or measuring peak modulation transients.

Theory and operation of the precision ±0.1% internal calibrator is discussed as well as HP-IB programming techniques which include annotated software examples and subroutines.

Check **F** *on the HP Reply Card for your free copy.*

Synthesized microwave signals from 18 to 37.2 GHz

Application Note 218-4, *Synthesized Signals from 18 to 37.2 GHz Using the 8672A*, outlines the use of the 8672A Synthesized Signal Generator with the 938A and 940A Frequency Doublers. The combination yields signals from 18 to 37.2 GHz. Typical power output, flatness and modulation characteristics are discussed.

For your complimentary copy, check **G** *on the HP Reply Card.*

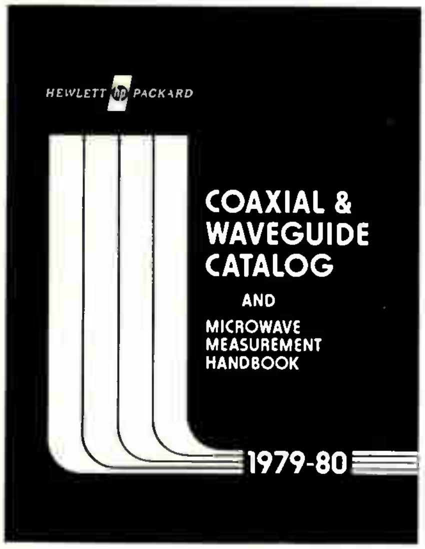
New coaxial and waveguide catalog and microwave measurement handbook

The new 1979-80 edition of the popular *Coaxial & Waveguide Catalog* is now ready for RF and microwave engineers. This 96-page volume is intended for design engineers, production test personnel, quality assurance and metrology labs, and a wide variety of field test and system maintenance engineers.

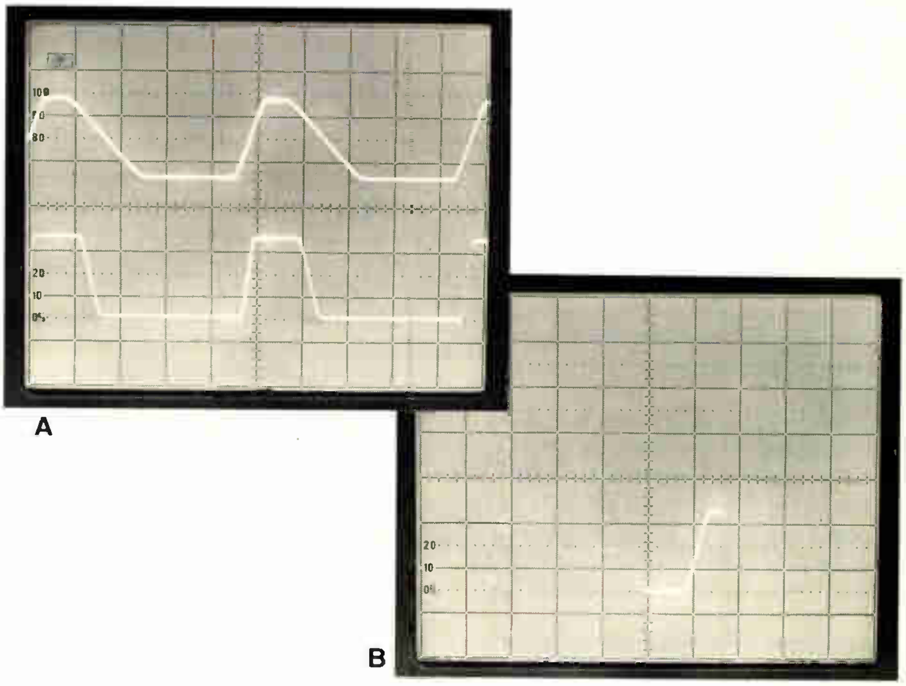
Product sections include over 350 measurement accessories including attenuators, detectors, couplers, filters, power sensors, as well as many special components such as a selection of 75Ω items.

Over 25 pages are devoted to a *Microwave Measurement Handbook* section, summarizing common scalar measurement techniques of attenuation, impedance, power, frequency and noise figure. Measurement tables offer comparison of accuracy vs. technique vs. cost. Equipment selection tables list model number vs. band vs. technique. Waveguide and flange charts, and coaxial connector information pages all add up to make a publication you should have on your desk.

Obtain a copy by checking **H** *on the HP Reply Card.*



Important new measurement capabilities for HP's 1741A storage oscilloscope



The delayed sweep markers (A) are used to window the area of interest to be displayed in the parametric mode. Using delayed sweep and A vs. B modes, a parametric display (B) of the intense field portion of the waveforms in A is obtained—without the bright dot usually produced by long periods of quiescent values.

Two new options for HP's Model 1741A Variable Persistence Storage Oscilloscope now add important measurement capability. Parametric measurements based on the Lissajous figure are added with triggered X-Y operation (Option 002). Automatic, hard-copy trace recording capability is added with Option 003.

Correct Phase Errors

Modern high frequency oscilloscopes contain delay lines in the vertical circuits which add significant phase errors in X-Y operation. With Option 002, a variable delay line is added to the horizontal circuit which provides a matched phase response to the full bandwidth of the oscilloscope's horizontal axis. In addition, phase errors introduced through the probes can be corrected.

Full windowing capability of the main and delayed sweeps during A vs. B modes allows display of only desired information. Whatever is displayed in the volts vs. time mode on channels A and B is parametrically plotted when switched to the A vs. B mode. Delayed sweep can then be used to move through a family of A vs. B curves permitting easy examination of worst case conditions of circuit operation. The use of delayed sweep to qualify the A vs. B display allows display of only the change in values which eliminates the bright stationary spots normally associated with A vs. B measurements. This new measurement, for example, is very useful for determining the safe operating area of switching regulator power transistors.

Automatic Trace Photography

Automatic hard-copy photographs of single-shot events, are practical with Option 003. This automatic trace photography capability is useful for applications requiring long term monitoring, as well as for every-day use.

The ability of the 1741A to wait indefinitely for a signal occurrence is even more useful with this automatic operation. With Option 003, the 1741A becomes an oscilloscope/camera system able to monitor a circuit node unattended and to capture a random signal.

Check **I** *on the HP Reply Card for all the details.*

Step up to excellence. Step up to Series E

Why settle for anything less than excellence. Especially now that it's available at a very affordable price in the Series E calculators. Five precision models for science, engineering and business.

The HP-31E—Scientific. A versatile scientific calculator that has trigonometric, exponential and math functions. Metric conversions. Fixed and scientific display modes with a full 10-digit display. Four separate user memories.

The HP-32E—Advanced Scientific with Statistics. Everything the HP-31E is and more. More math and metric capabilities. 15 user memories, plus comprehensive statistics. Engineering, scientific and fixed display modes. Decimal degree conversions.

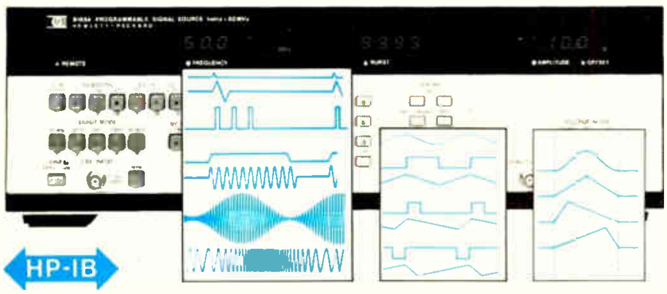
The HP-33E—Programmable Scientific. A scientific, math and statistical calculator, with programmability. 49 program lines of fully-merged key codes. Editing keys, control keys and a full range of conditional keys. 8 user memories.

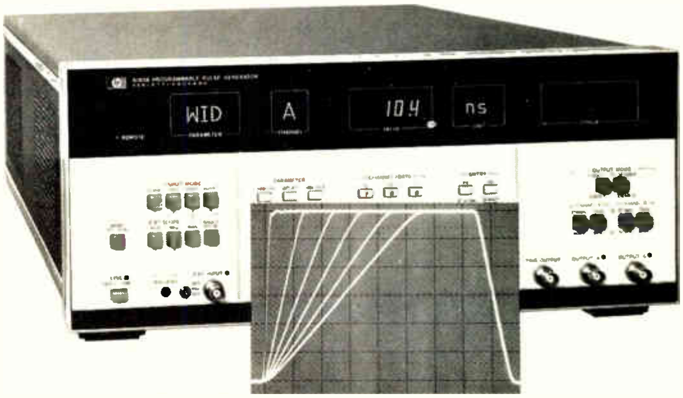
The HP-37E—Business Management. Your best choice for a basic business and financial calculator. Has the "cash flow sign convention" for intuitive problem solving. Handles PV, PMT and FV simultaneously. 5 financial and 7 user memories.

The HP-38E—Advanced Financial with Programmability. Our first financial programmable calculator has all the power of the HP-37E plus a lot more. Routine or sophisticated problem solving at the touch of just one key—no previous programming experience necessary. IRR and NPV for up to 1980 cash flows in 20 groups. 2000-year calendar. 5 financial and 20 user memories plus up to 99 program lines.

For more information on the HP-31E, HP-32E, and HP-33E, check **A** *on the HP Reply Card. For more information on the HP-37E and HP-38E, check* **B** *on the HP Reply Card.*

Accurate signal sources speed research and maintenance





HP's 8160A Programmable Pulse Generator and the 8165A Programmable Signal Source provide easy programming with the precision essential for research and speed for your testing applications. Both instruments can be operated manually as well as through the HP Interface Bus. Non-volatile memories provide rapid parameter and mode selection for repetitive test situations.

The 8160A brings 1-3% accuracy to pulse settings and, with option 020, full 2-channel programmability of all pulse parameters. Its very accurate timing and fast transition times meet today's stringent research needs as well as demanding requirements for investigations such as rms crest factors and IC development.

Outstanding for propagation measurements in radar and navigation systems, the 8160A has accurate channel delay with independent control of the pulse shape in each channel for fast, reliable module maintenance program.

The 8165A Programmable Signal Source, now offering haversine and havertriangle waveforms on a special basis, adds vibration testing, structure analysis, telephone line testing and servo response to its already impressive list of linear and digital applications. Combining the accuracy and stability of a synthesizer and the external trigger capabilities of a pulser, the 8165A's flexibility can save you hardware now and later with system expansion.

Check **J** *on the HP Reply Card to obtain all the details.*

Introducing a new family of data capture terminals for the manufacturing environment

More Than a Time Clock—Serving as a time clock, with a large digital time display, the HP 3077 wall-mounted time-reporting terminal is essential to cost accounting functions. It can also improve security by controlling access to restricted areas via electrical relays.

Hewlett-Packard's new family of interactive data capture terminals is designed primarily for manufacturing companies. These low-cost, compact terminals, the HP 3075, 3076, and 3077, can be tailored to accommodate a wide range of tasks—from machine shop management to time data reporting. Modular construction and 60 combinations of options make such versatility possible. User-definable prompting lights and an LED display lead the operator through transactions a step at a time. Employees can input and retrieve data without prior computer experience or training.

Variety of Options

The HP 3075 tabletop terminal and the HP 3076 wall-mounted version accommodate a variety of options:

- A choice of numeric or alphanumeric keyboard and display.
- An industry Type V identity badge reader. Badges can be read right side up or upside down.
- Multi-function reader. Reads marked sense cards, punched cards, industry Type III badges, and even dirty or crumpled punched cards without error—an important advantage in a manufacturing environment.
- An alphanumeric thermal printer. All user transactions can be documented.

A Choice of Connections

A choice of point-to-point, multipoint, and multidrop is available on all terminals by just setting a switch on the back of the terminal.

*Check **K** on the HP Reply Card for more information.*

New details on electronic counter specifications

With the increasing sophistication of frequency counters, technicians and engineers need new and more refined specifications. A new, 34-page HP Application Note 200-4 answers this need by detailing specifications on many characteristics including noise contributed by counter input, new input signal conditioning, and a "least significant digit displayed" for high-resolution counters such as HP's new 5315A.

*Check **L** on the HP Reply Card for a complimentary copy of AN 200-4.*

Recording data on tape/ problems and solutions

Three papers available from Hewlett-Packard discuss problems of dropouts, crosstalk, and interchannel time displacement errors associated with instrumentation tape recorders.

The illustrated papers, entitled ITR Note 1, 2 and 3 respectively, describe why and how these recording problems occur, then offer specific suggestions on ways to minimize or even eliminate them. Various illustrations provide additional clarity to the solutions presented.

*These notes are complimentary and if you would like to receive any of them, check on the HP Reply Card. **M** for Dropouts, **N** for Crosstalk, and **O** for Interchannel Time Displacement Error.*

HEWLETT-PACKARD COMPONENT NEWS

New LED light bar modules to backlight display panels

A new family of LED light bar modules, designed for use as backlighting of display panels for electronic instruments, computers, office equipment and automobiles, has recently been introduced by HP.

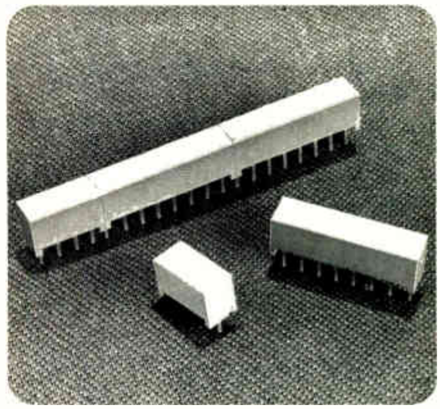
The new light bar modules provide large, bright, uniform light emitting surfaces, are suitable for multiplex operation, and mount easily on P.C. boards or sockets. They are X-Y stackable and may be mounted flush.

The rugged devices come in two sizes, 8.89 mm × 3.81 mm and 19.05 mm × 3.81 mm (8.35 × .15 and .75 × .15 in.). HLMP-2300 and HLMP-2350 are high efficiency red panels, HLMP-2400 and HLMP-2450 are yellow, and HLMP-2500 and HLMP-2550 are green. They provide the largest, continuously illuminated surfaces using LED technology ever offered by HP.

Illuminated legends, indicators, bar graphs and lighted switches represent just some of the uses for these devices.

The new lamps are available now through HP franchised component distributors.

Check **P** *on the HP Reply Card for details.*



Introducing a high resolution sensor for scanning color bar codes

The new HP HEDS-1000, a high-resolution, high-speed reflective sensor, is the only device on the market designed to scan color bar codes. Using a light emitting diode emitter, photo IC detector, and precision optics, the HEDS-1000 will also find application in optical inspection, facsimile sensing, pattern recognition, edge sensing and tachometry. Specific uses include counting, sizing, sorting, flaw detection, densitometry, mail sorting and inventory control. Furthermore, printers, plotters and copiers can use the edge sensing capabilities of the product.

The HEDS-1000 is HP's first entry in this very broad market. It is designed for applications where accuracy, size and repeatability are important. Also it can sense any bar code now on the market.

The HEDS-1000 operates from a single 3.5 V to 20 V power supply. It has a bipolar photo IC detector which allows simplified interface electronics. Exposed surfaces are metal and glass for durability and easy cleaning.

The sensor module is fully integrated, so that no precision alignment tools, optical test equipment or special training are required for its use. The HEDS-1000 has a resolution of 0.17 mm and a depth of field of ±0.5 mm.

Delivery is immediate from Hewlett-Packard franchised component distributors.

Obtain further specifications by checking **Q** *on the HP Reply Card.*

HP's first linear power GaAs FET for designs up to 14 GHz

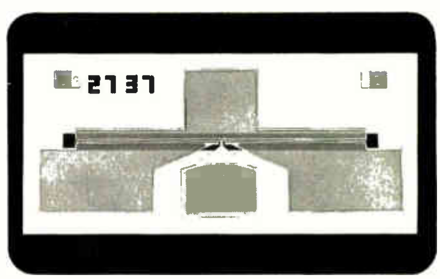
With the introduction of the new HFET-5001 linear power GaAs FET, Hewlett-Packard announces its first entry into the world of power FETs. This chip is the newest member of an established product family of 1 μm gate FETs available from HP.

It has been developed to satisfy the medium power needs of designers looking for output stage or driver stage power devices usable through 14 GHz. Full characterization information from 2 to 14 GHz is provided in the data sheet.

With typically over 100 mW of linear power and 8 dB associated 1 dB compressed gain at 8 GHz, and over 50 mW and 5 dB gain at 14 GHz, this versatile FET can solve many broad and narrowband power amplifier component requirements. The end result will be fewer stages and lower total component count.

Units are in stock now at HP franchised distributors. In quantities of one to nine, this GaAs FET is competitively priced.

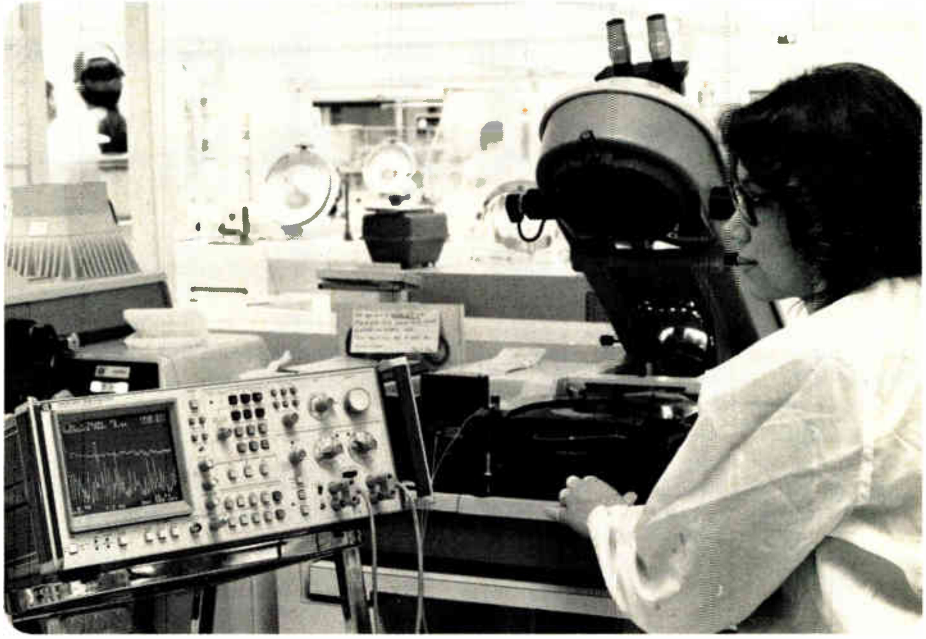
Check **R** *on the HP Reply Card.*



HP's first linear power GaAs FET, designed for both high gain and linear output power from 2 to 14 GHz, delivers 20 dBm power at 8 GHz.

Significant advancements in a new real-time spectrum analyzer

HP-IB



Designed for both mechanical and electronic applications, HP's 3582A Spectrum Analyzer can help you improve research and development results, reduce production costs and optimize maintenance efficiency. Covering the frequency range from 20 mHz to 25.6 kHz, the 3582A can measure and display amplitude spectra, phase spectra, the magnitude and phase of transfer functions, and the coherence function from 10 to 100 times faster than traditional analyzers. What's more, it is much lower in cost when compared to other dual-channel, real-time analyzers.

Its extensive and versatile measurement capabilities make this HP analyzer especially well suited for low frequency electronics, telecommunications, audio and acoustics, structural analysis and rotating machinery signatures applications.

Research and development results can be improved with the use of the 3582A thanks to its powerful and fast measurements. They make it possible to devote more time to creative aspects of the design process and less to testing and verification.

Production costs can also be reduced with the help of the 3582A. Making frequency domain measurements one to two orders of magnitude faster than conventional swept analyzers, the HP 3582A can reduce your measurement times and thus increase production throughput. In addition, the 3582A's HP-IB capability allows you to automate production testing to further speed test time per unit, with increased confidence in the quality of the final product.

Maintenance efficiency can be optimized with the 3582A which provides an HP-IB based method of storing and processing periodic maintenance data. This capability enables more precise formulation of test and repair strategy. By allowing more precise, repeatable measurements of the maintenance parameters, the 3582A also makes it possible to identify subtle but significant problems in time to take appropriate action.

The list of 3582A features and the measurement problems that can be solved by them is almost endless. Send for complete details by checking **S** *on the HP Reply Card.*

East-4 Choke Cherry Road, Rockville, MD 20850, Ph. (301) 258-2000

South-P.O. Box 10505, 450 Interstate North Pkwy., Atlanta, GA 30348, Ph. (404) 434-4000.

Midwest-5201 Tollview Dr., Rolling Meadows, IL 60008, Ph. (312) 255-9800.

West-3939 Lankershim Blvd, North Hollywood, CA 91604, Ph. (213) 877-1282.

Europe-Central Mailing Depot, P.O. Box 529, Amstelveen-1134, Netherlands, Ph. (020) 47 20 21.

Japan-Yokogawa-Hewlett-Packard Ltd., Ohashi 29-21 Takaido-Higashi 3-chome Suginami-ku, Tokyo 168, Ph. 03-331-6111.

HEWLETT hp PACKARD

MEASUREMENT COMPUTATION news

product advances from Hewlett-Packard

May/June 1979

New product information from

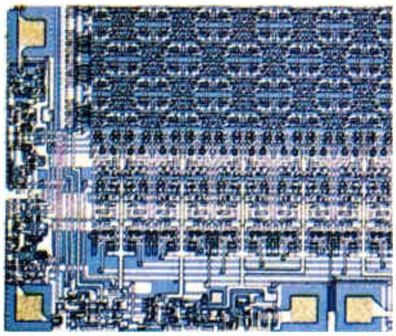
HEWLETT-PACKARD

Editor:
Bojana Fazarinc-Bitencourt

Editorial Offices:
1507 Page Mill Road
Palo Alto, California, 94304 U.S.A.

00983

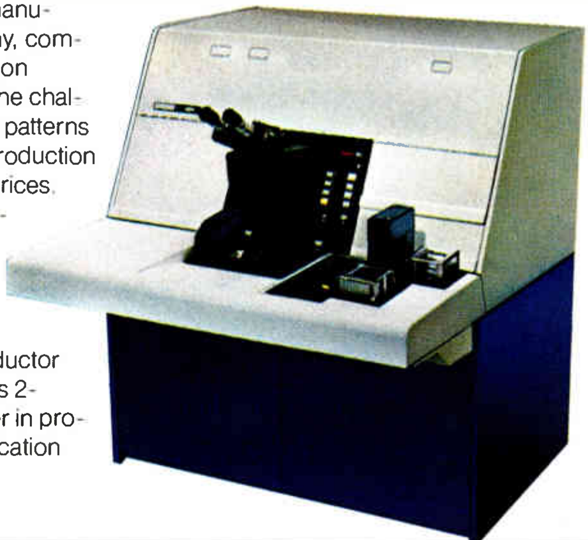
High throughput, high yield, high reliability: Manufacturing integrated circuits with the Perkin-Elmer Micralign 200 Series



The crux of microcircuit manufacture is the printing of tiny, complicated electrical patterns on photosensitive materials. The challenge is to reproduce these patterns crisply and accurately, in production quantities, at competitive prices. This is exactly what Perkin-Elmer Micralign mask aligners do.

The newest Micralign, the Model 200 Series, is responsive to the semiconductor industry's needs. It achieves 2-micron geometries or better in production, distortion/magnification tolerance of .25 micron and four percent uniformity of illumination.

Like other Micralign systems, the Model 200 Series uses the 1:1 optical projection concept, pioneered by Perkin-Elmer, to focus light from a mask. The mask contains many repeats of a single pattern. In one fast scan the Model 200 Series exposes all of these patterns onto a silicon wafer coated with a photosensitive material. After development, the wafer is further processed—etched, doped, and recoated. By repeating this procedure a number of times circuits are built, layer on layer, on a single wafer. Finally the wafer is cut to separate each individual circuit.



Because dust, heat and vibration are major enemies of precise projection, the 200 houses its optics in a quiet, clean, wear-free world of their own. Vibration is minimized by two frames, one inside the other. All vibrating components have been mounted to the outer frame, thereby isolating the projection optics from all sources of vibration.

The 200 Series has a built-in environmental chamber. External air is blown through the top of the unit. The air is filtered and temperature regulated. A positive-pressure, Class 100 environment is carefully controlled to better than 1°F.

Options include automatic wafer loading and a revolutionary automatic alignment system. Deep UV coatings for even smaller geometries will be available soon.

"Sputtering" thin films onto microcircuits quickly, uniformly, economically: The Perkin-Elmer 4410

The thin metal films used in making semiconductors are deposited by sputtering systems. Evacuate a chamber; fill it with argon; place a high-potential cathode on the ceiling of the chamber and a lazy susan loaded with silicon wafers on the floor; attach to the cathode a target of the material to be deposited; turn on the current.

That, in essence, is sputtering. The current ionizes the argon, and the argon ions in their efforts to reach the cathode bombard the target material, knocking off atoms which settle, uniformly dispersed, on the wafers circling below. Layer by layer, the film builds up to the desired thickness.

Perkin-Elmer sputtering equipment has long set industry standards worldwide. Our latest unit, for example, the 4410, features a novel delta-shaped DC magnetron cathode and microprocessor controller. Both play an important role in producing the high quality films and high throughput essential for the economic production of semiconductors.

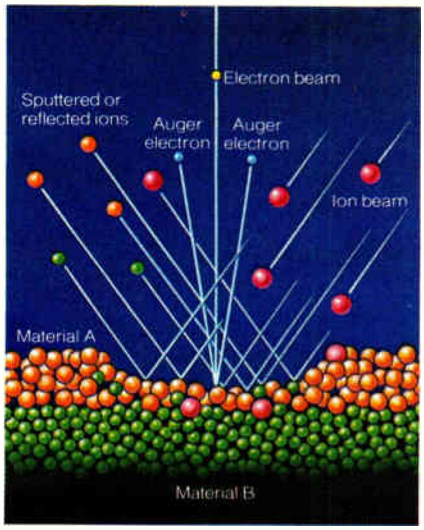
The Delta™ cathode deposits aluminum alloy and other metallic films at very high rates. This is important for building dependable microcircuits today. It's even more important for the high density semiconductor devices of the not-too-distant future.

The microprocessor automatically controls all process variables and eliminates human error. It thus assures run-to-run repeatability for high yield and throughput.

All of which help make the 4410's return-on-investment better than that of any competitive system.

The Perkin-Elmer SAM 590: Probing semiconductor quality layer by atomic layer

As the Micralign system is the world's leading producer of micro-electronic surfaces, so the leading tool for analyzing such surfaces is the Perkin-Elmer 590 Scanning Auger (pronounced Oh-djay) Microprobe, familiarly known as SAM.



Three-dimensional materials characterization using Auger analysis with ion sputter-etching.

Typical tasks for SAM include evaluating the integrity of a semiconductor's thin film interfaces and checking to be certain impurities were not introduced during manufacture. Or detecting such imperfections as microscopic aluminum spikes between semiconductor layers which can cause short circuiting. Or scrutinizing bonding pads for trace contaminants which cause poor bonding adhesion.

To do such jobs, SAM bombards a specimen with a beam of electrons, causing the emission of X-ray photons and chemically specific Auger electrons. These Auger electrons originate in the topmost two or three atomic layers of a specimen surface. By measuring the kinetic energy and number of Auger electrons emitted, SAM provides a quantitative as well as qualitative identification of surface constituents. If the electron beam is scanned, SAM can map the distribution of chemical elements over a selected area.

SAM incorporates an ion bombardment gun that continuously erodes an area of the surface so that the microprobe can analyze downward, layer by atomic layer. This makes possible a true three-dimensional analysis of thin films.

Where applications require, SAM can be expanded into a multiple-technique instrument through addition of ESCA (Electron Spectroscopy for Chemical Analysis), which measures electrons released due to X-ray stimulation of a surface, and SIMS (Secondary Ion Mass Spectroscopy), which detects ions emitted after primary ion bombardment.

For more information on these products, please write: Corporate Communications, Perkin-Elmer, Main Ave., Norwalk, CT 06856.

PERKIN-ELMER
Responsive Technology

Circle 28 on reader service card

Meetings

Joint Automatic Control Conference, IEEE and American Institute of Chemical Engineers, University of Washington, Seattle, Wash., June 16–21.

International Symposium of the IEEE Antennas and Propagation Society, IEEE, University of Washington, Seattle, Wash., June 18–22.

PC '79—International Printed Circuits Conference and Exhibition, Circuits Manufacturing Magazine (Boston) *et al.*, Statler Hilton Hotel, New York, June 19–21.

Power Electronics Specialists Conference, IEEE, Bahia Hotel, San Diego, Calif., June 19–21.

33rd Annual Convention of the Armed Forces Communications and Electronics Association, Afcea (Falls Church, Va.), Sheraton Park Hotel, Washington, D.C., June 19–21.

Ninth Annual International Conference on Fault-Tolerant Computing, IEEE, Concourse Hotel, Madison, Wis., June 20–22.

Computers in Communications Conference, American Institute of Aeronautics and Astronautics (Los Angeles), Hyatt L. A. International Hotel, Los Angeles, June 25–26.

16th Design Automation Conference, IEEE, Town and Country Hotel, San Diego, Calif., June 25–27.

37th Annual Device Research Conference, IEEE, at the University of Colorado, Boulder, Colo., June 25–27.

Syntopican VII, International Word Processing Association (Willow Grove, Pa.), Palmer House, Chicago, June 26–28.

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

Video and Data Recording Conference, IEEE *et al.*, University of Birmingham, Birmingham, England, July 17–20.

Computers in Manufacturing Conference, American Institute of Industrial Engineers (Santa Monica, Calif.), Jack Tar Hotel, San Francisco, July 30–Aug. 1.

IECEC—Intersociety Energy Conversion Engineering Conference, IEEE, Sheraton Boston Hotel, Boston, Aug. 5–10.

Pattern Recognition and Image Processing Conference, IEEE, Hyatt Regency O'Hare Hotel, Chicago, Aug. 6–8.

Siggraph '79—Sixth Annual Conference on Computer Graphics and Interactive Techniques, Association for Computing Machinery (New York), Hyatt Regency O'Hare Hotel, Chicago, Aug. 6–10.

Conference on Simulation, Measurement and Modeling of Computer Systems, National Bureau of Standards *et al.*, University of Colorado, Boulder, Colo., Aug. 13–15.

International Conference on Parallel Processing, IEEE, Shanty Creek Lodge, Bellaire, Mich., Aug. 21–24.

Short courses

The International Standard X.25 Interface Protocol for Packet Networks and Related Network Protocols, Data Communications Magazine (New York), The Highlands Inn, Carmel, Calif., June 20–21. For information, contact McGraw-Hill Conference Center, 1221 Avenue of the Americas, Room 3677, New York, N. Y., 10020, or telephone (212) 997-4930.

Three engineering short courses: **Fiber Optic Communication Systems,** July 9–13; **Guided Wave Optical Circuits,** July 16–20; and **Detection of Infrared Radiation,** July 23–27. For information, contact University of California Extension, Santa Barbara, Calif. 93106.

Our programmer isn't sidetracked by every new PROM.

Dozens of new PROMs come along every year.

Many of them are obviously different; different technologies, configurations, speeds, pinouts. Some have more subtle differences. A specific PROM may be altered by the manufacturer to require a different programming algorithm, for instance. Your problem? How to keep both your programming equipment and your knowledge of PROMs current.

One PROM programmer has kept pace.

Pro-Log's Series 90 PROM programmer is still as up-to-date today as it was when we introduced it in 1974. The secret? A design that lets you update your programmer easily, quickly and inexpensively.

Our plug-in personality modules now let you program more than 200 different PROMs. We constantly monitor PROM technology, modifying personality modules or developing new ones as PROMs change and new PROMs come along. We work closely with PROM manufacturers and get their approval on all new modules.

Need a selectable baud rate RS232 interface, Checksum, CMOS RAM buffer, paper tape reader, TTY control, or parallel input/output? Easy. We can add what you need to your basic control unit, even if it's one of the units we made in 1974.

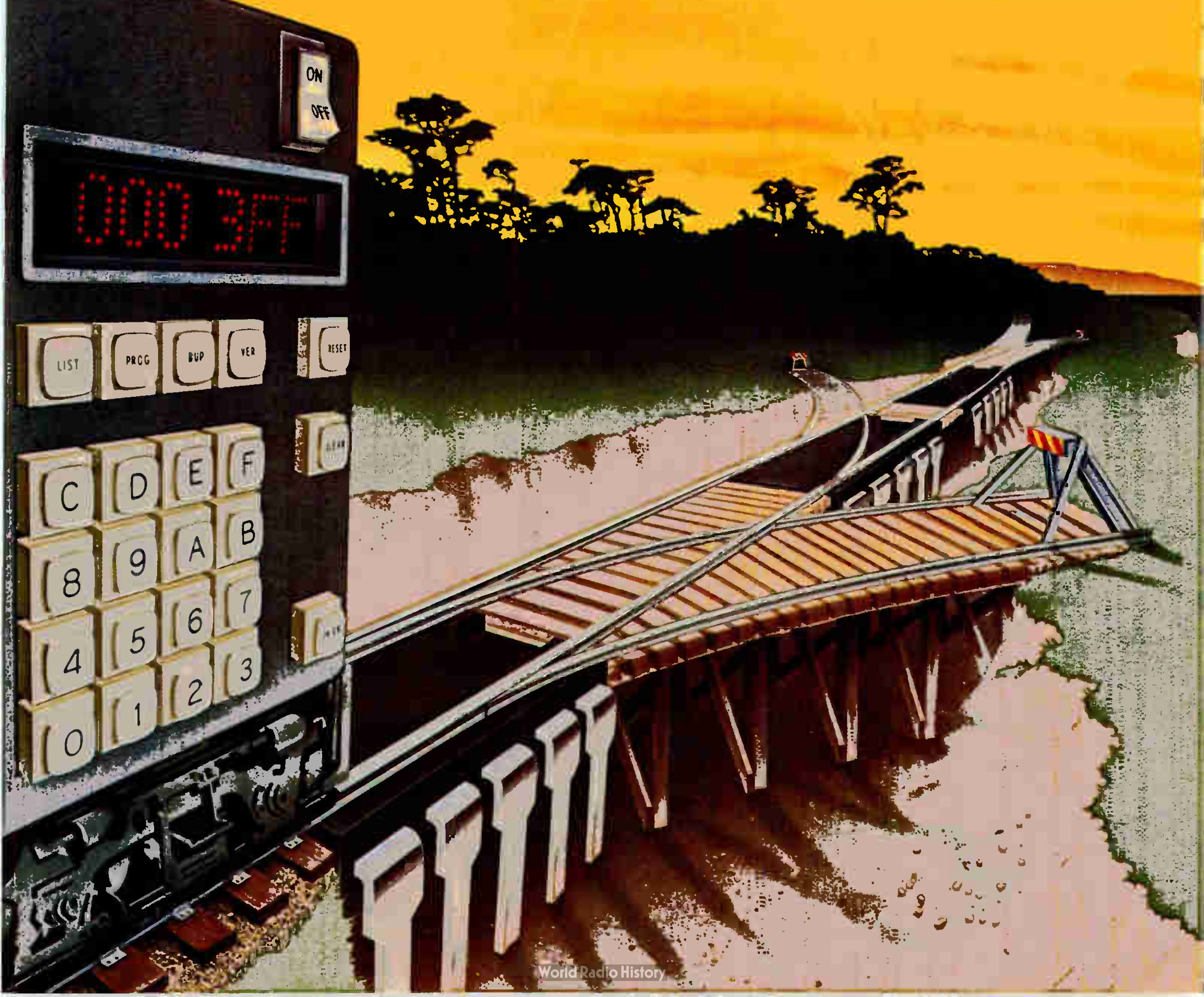
We also provide you with the latest PROM information.

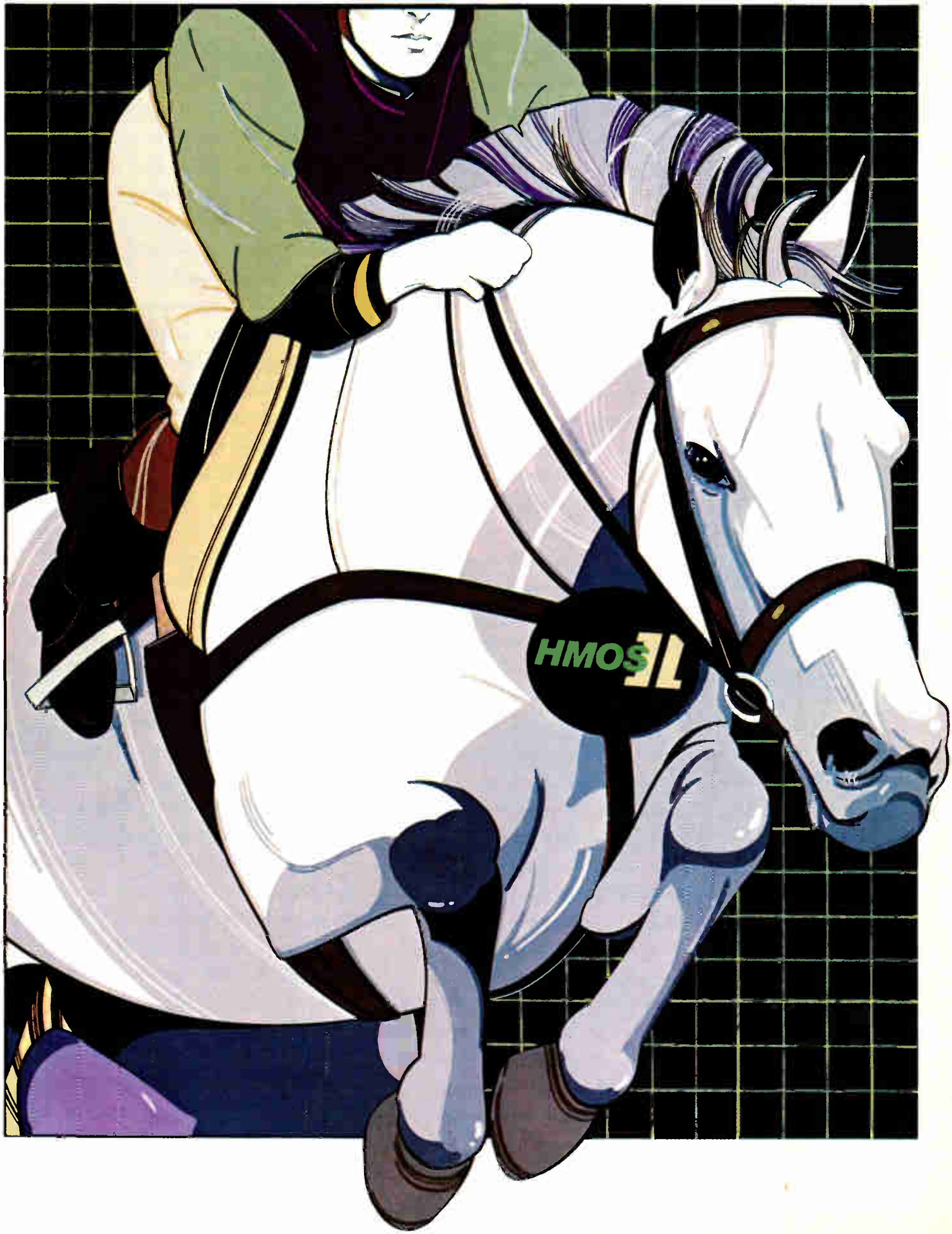
Our recently published 98-page PROM User's Guide includes chapters on PROM selection and PROM technology plus a complete PROM cross reference. Our PROM Programmer Comparison Guide helps you evaluate programming features. To get your free copies, call or write Pro-Log Corporation, 2411 Garden Road, Monterey, CA 93940, phone (408) 372-4593.

PRO-LOG CORPORATION

Microprocessors at your fingertips.

Circle 31 on reader service card



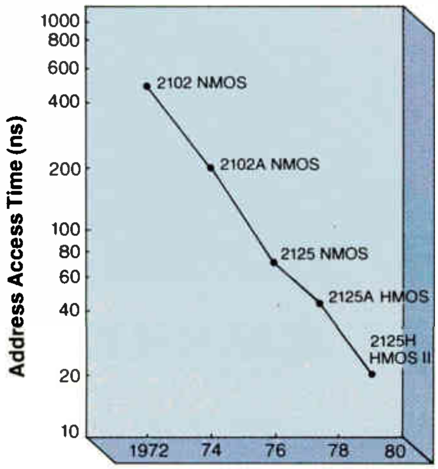

HMOS II

New Breed of MOS.

Intel introduces HMOS II*– and a new family of static RAMs that cross the finish line in 20 ns.

Intel just set a new pace for high performance memory with HMOS II. It's our patented next generation MOS technology so advanced it delivers speeds faster than bipolar and even our own first generation HMOS process. HMOS II gives designers the fastest, lowest power static RAMs ever—plus traditional MOS economy and reliability. Our new

History of MOS speed



Intel's continued process and scaling improvements have doubled MOS speeds every two years. The above graph demonstrates this trend with Intel's 1K x 1 static RAMs.

1K and 4K RAMs are fully compatible, higher speed upgrades of Intel's time-tested 2115A/2125A and 2147 devices.

1K fast statics that leave bipolars behind

Designers building cache, writeable control store or buffer memories will find our 16-pin 2115H/2125H 1K RAMs ideal. For new designs, two versions deliver record access speeds of 20 ns and 25 ns, with a speed/power product twice as good as slower bipolar RAMs.

Our 35 ns and low power 30 ns models can be used as direct plug-in replacements for 93415A and 93425A bipolar RAMs. They'll cut power dissipation up to 36%. And, best of all, they're available now.

New, faster 4K with no power increase

Intel's new 2147H gives you all the advantages of our 18-pin 4K x 1 industry standard 2147, with twice the speed and no increase in power. With access times as fast as most 1K RAMs, it's important news for anyone designing buffer, cache, control store and main memory systems. If you're presently working with 1K RAMs, you can increase density or reduce board space by a factor of four. In a 4K format, the 2147H makes possible a new dimension of higher performance systems.

The 2147H's low active power dissipation and automatic power down on deselection also mean dramatically reduced power consumption compared to constant current static RAMs. In fact, because most devices are deselected at any given time, the larger your system, the lower your power dissipation per bit. It all adds up to simplified designs and major

HMOS II fast static RAMs

Part No.	Maximum Access Time (ns)*	Power Consumption (mA)* Active	Standby
4096x1			
2147H-1	35	180	30
2147H-2	45	180	30
1024x1**			
2125H-1	20	125	
2115H-2 2125H-2	25	125	
2115H-3 2125H-3	30	100	
2115H-4 2125H-4	35	125	

*Over full 0° to 75°C operating temperature range.
**All 2115H versions have open-collector outputs, all 2125H versions have tri-state outputs.

savings in cooling and power supplies.

All HMOS II components are fully static and can be used in clocked and unclocked systems. They are directly TTL compatible in all respects: inputs, outputs and operation from a single +5V supply.

Order 2115H/2125H and 2147H RAMs from your Intel distributor. Or, for more information, contact your local Intel sales office or write: Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA 95051.

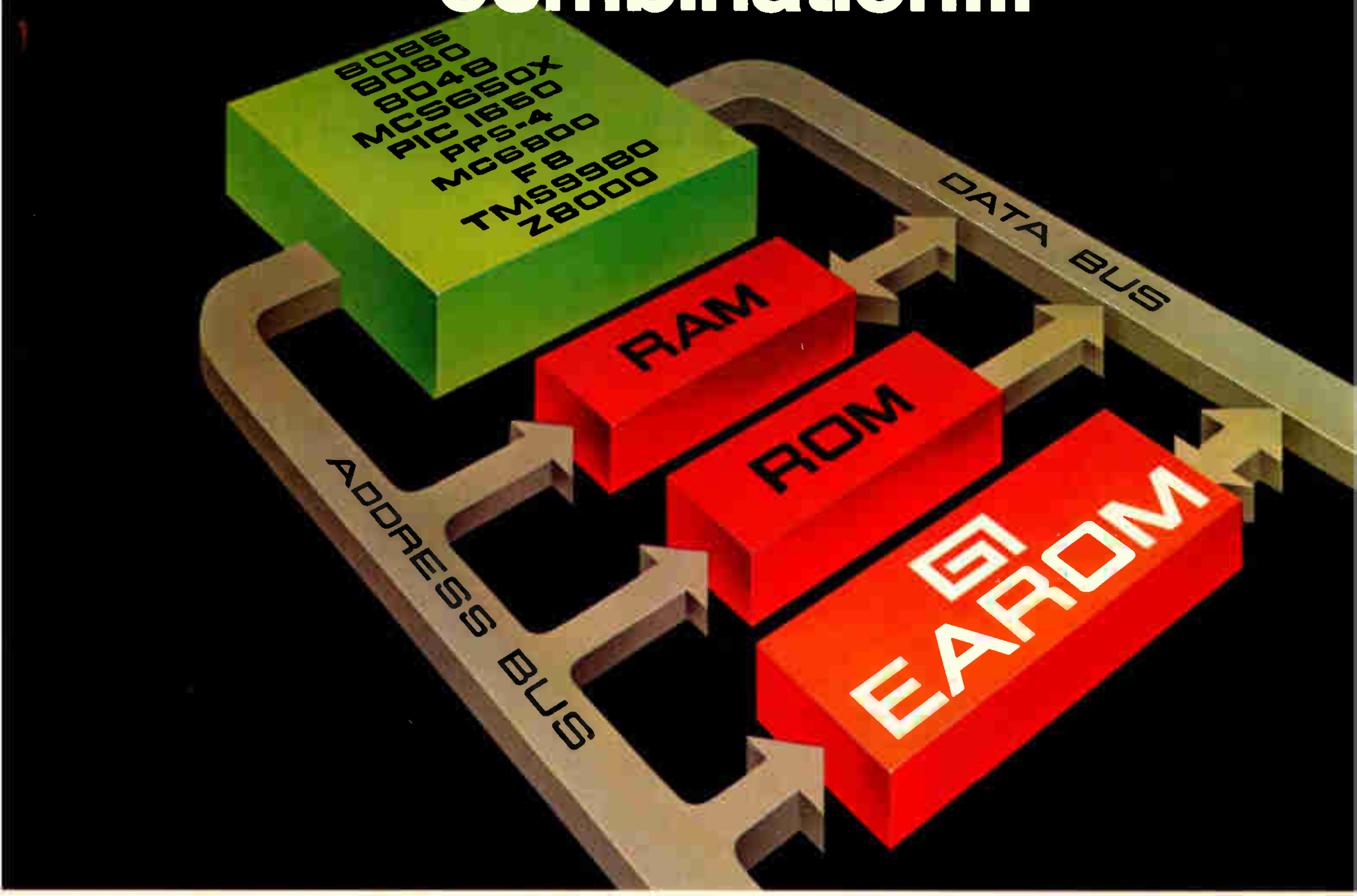
intel® delivers.

Europe: Intel International, Brussels, Belgium. Japan: Intel Japan, Tokyo. United States and Canadian distributors: Arrow Electronics, Alliance, Almac/Stroum, Component Specialties, Cramer, Hamilton/Avnet, Harvey, Industrial Components, Pioneer, Sheridan, Wyle/Elmar, Wyle/Liberty, L.A.Varah and Zentronics.

*HMOS II is a patented process of Intel Corporation.

Circle No. 33 for Information

The natural combination...



...GI EAROM and <u>any</u> microprocessor.

It's a fact. More and more designers are discovering GI EAROMs as standard memory components which combine *naturally* with any microprocessor they choose.

For very convincing reasons, the GI EAROM family is truly in a class by itself, as evidenced by the more than three million GI EAROMs now in use, and the hundreds of thousands more we're producing each month.

GI EAROMs will meet your needs for parallel or serial I/O, in 4, 8 or 16-bit word widths. A non-volatile electrically-alterable ROM, it allows you to erase and program individual words, while data can be stored reliably, and without power, for ten years.

Unlike EPROMs, EAROM-stored data can be easily updated—reprogrammed electrically in the system. As a non-volatile memory, EAROM can save data or pointers in the event of a power failure...like a RAM with a battery—without the battery!

GI EAROMs are available *now*. In quantity. Priced competitively. For metering pumps, appliance timers, controllers, calculators, data terminals, and countless other applications. If the system is microprocessor-based, GI's EAROM is bound to make it better!

Prove it yourself on your next project. Our Application Notes and engineers will assist you. Just write or call General Instrument Microelectronics, 600 West John Street, Hicksville, New York 11802, (516) 733-3192.

We help you compete.

GENERAL INSTRUMENT CORPORATION
MICROELECTRONICS

AMD improves math chip . . .

The highly successful and still unrivaled Am9511 arithmetic processing unit, a universal number-crunching chip from Advanced Micro Devices Inc., Sunnyvale, Calif., is now in a new production run. The 9511A, phasing out the earlier design, **will offer user-wanted improvements like easier chip-enable and reset functions and better synchronous operation.** It is believed that the chip, a hot seller for which AMD can barely meet demand, will soon be second-sourced.

. . . and readies version to meet proposed standard

Meanwhile AMD has also designed a new math-processing chip, essentially a spinoff of the 9511. **The Am9512 will perform 32-bit single-precision and 64-bit double-precision calculations in accordance with the floating-point standard** proposed by the Institute of Electrical and Electronics Engineers [*Electronics*, May 24, p. 98]. The 9512 will not make the 9511 obsolete: it sacrifices transcendental functions for greater precision and is slightly slower than its predecessor because it rounds off rather than truncates. Like the 9511A, the 9512 is priced at $175 in lots of 100 or more. But competition expected by a similar chip from Intel Corp. could lower that figure significantly.

Memory upgrade for IBM 370, 303X shown by Itel

Still reeling from recent IBM marketing announcements, such as the 4300 series [*Electronics*, Feb. 15, p. 85], Itel Corp. is fighting back with a new universal main memory that will upgrade System/370 and 303X central processing units. **What's more, the San Francisco company has dropped the price to a low $400,000 for the 8-megabyte unit and $700,000 for the 16-megabyte option,** somewhat less than comparable IBM or other memory products, it says. The universal memory features 16-K dynamic random-access memories, memory-address relocation, on-line performance monitoring, and error-checking and correction display.

Philips to make 25–35-MHz scopes in the U. S.

"Made in the U. S." will soon be found on the Philips' 25-to-35-MHz oscilloscopes sold in this country, perhaps by the fourth quarter of 1979. Philips Test and Measuring Instruments Inc. will be making the scopes in its Mahwah, N. J, facility. By next year, the company plans to be manufacturing Philips' line of 100-MHz scopes—and eventually **it may make many of the NV Philips test and measuring instruments it now imports from the Netherlands-based firm,** says Dominick Protomastro, president of Philips Test's parent, Philips Electronics Instruments Inc. A new department in Mahwah, aimed initially at production engineering, could become a development center, Protomastro says. Philips made oscilloscopes in the U. S. early in the decade, but low market acceptance forced it to abandon that venture.

Data General unveils interactive communictions protocol

Data General Corp. has introduced its Remote Cluster Executive software emulation package. It is compatible with IBM 3270 series equipment and runs on Data General's Eclipse computers under the Advanced Operating System, or AOS. Called AOS RCX70, it is the Westboro, Mass., minicomputer maker's first interactive communications protocol and **allows transparent replacement of IBM 3270 equipment, at the same time making possible either stand-alone or true distributed data processing.**

Microprocessor sales to hit $1.3 billion by '83

Worldwide microprocessor sales will jump to more than $1.3 billion by 1983, three times more than 1978 sales, according to a new analysis by Creative Strategies Inc., a San Jose, Calif., market research company. Eight-bit devices will remain dominant with a 60% share of the market. Market share for newer 16-bit microprocessors will rise from 6% to 23%, paced primarily by new applications in the computer peripherals and communications segment.

TI finally permits personal computer to make debut

Texas Instruments Inc. has finally decided that the on-again, off-again introduction of its first personal computer should coincide with the Consumer Electronics Show in Chicago and the National Computer Conference in New York, both scheduled the week of June 3. Though a color display is included in its $1,150 price, the machine is not the bombshell that some predicted (for details see p. 87), but the explosion could come later if the Federal Communications Commission decides to alter its Class I restriction limiting home TV hook-ups. **Then the computer, called the 99/4, could be sold sans monitor for as much as $400 less,** granting TI its wish to turn out a low-price personal computer that would be the first in a family of machines.

Thin-film heads for disk storage to be next wave

Soon after IBM ships its first 3370 disk drive incorporating new thin-film–head technology to a customer, rumored to be as early as October, expect a flood of activity in that direction from competitors. The reason is that **some companies want to find out what the computer giant has done before they put the finishing touches on their own thin-film heads.** The technology uses semiconductor techniques to reduce size and increase density, data speed, and reliability. Companies developing it include Applied Magnetics, Dastek, ISS-Univac, Information Magnetics, Magnex, Memorex, Storage Technology, and CII–Honeywell Bull (p. 76).

Dolby circuits for TV, audio in international bow

New circuits from Dolby Laboratories of San Francisco turned up on both sides of the Atlantic during the past fortnight. The just ended International Television Symposium at Montreux, Switzerland, saw the first commercial application—in a studio videotape recorder by International Video Corp.—**of the new video noise-reduction circuit.** The circuit splits the video composite color signal into three bands and processes each of them. At last week's Consumer Electronics Show in Chicago, Dolby unveiled a circuit that **improves the high-frequency characteristics of recordings made on consumer audio cassette recorders** at high volume.

Addenda

Ford Motor Co.'s 1980 luxury cars will offer optional microcomputer-controlled door locks. **A preset code punched into five buttons above the door handle will unlock the doors and the trunk.** Also, doors will lock automatically upon the appropriate signals from sensors in the driver's seat, ignition, and transmission lever. . . . Among the 274 persons aboard the American Airlines DC-10 killed when it crashed May 25 on takeoff from Chicago was **George J. Hart, 61, vice president and general manager of the TRW Electronic Component divisions,** which are based in Los Angeles.

A NEW AND BETTER APPROACH TO ELECTRONIC CONTROLS

the tasa

FERENSTAT

MODEL: FR-105

WHAT IT IS . . .

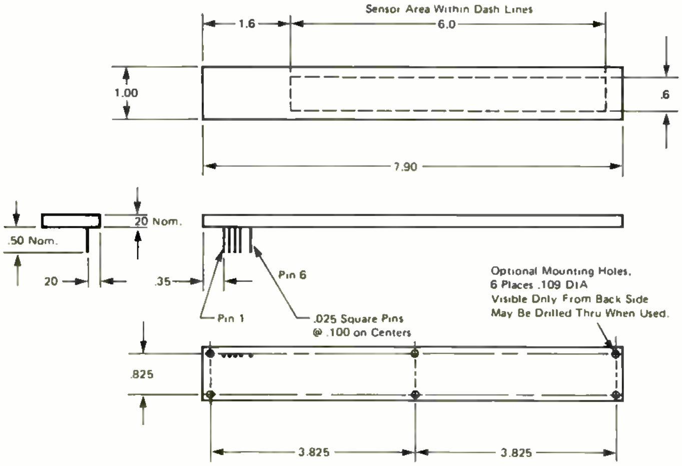
A variable touch control with no moving parts, it is like a "solid state potentiometer."

WHAT IT DOES . . .

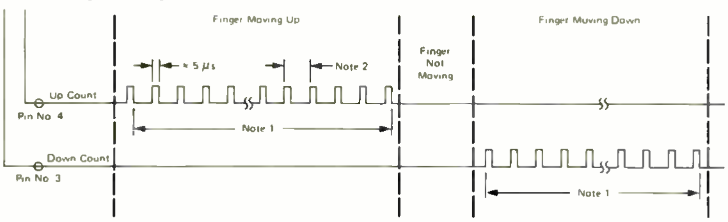
The "FERENSTAT" uses a proprietary array of miniature proximity detectors to respond to the presence, the motion, and the direction of motion of a human finger on the sensing area. Its logic system evaluates the activation of the sensors to detect the direction in which the

finger is moving and increments up or down accordingly. Thus, the sliding of a finger on the surface causes a digital change of state, which in turn can be used for controlling electronic devices.

MECHANICAL OUTLINE



TIMING DIAGRAM



FEATURES

Absolute repeatability in settings • Micro-processor compatability • No contact noise or resistance • Environmentally sealed • Flush control surface • Tolerance to abuse • Digital output

SUGGESTED APPLICATIONS . . .

Digital tuning • Professional audio equipment • PCM recording-playback • Video-Audio controls in broadcast equipment • Computer-ized lighting controls • Public-use coin-operated equipment • T.V. games • Medical equipment • Computerized industrial controls

ORDER ONE NOW

Evaluation units, $145 each (prepaid UPS) plus appropriate sales tax for California orders. Master Charge or Visa accepted on phone or mail orders (include number and expiration date).

tasa

Touch Activated Switch Arrays, Inc.

2346 Walsh Avenue, Santa Clara, CA 95050, (408) 247-2301 TWX 910-338-7620

AMI's S6802 without cuttin

Why use two or three chips when one will do? Our new S6802 MPU has a clock and RAM built right into the circuit. So you save a lot of time, money and real estate when you're putting together a micro-processor system. (If you don't need the RAM, our S6808 has the clock right on board, too.)

You save your existing software, too, because the S6802 is object code compatible with the S6800. So you can easily fit them right into your present system. All you need is an inexpensive crystal, and you're ready to go.

Both are 1MHz devices, available in 40-pin ceramic, cerDIP or plastic packages. The S6802's 128 bytes of RAM include 32 bytes that can be retained in a low-power mode using V_{CC} standby.

Why the leading alternate source should be your first source.
Unlike most suppliers who are only interested in selling you parts, AMI offers systems solutions. You can simply order from our 6800 family (see chart). Or we'll sit down with you and, using our experience as the leading custom MOS company, work out the most cost-effective way to control your product.

As you can tell, we have a lot of choices for you. We're adding new members to the family, such as our S68047 Video Display Generator that turns digital output into words and pictures. And, coming up, our new S6809 will have both 8-bit and 16-bit processing capability.

cuts costs g corners.

A special $3-off offer.

This primer, "Basic Microprocessors and the 6800," normally costs $11.95. But, for a limited time, AMI is making it available for just $8.95 a copy.

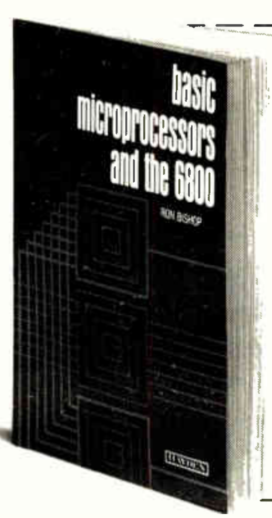
A Hayden Publication, it covers everything from basic electronics and the principles of microprocessors to the 6800 MPU and its support chips, addressing modes, systems configurations and instruction set.

We also have free S6800 literature for you. It's yours for the asking. So ask one of these AMI distributors: Arrow Electronics; Bowtek Electronic Co., Ltd.; Century Electronics; Cesco Electronics, Ltd.; Future Electronics; Intermark Electronics; Kierulff Electronics; Resistacap; R/M Electronics; R.V. Weatherford; Schweber Electronics; Sterling Electronics; Western Microtechnology.

And if you want to discuss a microprocessor systems solution, contact George Nelson, AMI S6800 Product Marketing, 3800 Homestead Road, Santa Clara CA 95051. Phone (408) 246-0330. He'll help you get more out of your 6800 system while putting less into it.

The 6800 is one big, happy family. And it's getting bigger and better all the time.

MPUs	
S6800, S68A00, S68B00	MPU
S6802	MPU plus on-board clock & RAM
S6808	MPU plus on-board clock
S6809	Enhanced MPU plus on-board clock (Available 1Q'80)
PERIPHERALS	
S6821, S68A21, S68B21	Peripheral interface adapter
S6840, S68A40, S68B40	Programmable timer module
S6850, S68A50, S68B50	Asynchronous communications interface adapter
S6852, S68A52, S68B52	Synchronous serial data adapter
MPU Memories	
S6810, S68A10, S68B10	128x8 Static RAM
S6831	16K Static ROM
S68332	32K Static NMOS ROM
S6834	4K EPROM
S68364	64K Static ROM
S6846	16K ROM with on-board I/O and timer
S6814/2114	1Kx4 Static RAM
S6816/4028	2Kx8 Static RAM (Available late 2Q'79)
S6818/4018	1Kx8 Static RAM (Available late 2Q'79)



Yes, I want the primer, "Basic Microprocessors and the 6800." (An $11.95 value for just $8.95.) I enclose my check/money order. (California residents add 6% sales tax.)

☐ Send me S6800 literature.

Name________________

Title________________

Company________________

Phone________________

Address________________

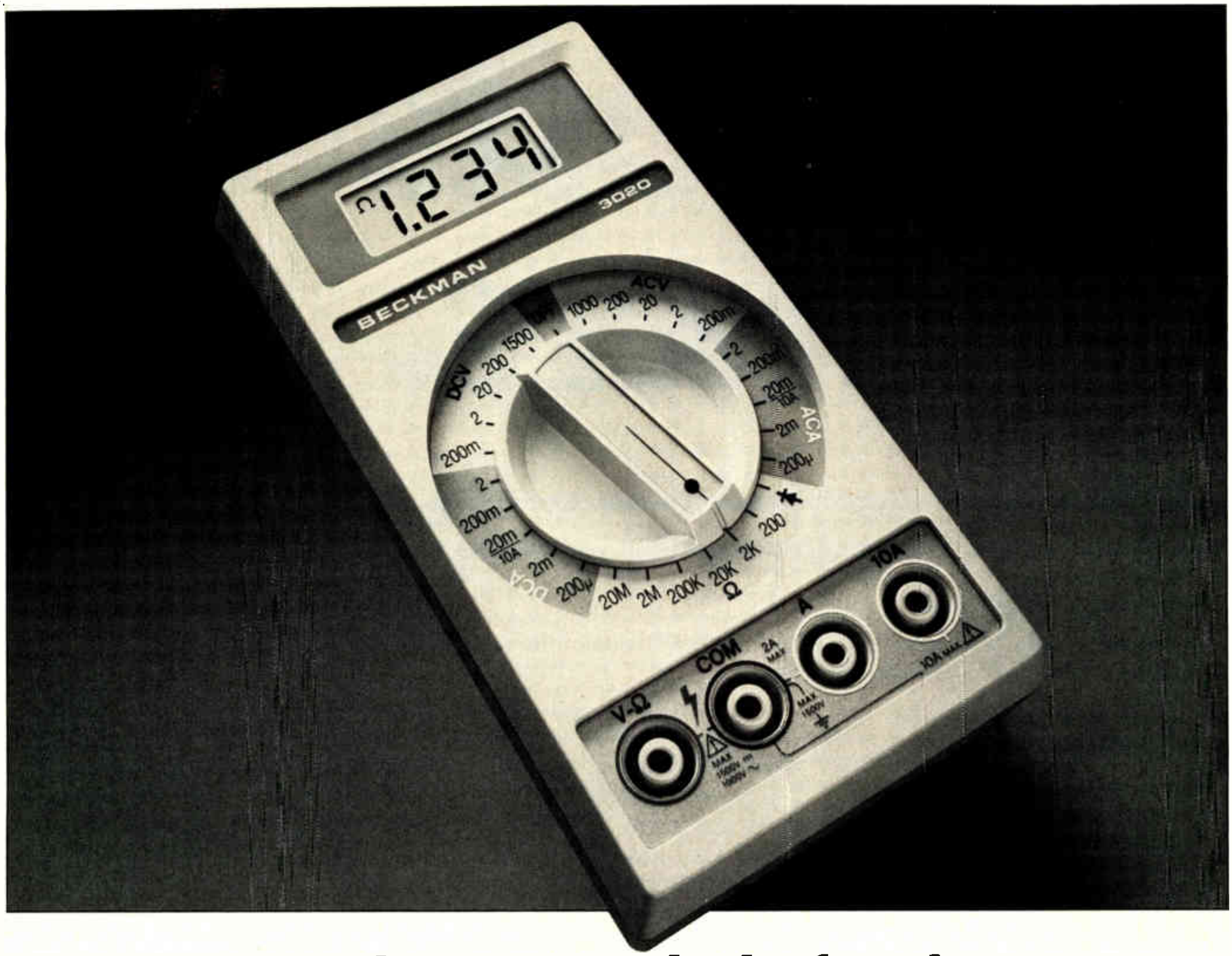
City/State/Zip________________

Mail to:
AMI S6800 (III) Marketing
3800 Homestead Road
Santa Clara CA 95051

AMI® AMERICAN MICROSYSTEMS, INC.

Circle 39 on reader service card

NEW DIGITAL MULTIMETERS THAT WORK THE WAY YOU DO.



Featuring new continuity function.

You do your job as well as it can be done. Now there's a line of digital multimeters from Beckman that does the same. A new generation of 3½-digit multimeters a step above all other digital and analog multimeters. We've combined the best of both to give you useful and easy-to-use features found in no other multimeter.

Features like a unique continuity test function. With Beckman's new Insta-Ohms™ quick continuity indicator, you no longer need an analog VOM for fast, convenient continuity checks.

There's also 10-amp current ranges, in-circuit measurement capability in all six-ohm ranges, a dedicated diode test function, and up to two years normal operation from a common 9V battery.

The Model 3020 with all these features, 7 functions, 29 ranges, and 0.1% Vdc accuracy, is only $170.

These features are also available in the Model 3010 with a 0.25% Vdc accuracy for just $130.

Then the Model RMS 3030 features true RMS ac current and voltage measurement capability, and 0.1% Vdc accuracy, for only $190.

Whichever model you choose, you get long-term accuracy and reliability, assured through the use of band-gap reference elements, thin-film resistor networks, custom-designed CMOS LSI chips and more.

So get the Beckman digital multimeter that does its job as well as you do yours. For information on the complete line and accessories, write or call your local distributor or the Advanced Electro-Products Division, Beckman Instruments, Inc., 2500 Harbor Boulevard, Fullerton, CA 92634, (714) 871-4848, ext. 3651.

BECKMAN

Electronic modulator speeds up processing for optical computer

by James F. Brinton, Boston bureau manager

Experimental MIT device uses laser light and runs in real time; result is a fast, sensitive way of getting data in and out

Laser-based optical computers work literally at the speed of light. A laser system with the right lenses, mirrors, and filters can process images and other large arrays of data faster than the speediest digital computers—in theory.

In practice, there are problems with these systems that drastically slow processing. To help solve them, a team at the Massachusetts Institute of Technology, Cambridge, Mass., has developed what it calls a microchannel spatial light modulator, or MSLM, now being patented.

Developed under the direction of Cardinal Warde, assistant professor of electrical engineering and computer science, and with the aid of graduate student Arthur D. Fisher, the light modulator is a fast, sensitive way of getting data into and out of an optical computer.

The old way, in many cases, used film. Film is sensitive and has high resolution, and that's good; but it takes time to develop, and that's bad.

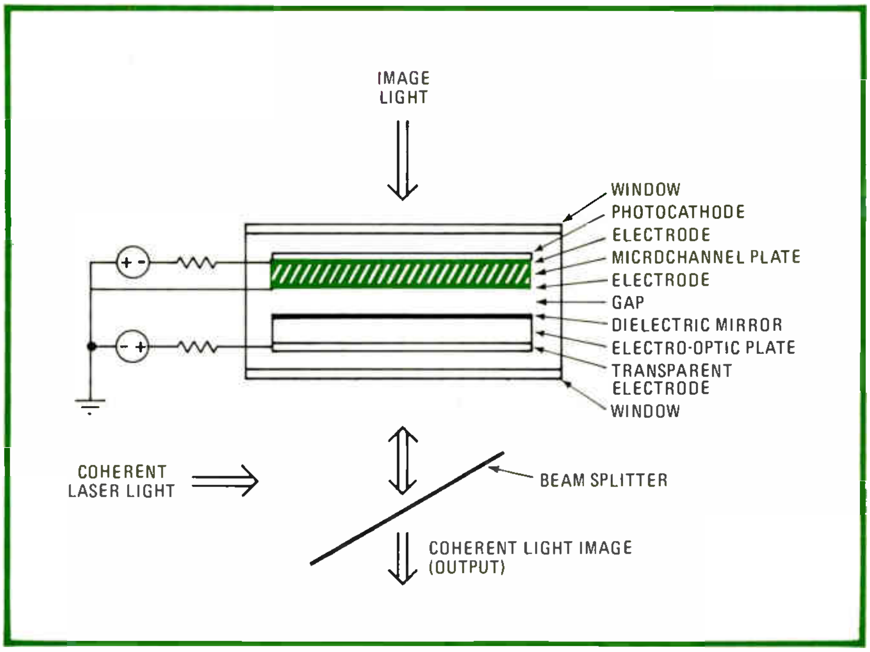
MIT's modulator, on the other hand, is electronic, runs in real time, has potentially decent resolution of 20 line pairs per millimeter (about 500 line pairs per inch), and borrowing technology from night-vision systems, is very sensitive. Warde expects to be able to detect optical signals as weak as 1 nanojoule per square centimeter, making the MSLM a candidate for astronomical work or military night reconnaissance applications.

Warde's funding came from the National Science Foundation and the Air Force's Office of Scientific Research. The Air Force would like to use such a device in image processors, where an optical computing approach would far outspeed traditional photointerpretation.

Tech sandwich. The prototype MSLM disk is approximately 1 inch in diameter and 0.2 inch thick. Its several layers convert images into the sort of coherent information an optical computer needs. It is a kind of phase modulator with an image entering at one end and a reference, or coherent, beam of laser light entering at the other.

An incoming image (at the top of the figure below) is focused on a photocathode, which gives up electrons where the light strikes. The electrons then pass inward to a so-called microchannel plate—an off-the-shelf electron multiplier that amplifies the cathode's electron output ten-thousandfold. Electrons from the multiplier charge a dielectric mirror coating a lithium-niobate electro-optic plate. This charge on the mirror locally changes the refractive index of the lithium niobate.

Thus, when the laser beam passes through the plate and reflects from the mirror and back through the electro-optic plate, its wave front is altered—now there are phase differ-



Modulator. Microchannel spatial light modulator developed at MIT relies on electrons from a photocathode to charge a dielectric mirror. The result of combining the image and laser light is phase differences in the output light that correspond to the original image.

ences in it that correspond to the original image's lighter and darker areas. An optical computer can now process the image data by comparing these phase differences with its own phase-constant beam.

Since the MSLM basically alters a wave front's phase, many applications are open to it. After all, lenses, some filters, and all holograms work similarly. MSLMs could impersonate all of them, making possible multistage optical computers with real-time operation as portions of the system's beam took side trips through an MSLM programmed, optically or electronically, to alter phase as desired.

The MIT MSLM needs more work, says its developer. But the promise is there, and the result should be more interest in optical computing.

Companies

Fairchild's merger with Schlumberger: a good deal for both parties

"Schlumberger has close to $1 billion in cash and can use semiconductor know-how for most of its businesses, so the Fairchild acquisition makes superb sense." That's how a former executive of Schlumberger Ltd. sums up its purchase of Fairchild Camera and Instrument Corp. for $66 a share, or a total of more than $360 million. The deal caused Gould Inc. to end its takeover attempt [*Electronics*, May 24, p. 58].

Agreeing with the ex-executive is one official of a Silicon Valley market-research and consulting company. "I see it as a move by a large multinational corporation to get a basic semiconductor capability," he says, adding that "it's difficult to start a semiconductor company from scratch today."

In another sense, Schlumberger, an instrument and oil-field equipment maker that took in $2.7 billion last year, is joining a trend—that of large European firms gaining control of American semiconductor houses. Precedents were set by two West German companies, Robert Bosch GmbH (American Microsystems Inc.) and Siemens AG (Advanced Micro Devices Inc. and Litronix Inc.) and by NV Philips Gloeilampenfabrieken (Signetics Corp.).

Not only that, but Schlumberger's instrument-making subsidiaries, like Sangamo-Weston Inc. of Toronto and Newark, N. J., Solartron Ltd. and Membrain Ltd. in Britain, and Enertec SA in France, could add up to a solid semiconductor outlet for Fairchild. Another good fit is for automatic test equipment. Schlumberger has already staked out a position at the St. Etienne department of Enertec and at Membrain. It should do even better in the growing field with Fairchild's items added.

One analyst, John Hayward, a vice president at Merrill Lynch Pierce Fenner and Smith in New York, says, "Schlumberger looks on semiconductors as a fast-growing market where it can redeploy its cash flow from the oil-service business." Schlumberger's major pursuit is wire line services, a business that Schlumberger invented. Instruments are lowered into a potential oil borehole by an armored electrical cable called a wire line to determine underground physical properties. "That is an R&D business," says Hayward. "Consider the R&D potential of a Fairchild."

Smart buyer. Jean Riboud, president and chairman of Schlumberger, headed $360 million-plus purchase of Fairchild.

There are two big questions about the deal: what does Schlumberger bring to the wedding, and will there be a management shakeup at Fairchild, which, in the words of one competitor, "is no competition *anywhere*"? The answer to the first is cash. But the second is a puzzler. Schlumberger's style is more *laissez faire* than "off with their heads."

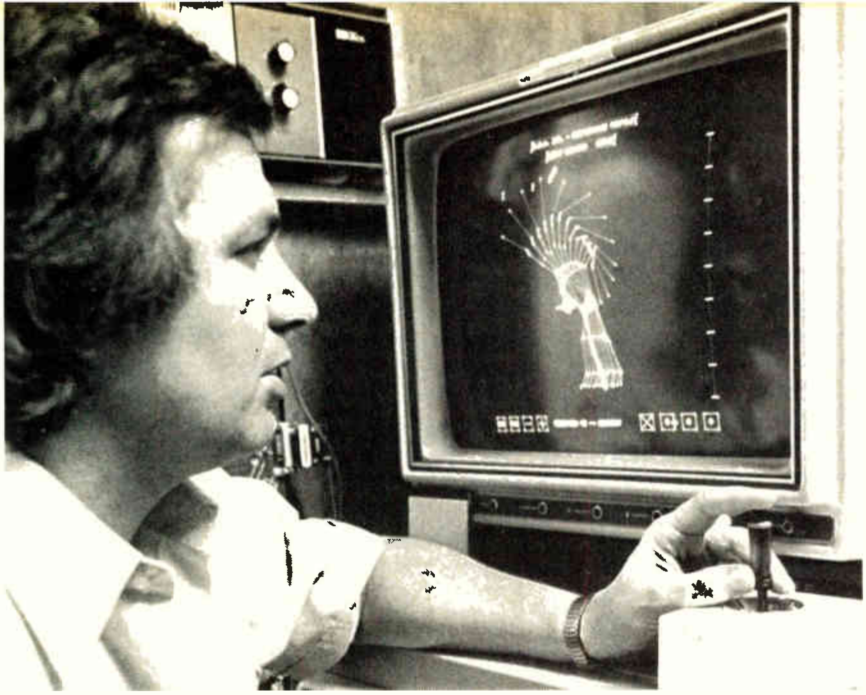
Tony Davies, founder of Membrain and now general manager of the Membrain-Solartron group, says he favored acquisition by Schlumberger because of its "relaxed management style." Merrill Lynch's Hayward says, "They are very profit-oriented, but will put profit incentive in a time horizon that is reasonable." Still, one West Coast analyst predicts that Fairchild president Wilfred J. Corrigan and the top management will be gone in 6 to 12 months.

Also a question is whether Schlumberger considers itself French or American. It coyly insists that its headquarters on rue Saint-Dominique in Paris and on Park Avenue in New York are equal and that Jean Riboud, Schlumberger's president and chairman, spends half his time in each city. The company is incorporated in the Netherlands Antilles. *-Electronics* **staff**

Medical

Computer aids Olympic athletes

American athletes preparing for the 1980 Olympic Games will be getting an unusual boost from computers, thanks to a gift to the U. S. Olympic Committee from Data General Corp., Westboro, Mass. The company is donating a computer system



Stick man. Gideon Ariel adjusts stick-like figure on CRT display, which he uses to judge how slight modifications in what an athlete does may affect overall performance.

built around an Eclipse S/250 (with its peripherals, worth well over $200,000) for use in a new kind of modeling and simulation laboratory.

To be installed at the Olympic Committee's new Bio-Mechanics Laboratory in Colorado Springs, Colo., the system digitizes the motions of athletes so that their performances can be manipulated and modeled in the computer. The result is that athletes and their coaches will be able to study how variations in extremely fine points of style may be able to affect overall performance

According to Dr. Irving Dardik, chairman of the Olympic Committee's sports medicine committee and chief of the Bio-Mechanics Laboratory, the approach will be "a great tool for our coaches and athletes."

The system was developed by Gideon Ariel, who will carry the title of director of computer sciences/biomechanics at the Colorado Springs facility. Through his own firm, Computerized Biomechanical Analysis Inc., Amherst, Mass., Ariel has used the technique to improve the performance of professional athletes, including golfers and members of the Dallas Cowboys football team. Ariel holds a Ph.D degree in exercise science.

Movies. The basic input for the computer comes from motion picture images of an athlete performing. These are taken at anywhere from 64 to 10,000 frames per second. Most athletes are filmed at the lower range; the upper range is used, for example, to photograph the snap of a golfer's wrists. The film is digitized using a combination projection screen and light pen. The computer then converts these data points to a model—displayed on a cathode-ray tube—that looks like a cross between a stroboscopic photograph and a stick figure drawing.

These schematic models are analyzed by the computer, which calculates the velocity, acceleration, direction, and force generated by the athlete's movements. It is then possible to make changes, perhaps minute—in foot position, or in timing the release of a discus or shotput, or in any of hundreds of variables of athletic style—and the computer will calculate the result. Finally, suggestions of new movements for the athlete to try are drawn up.

This approach could change the face of coaching, now a personal involvement of the coach's experience and the athlete's understanding, according to Ariel. He points out that the human eye is just not fast enough to catch all the data needed to make very fine judgments. "Every type of movement obeys Newton's laws; no engineer would build a bridge without calculating the stresses involved—and competing athletes generate tremendous force," he says.

By combining the camera's eye and the computer's calculating power, Ariel believes he can find how best to use those forces. He has already proved successful. Perhaps the most interesting story is Al Oerter's. A 44-year-old discus thrower, he is a four-time Olympic gold medal winner whom Ariel describes as one of the best athletes of all time. Now making a comeback, and working with Ariel, Oerter recently made the best throw of his life to win the California Relay Games discus event.

The computer system will be installed at Ariel's laboratory in Amherst by mid-June. He intends to debug it there before shipping it to Colorado Springs late in July. Once installed there, the system, with its several interactive display consoles, can also be used to keep track of personal and team performance, as well as compare the performances of American athletes and those of other countries. **-James F. Brinton**

Memory

Intel announces disk replacement

The question of which semiconductor device will best supplant electromechanical disk drives is getting still another answer this week, namely, 16-K random-access memories. At the National Computer Conference in New York, Intel Corp., the microprocessor maker, is introducing a system built of RAMs to replace IBM Corp.'s 2305 fixed-head disk.

Called the FAST 3805, for fast-access storage technology, the system offers at 400 microseconds about 10 times the access speed of the IBM unit, about the same data transfer rate, and greater capacity—for lower cost.

Other companies offering similar fixed-head disk replacements include Storage Technology Corp., Louisville, Colo., and Memorex Corp., Santa Clara, Calif. However, they are using 64-K charge-coupled-devices instead of RAMS, hoping for a more compact and cheaper system with the denser device (see "Reappraising CCD memories: can they stand up to RAMs?" p. 122).

Triple traffic. The 3805 will at least triple disk traffic, says Intel, unclogging bottlenecks caused by loading down input/output channels with too many on-line options. "Mainly we're offering a way to extend the life of System/370 and 303X family mainframes," says Stephen G. Maysonave, business planning manager at Intel's recently estabished Commercial Systems division in Phoenix.

It will not be developing memory systems for IBM's new 4300 machines, however. Although Intel does not say why, it is probably because of the way IBM has included memory within the 4300 enclosure, rather than as a separate add-on.

Intel offers a 12-megabyte system at $130,500, undercutting a comparable IBM 2305 system by 20%; a 48-megabyte Intel system priced at $507,920 is 31% less expensive than a 45-megabyte IBM system that is built with 2305s.

According to Storage Technology product manager Gary Holtwick, CCDs remain the most economical part for such applications—and STC's prices bear him out. STC's biggest, 45-megabyte 4305 is priced at $400,000, or about $8,889 per megabyte—some 16% less than Intel's $10,625 per megabyte.

Maysonave notes that Intel has gone to an extended error-checking and -correcting (ECC) scheme that can detect and correct single- and double-bit errors and at least detect triple-bit errors—the first double-bit correction ever used in a commercial memory system, he says.

"Our studies have shown that a 72-megabyte semiconductor memory system will have a double-bit failure every six days," he maintains. "With double-bit correction, three bits must fail at once to stop the system, and a triple-bit error will only occur once in about seven months."

Great attention is being paid to reliability, adding to the system's selling price. Intel, for example, is including a built-in iSBC-86 16-bit microcomputer that performs diagnostics, cycles the memory to hunt for errors, logs them, and reroutes storage around bad memory blocks; a motor-generator power-line regulating system that accommodates 200-millisecond brownouts; a battery backup option that keeps the memory alive for 12 minutes. The reason for this extra care is that semiconductor memories have yet to establish total credibility in a magnetic-disk environment. Here reliability is as important as nonvolatility.

Since it originally introduced what it calls its model 4305 Solid State Disk [*Electronics*, Sept. 28, 1978, p. 43], Storage Technology has added double-bit error correction, Holtwick points out, and a purge capability that periodically reads portions of memory and corrects and rewrites any failing bits, thereby purging soft errors. A prototype system operating for over a month has yet to suffer a debilitating hard failure—in other words a triple-bit error—he maintains. **-Raymond P. Capece**

TI applies 64-K partials

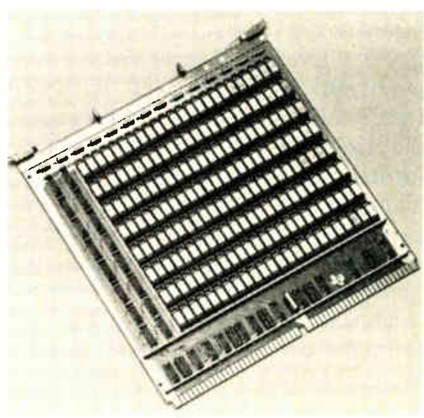
As manufacturers gear up to produce the emerging generation of 64-kilobit random-access memories, large numbers of partially defective devices will be produced as well. At Texas Instruments Inc., officials plan to make use of these partial devices to enter a market previously untapped by the giant Dallas-based semiconductor house.

Scheduled for introduction at this week's 1979 National Computer Conference in New York are two new memory module products from TI populated with 64-K partials aimed at the minicomputer add-in and add-on markets. The chips will be at least half-functional, thus providing 32 kilobits of storage per device, and will enable TI to offer several advantages over currently available add-on and add-in boards supplied by other manufacturers that use 16-K RAMs, it says.

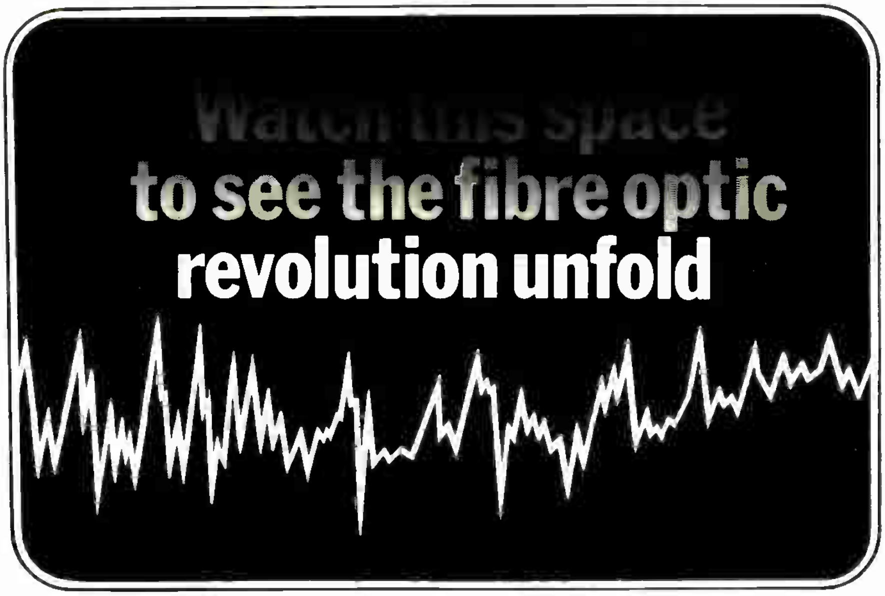
"We realize we're late getting into this market," says Dick Gossen, TI's MOS memory development manager in Houston. In all, independent vendors shipped a total of $95 million worth of standard product minicomputer add-on and add-in memory last year, according to estimates by International Data Corp., Waltham, Mass.

To gain a foothold against already entrenched MOS memory system competitors such as Intel, Motorola, Mostek, and National Semiconductor, TI's new memory systems department, formed last January, will provide customers with increased density and performance characteristics at competitive prices by using the big TMS 4532 chips. Other manufacturers also are making plans for use of their 64-K partials. Motorola's main thrust will be in component-level sales of the devices, for example, whereas Mostek is planning use of 64-K partials by its memory systems group. But TI hopes to gain the advantage by being the first out with module products using 32-K devices and is already engaged in contracts for custom-designed memory systems for delivery this year.

Main thrust. Indeed, says A. C. D'Augustine, MOS memory strategic marketing manager, "the custom business is really our main thrust." The new standard module products being offered will serve as a base and provide visibility in the marketplace, he continues. But initially, "our



Module. TMM-A50 general-purpose array add-on stores up to 1/2 megabyte, costs $9,500 for a single unit.



Our 10 years experience with fibre optic CRTs has convinced us of one thing.

The future impact of this exciting new technology, on recording techniques, remains incalculable.

What *is* certain is that it is making rapid inroads into areas that would not have seemed remotely possible a short time ago.

First, M-OV fibre optic CRTs allied to oscillographic applications have revolutionised photographic recording by obviating the need for an external camera and improving quality dramatically.

Then they were developed for use in an important military counter measure role.

In the electro-medical world, M-OV fibre optic CRTs enable highly accurate instant photo-recordings to be made of minute muscular responses. And they improve performance at high frequencies into the bargain.

Yet another area that is enjoying a new lease of life is typesetting. This traditional craft has now joined the technological front-runners.

Because of fibre optics CRTs.

And M-OV.

At M-OV we are building up our range very rapidly and new developments are taking place all the time. It is quite likely that we can help you with your problems.

Please let us know what they are. Maybe the fibre optic revolution will be taking place in your field any time now.

M-OV

A MEMBER OF THE GEC GROUP

Genalex

S 662

THE M-O VALVE CO LTD, HAMMERSMITH, LONDON, ENGLAND W6 7PE. TEL 01-603 3431. TELEX 23435. GRAMS THERMIONIC LONDON objective is to have more than half of our business in custom," with sales both to end users and to original-equipment manufacturers.

New standard TI products shown at NCC included the TMM-11, an add-in module providing up to 64 kilowords of storage for use with Digital Equipment Corp.'s new 16-bit LSI-11/23 processor. Priced at $2,200 for a single unit in its maximum configuration of 64 kilowords by 18 bits, the memory will allow 11/23 users to reach a maximum 128-kiloword storage capacity with only two boards, according to the company.

Also announced at the show is the TMM-A50, a general-purpose array add-on module that can store up to ½ megabyte. Priced at $9,500 for a single unit in its maximum configuration of 256 kilowords by 24 bits, the TMM-A50 board, like the TMM-11L, is scheduled to start shipping in the third quarter.

The TMM-11L includes parity control as standard, and the TMM-A50 will provide for off-board error-correction techniques. Later products in the new module line are expected to use a bipolar chip currently being designed by TI's linear group that will make possible on-board single-bit error correction and double-bit error detection. The new ECC (error-correction coding) chip will be offered on boards designed for Digital Equipment Corp.'s PDP-11 line of Unibus machines, TI says. -**Wesley R. Iversen**

Consumer

Matsushita promises hand-held computer

Brand new. The Panasonic name on a language translator presages a raft of new kinds of hand-held computer products for the consumer field that rely on plug-in modules.

Language translation was simply the opening act of the hand-held translators introduced late last year. Designed basically as specially applied microcomputers, the translators—one from Craig Corp., the other from Lexicon Corp. [*Electronics*, Dec. 21, 1978, p. 34]—are now being readied as personal computers that are capable of handling a variety of tasks with a simple plug-in customizing module.

Certainly the biggest impact was made late last month by Matsushita Electric Industrial Co., of Osaka, Japan, one of the world's largest consumer electronics manufacturers, with trade names like Panasonic, Technics, and Quasar. It announced at a press conference in New York that it was developing "the first practical hand-held personal computer" built around the same basic unit used by Craig for its M-100 language translator. (For a discussion of the more powerful home computers, see "Personal computer market multiplies," p. 87.)

Hardware and software for the system will be developed jointly by Matsushita and Friends/Amis Inc., the Redwood City, Calif., software development house that put together the translator for Craig. Craig has exclusive rights to the unit in the U. S. for the remainder of the year, so Matsushita will not introduce its units here until early in 1980. It will begin to sell them in Japan later this year, however.

Still uncertain. At this point Matsushita says it has not yet decided just what features it will offer or the prices of its units. (The language translator lists for $200 but is being discounted.) Ronald Gordon, president of Friends/Amis, points out that the units will be heavily applications-oriented. They will be aiming at the middle-of-the-road consumers—those who have comparatively little knowledge of computers—rather than at hobbyists who like to develop their own programs.

The machine, built around a single-chip, 8-bit Mostek 3870 microcomputer, will accept four random-access or read-only memory modules through slots in the back. It can now store four 64-K ROMs or four 8-K RAMs, according to Gordon. The applications are unlimited because the machine will store interpretive languages like Basic and Forth, not just programs themselves, he says.

Matsushita is also committed to a broad range of peripherals. Thus, at the press conference Gordon mentioned items like a voice synthesizer, dot-matrix displays, a "miniprinter," and the ability to plug into a data bank via telephone lines.

Panasonic is showing off initial versions of its microcomputer at this week's Consumer Electronics Show in Chicago. The keyboard is different from the one on the Craig language translator. It allows new functions, like a calculator, and lets a user customize programs for specific applications. The unit will also have the external jack that gives access to the planned peripherals.

As for Lexicon in Fort Lauderdale, Fla., it is "working on products to be introduced in early 1980 that will be revolutionary in their own right," says executive vice president Michael Levy. Lexicon is also showing new non-language-translating applications at the Consumer Show. He points out that Lexicon's hand-held unit is already being applied in a custom-filing application—clerks

can use it to file and retrieve documents without any need for precoding them. -Alfred Rosenblatt

Solid state

Rockwell readies C-MOS on sapphire

Although the recent interest in very high-speed integrated circuits spurred by proposed Pentagon funding has put complementary-MOS-on-sapphire technology once again in the spotlight, high-performance devices built with this technology remain largely limited to research. They are available, for the most part, from only a few nonmajor IC houses as big-ticket custom jobs [*Electronics*, Oct. 26, 1978, p. 96].

Pushing hard to be among the first to get these devices into production and offer a commercial product line is Rockwell International Corp. It hopes to have devices with dimensions as small as 3 to 4 micrometers, perhaps as early as late summer. Aimed at high-speed signal processing for the company's own military systems, they will be built at the Microelectronics Devices division, Newport Beach, Calif. Prototypes were built at the Electronics Research Center in Anaheim, Calif.

Among the upcoming new products will be frequency synthesizers that operate at 160 megahertz with average power consumption of less than 25 milliwatts and "10 or more different chips now in design," according to Daryl T. Butcher, manager of systems technology at the research center (see "C-MOS on sapphire to move in three steps").

Pointing up the attraction of the technology is the performance of Rockwell's latest experimental chip, made for researchers at Ford Aerospace and Communications, Palo Alto, Calif. Called a Viterbi decoder, it is destined for an advanced communications satellite as an error-correction device for transmitted digital data, enhancing the effective signal-to-noise ratio, according to Butcher. (Its name comes from the Viterbi algorithm employed in complex coding and decoding work.)

Next phase. The Viterbi chip, with 1-to-2-μm dimensions, is an example of the second phase of C-MOS-on-sapphire products planned by Rockwell. It is the first time the Viterbi algorithm has been implemented in LSI, the company says.

The chip, with 8,188 transistors on a 124-by-184-mil chip, operates at 70 megabits per second, with average power consumption of 40 milliwatts. It can operate at as high as 100 megabits per second. The decoder could not have been built before, nor was its speed-power product of 0.36 picojoule per state-changing transistor possible, says Butcher. The interconnection delays of the complex circuit functions required by the algorithm held previous data rates to 10 MHz, with power requirements in the tens of watts, he says.

At the center of the decoder and illustrative of its complexity are addition-comparison-selection circuits, where 27 logic levels are needed between storage circuits. With high-speed 8-bit adders and magnitude comparators, average signal propagation delays of only 600 picoseconds per level can be achieved, Butcher says. Boosting this speed are two factors: 2-μm silicon-gate technology with threshold voltages of 0.8 volt, and low impedance undercrossing material of molybdenum-polysilicon with very low sheet resistance of 3 to 6 ohms per square that reduces resistor-capacitor time-constant delays.

Continued improvement of Rockwell's computer-aided design package for semiconductors makes the advanced C-MOS on sapphire possible, Butcher continues. "Fully functional devices were achieved on the first mask checkout run with a total absence of logic errors and layout violations," he says. The company soon will have interactive graphic terminals tied into CAD and hopes to offer such a service later.

Butcher considers Rockwell's C-MOS-on-sapphire work with 2-μm dimensions "a little ahead of the Pentagon's very high-speed integrated-circuit program." Furthermore, Rockwell has demonstrated test devices at the 0.9-μm level by scaling down dimensions in the CAD system. The next step for Rockwell is a decoder four times as complex as the present one, on a 200-by-200-mil chip. It will be completed in about three months. -Larry Waller

C-MOS on sapphire to move in three steps

Rockwell plans to develop its C-MOS-on-sapphire technology in three steps, with increasingly dense devices in each. By the end of 1979, its 3-to-4-micrometer channel-length chips will combine 10,000 transistors and 2,500 gates; gate delays will range from 2 down to 0.7 nanoseconds, speed-power products from 5 to 2 picajoules. A more advanced process to go into production around 1981 or 1982 will have 1-to-2-μm channel lengths, 50,000 transistors, and 12,500 gates. Gate delays will range down to 0.2 ns and speed-power products down to 0.3 pJ.

In 1985, Rockwell plans to move from optical to electron-beam lithography, producing C-MOS-on-sapphire devices with more than 500,000 transistors and 125,000 gates. Channel lengths will be less than 1 μm, and gate delays and speed-power products less than 0.1 ns and 0.1 pJ, respectively.

Automotive

Motorola changes its strategy

While many in the electronics industries angle to increase their business with Detroit auto makers, Motorola Inc. is looking to be stronger in the aftermarket. With its business built on selling—since 1930—radios to car makers and dealers, Motorola's Automotive Products division in Schaumburg, Ill., wants to boost sales not only of aftermarket radios, which it has been making, but of

electronic engine-control and diagnostic instruments as well.

Although the division, with $202 million out of the $2.3 billion in sales last year by parent company Motorola Inc., already sells car radios through independent auto-supply shops and audio stores, it has traditionally concentrated on sales to the auto makers themselves.

Recent pollution-control and fuel-economy directives from Washington have created, in addition, a market for microprocessor-based engine-exhaust and spark-timing control systems. The latter have been profitable so far, but for the long run, Motorola wants to broaden its customer base, says Levy Katzir, vice president and general manager of the division. "We have been too OEM-oriented," he says, and adds that the company will be less "vulnerable" to weak new car sales if it strengthens its aftermarket presence.

Full line. Motorola's initial target is the burgeoning market for high-fidelity entertainment systems in autos [*Electronics*, April 12, p. 88]. Early next month, it will unveil its new all-electronic a-m/fm stereo and cassette player for the aftermarket, to compete with similar units just introduced by Japanese home-audio giant Pioneer Electronics of America.

To get a bigger share of a crowded and shrinking market, Katzir says Motorola will add features and cut labor costs to compete with offshore car stereo manufacturers. "We can compete with the Japanese. In fact, we will be better," he boasts.

Part of Motorola's aftermarket strategy is to offer a complete electronic product line, including engine controls and diagnostic equipment, and to exploit its original-equipment manufacturer status in promoting products to dealers and consumers.

To encourage its aftermarket sales of engine controls and other sophisticated hardware, it will offer specialized training and diagnostic equipment to service station operators. In fact, a diagnostic system for electronic engine controls is on the horizon, representing his division's entry into the new electronics aftermarket, Katzir says.

Motorola's plan to promote its OEM connection in order to sell aftermarket electronics will give the company an edge, analysts agree, though Detroit officials scoff at the move. They note the relatively small number of cars now equipped with the microprocessor-based systems and say that consumers will rely on Detroit's dealers for repairs and replacements.

Competition. However, other companies plan to match Motorola's move: TRW Inc., of Cleveland—already a major OEM supplier of mechanical systems—recently set up a new group to develop similar electronic products for its aftermarket of pumps, gears, and motors.

Auto electronics companies are preparing for a new era—all of General Motors Corp.'s 1981 model cars will be equipped with at least one microprocessor-based control system for spark advance, and most of Ford Motor Co.'s cars will be similarly equipped [*Electronics*, Jan. 5, 1978, p. 105]. Ironically, Motorola is already turning down automaker business because its order books for electronic control systems are bulging—it will supply 25% of Ford's 600,000 engine-control units for 1980 model cars and share more than half of GM's 6-million-unit procurement with Hitachi and Fairchild. **-Larry Marion**

All-electronic radios auto-bound

Motorola's new all-electronic radio will join several already available from Detroit auto makers—General Motors, Ford, and Chrysler now offer electronic models, including an eight-track or cassette tape player—and retailers. The new Motorola unit will compete head on in auto-supply shops and audio stores with the $400 model recently introduced by Pioneer Electronics of America. The aftermarket versions are slightly less expensive than the Detroit models, but Motorola has not yet determined the retail price or whether to include a digital clock.

An all-electronic radio has no moving parts in the audio section. To replace the bulky and heavy mechanical tuner, Motorola and the other manufacturers designed a circuit with a quartz-crystal reference to feed a frequency synthesizer. Motorola's version has two microprocessors and six other integrated circuits, whereas GM relied on five ICs, including three large-scale integrated chips.

One of the microprocessors is a 4-bit device. It will drive the light-emitting-diode frequency display that replaces the slide-rule station indicator of a mechanical set, explains David J. Priniski, engineering manager for retail products at Motorola. The other is an 8-bit device linked to 1 kilobyte of memory for frequency programming. GM uses three custom LSI chips and two other ICs in its version.

Other differences are also apparent—GM and Motorola use LEDs to display frequencies, whereas Ford uses a vacuum fluorescent display. Also, Motorola's unit may not include a clock, Priniski says, because most cars already have one and the timing circuit may need extra memory capacity.

Military

New display tells the odds

With today's heads-up displays, a fighter pilot knows if he is on target and within range when he launches a missile, but not much else. And since in air combat the probability of a hit is as much a matter of the target's maneuvers as the attacker's flying, present displays leave much to the pilot's judgment and experience.

A new type of display that could enhance any pilot's ability to hit enemy planes is called MICF, for missile intercept confidence factor. And according to spokesmen from the General Dynamics Corp.'s Fort Worth (Texas) division, it could be added to many of the heads-up displays aboard today's fighters. The MICF display gives a visual indicaintel delivers.

Success Manual for Industrial Control Designers.

There's a new Industrial Revolution. And it starts with Intel® Microcomputers.

Intel, first from the beginning in microcomputers, is first to deliver a full family of compatible 8- and 16-bit micro-computer products built to tough it out in the harsh reality of the industrial world. Now both OEMs and end-users with volume requirements can take full advantage of the promise and potential of the microcomputer.

That spells success for designers of chemical, plastic, textile and other process control systems... success for designers of


Extensive line of Intel® Single Board Computer products.

automated test systems and sophisticated machinery controllers... success for designers of any sort of automated control system.

Microcomputers are already revolutionizing scores of industries, revitalizing existing applications and creating new ones, adding features and improving reliability. They add performance while they cut costs, obsoleting TTL, PLC and relay logic systems. And their low cost intelligence solves problems you just can't afford to tackle with larger computer systems.

Now Intel single-board microcomputer products are available in a rugged industrial chassis, with new, special purpose industrial signal conditioning panels. For the first time, the power and economy of the microcomputer has been adapted for your industry, your environment, your way of doing things.

Success starts with Intel® Single Board Computers.

Our industrial control line of products is based on the iSBC™ family of 8- and 16-bit Single Board Computers—complete microcomputer systems on a single, standard-size printed circuit board, fully assembled and rigorously tested. Intel has led the way with single board computers and offers you low cost flexibility with a broad selection of over 30 boards. Our Multibus™ architecture has become such a widely accepted standard that today there are scores of special purpose boards from dozens of independent manufacturers, all compatible with the Multibus architecture and easily integrated into the iCS 80™ Industrial Chassis.

Introducing the iCS 80™ Industrial Chassis.

Now we've taken our family of board products and built an industrial grade chassis to house them. It's in the industry standard 19" wide configuration for rack mounting or, in severe environments, for NEMA cabinet mounting. We built the iCS chassis to house up to twelve boards, mounted vertically to take advantage of convection cooling. We've built in four fans for forced air cooling. So only the most severe applications will require additional environmental isolation.

The iCS™ chassis, submitted for UL approval, also includes your choice of 14- or 30-amp power supply. So no external components are required.

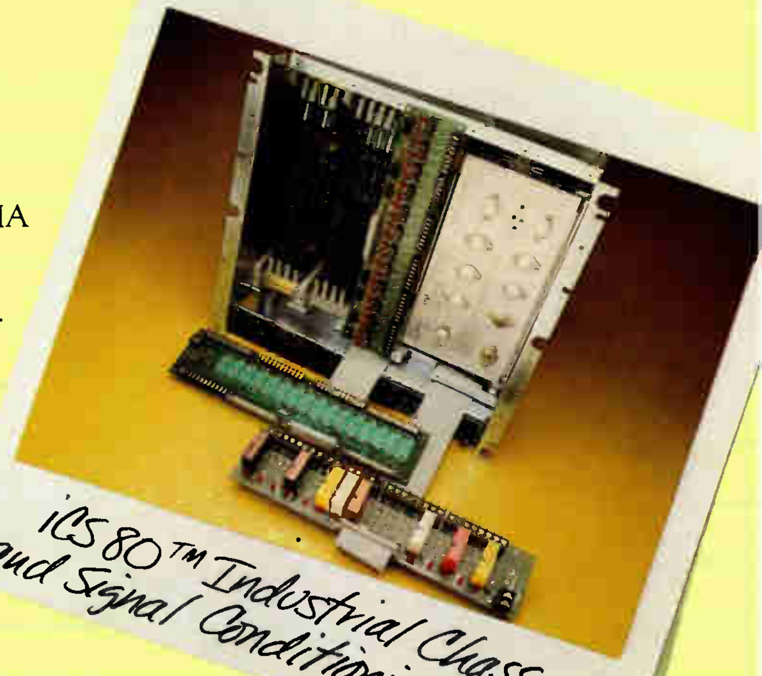
Our boards have an incredibly high reliability record—91,000 hours MTBF for the iSBC 80/10.™

Still, serviceability has been given special attention. All iCS components can be reached from the front of the chassis. Power supplies are on quick-disconnect slide-in rails. And slide-in/slide-out convenience makes board exchange maintenance with on-site spares practical. And faster than waiting for any repairman.

Special Signal Conditioning Panels make the difference.

Using microcomputers in industrial applications has, until now, required special custom interface circuitry. Now Intel Signal Conditioning Panels provide an alternative to costly, custom design. They're heavy duty printed circuit boards with rugged 14-gauge terminal strips for field signal hook-up. All the circuitry you need to convert signal levels from the microcomputer domain to the levels present in your environment—and vice versa—can be mounted on these panels.

The iCS 910/920/930™ panels provide termination and conditioning for analog inputs, opto-isolation for digital input/output, and interface for high power AC and DC signals. They mount face-out in the iCS chassis, or in a standard 19" rack or NEMA cabinet.



iCS 80™ Industrial Chassis and Signal Conditioning Panels.

RMX/80™ real time software gets you started.

RMX/80 software is the framework that makes it easy to develop dedicated, low-cost iSBC systems that monitor and control multiple asynchronously ocurring events. With RMX/80 software, you can develop each task in your application in small manageable modules. Then communication between modules, synchronization and prioritization of tasks is managed by the RMX/80 executive.

Intel's Intellec® system and in-depth development support speeds and simplifies programming.

Choosing Intel's family of control products for your industrial automation application can give you a big competitive edge. An integral part of that decision is how to manage software development.

Intel helps ensure your success with the Intellec® Microcomputer Development System. It provides a choice of programming languages and advanced debugging capability with ICE™ In-Circuit Emulation. With simple commands, ICE™ emulation provides control of program execution and symbolic debugging.

The Intellec system speeds and simplifies the development of your application programs and your configuration with the RMX/80 modules. It's a complete, self-contained software development center. The Model 230, for example, includes a standard typewriter-style keyboard and CRT display for operator interaction.

High-level languages provide fast composition of even very complex programs. FORTRAN-80, the language most control engineers know best, is ideal for computational applications. And the BASIC-80 interpreter gives industrial users a programming language that's easy to learn and use. The Intellec system also puts at your fingertips the world's most widely-used microcomputer language, PL/M. PL/M is available for both 8- and 16-bit single board computer systems. You use the Intellec system to generate RMX/80 task modules in any of these languages.

Once your application program is finalized, you use the Intellec Universal Prom Programmer to permanently store the program on non-volatile Intel® EPROMs (erasable, programmable read only memories) that plug into your single board computer. Your application programs can be easily designed to be stored in reliable, cost-effective EPROMs. So there's no chance of programs being lost or accidentally altered. EPROMs eliminate the need to re-load programs at every start-up, and eliminate costly program loading peripherals.

No need to wait for success.

You can begin writing your own success story with one call to the Intel sales office in your area. That puts you in touch with an Intel field engineer. He can show you how to configure the optimum microcomputer-based system for your needs. And can show you how to purchase the complete Industrial Control Success Manual.

The complete iCS Industrial Control product line, including Intellec Development aids, is available now. So don't delay. Call your nearest Intel sales office or distributor. Or write Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA 95051.

intel® delivers.

Circle 210 for more information. Circle 211 for configuration and pricing assistance.

U.S. and Canada Sales Offices: Huntsville, Alabama (205) 883-2430 □ Phoenix, Arizona (602) 242-7205 □ San Diego, California (714) 268-3563 □ Santa Ana, California (714) 835-9642 □ Sherman Oaks, California (213) 986-9510 □ Santa Clara, California (408) 987-8086 □ Denver, Colorado (303) 758-8086 □ Danbury, Connecticut (203) 792-8366 □ Ft. Lauderdale, Florida (305) 771-0600 □ Orlando, Florida (305) 628-2393 □ Oakbrook, Illinois (312) 325-9510 □ Hanover, Maryland (301) 796-7500 □ Chelmsford, Massachusetts (617) 667-8126 □ Southfield, Michigan (313) 353-0920 □ Bloomington, Minnesota (612) 835-6722 □ Edison, New Jersey (201) 494-5040 □ Hauppauge, New York (516) 231-3300 □ Poughkeepsie, New York (914) 473-2303 □ Rochester, New York (716) 328-7340 □ Dayton, Ohio (513) 890-5350 □ Cleveland, Ohio (216) 464-2736 □ Fort Washington, Pennsylvania (215) 542-9444 □ Dallas, Texas (214) 241-9521 □ Houston, Texas (713) 784-3400 □ Bellevue, Washington (206) 453-8086 □ Milwaukee, Wisconsin (414) 747-0789 □ Ottawa, Ontario, Canada (613) 829-9714 **Europe:** Brussels, Belgium, Tel: (02) 660 30 10, Telex: 24814 □ Rungis Cedex, France, Tel: (01) 687 22 21, Telex: 270475 □ Bromma, Sweden, Tel: (08) 98 53 90, Telex: 12261 □ Oxford, England, Tel: (0865) 77 14 31, Telex: 837203 □ Muenchen, Germany, Tel: (089) 55 81 41, Telex: 523 177 **Israel:** Haifa, Tel: 972/452 4621, Telex: 922 46511 **Japan:** Tokyo, Tel: (03) 426-9261, Telex: 781-28426
United States and Canadian distributors: Arrow Electronics □ Alliance □ Almac/Stroum □ Component Specialties □ Cramer □ Hamilton/Avnet □ Harvey □ Industrial Components □ Pioneer □ Sheridan □ Wyle/Elmar □ Wyle/Liberty □ L.A. Varah □ Zentronics

News briefs

TI gets Federal support for energy-storing photovoltaic system
The U. S. Department of Energy has awarded a four-year, $14 million contract to Texas Instruments Inc. to continue developing an inexpensive electrical generator based on silicon photovoltaics and fuel cells. The key to the system's expected low cost, according to the Dallas firm, is the use of doped silicon droplets, rather than costly wafers, to convert sunlight to electric current. When light strikes the droplet electrodes, which are immersed in an electrolyte, the resulting current decomposes the liquid into substances, including hydrogen, that are stored and then used to charge a fuel cell that generates electricity when needed. Before scaling up from a bench model, TI researchers must still answer several technical questions, including the long-term stability of the electrodes in their harsh environment.

Oil company develops motor controller
Exxon Corp., the oil company, says that its new business development subsidiary, Exxon Enterprises Inc., New York, is perfecting a new way to control the alternating current motors heavily used to drive industrial pumps and compressors. It does this by synthesizing ac from direct current to produce ac power of any desired frequency and voltage. The result is that the speed of the ac motors can be controlled over a much broader range than heretofore possible, and with greater efficiency, Exxon says. The work is going on at the Advanced Energy Systems division, Florham Park, N. J. The alternating current synthesizers, as they are called, will not be ready commercially—for motors in the 1-to-200-horsepower range—until the early 1980s. In the meantime, to help it penetrate the market, Exxon Corp. has made an offer worth some $1.17 billion to acquire Reliance Electric Co., the Cleveland, Ohio, motor and controller maker.

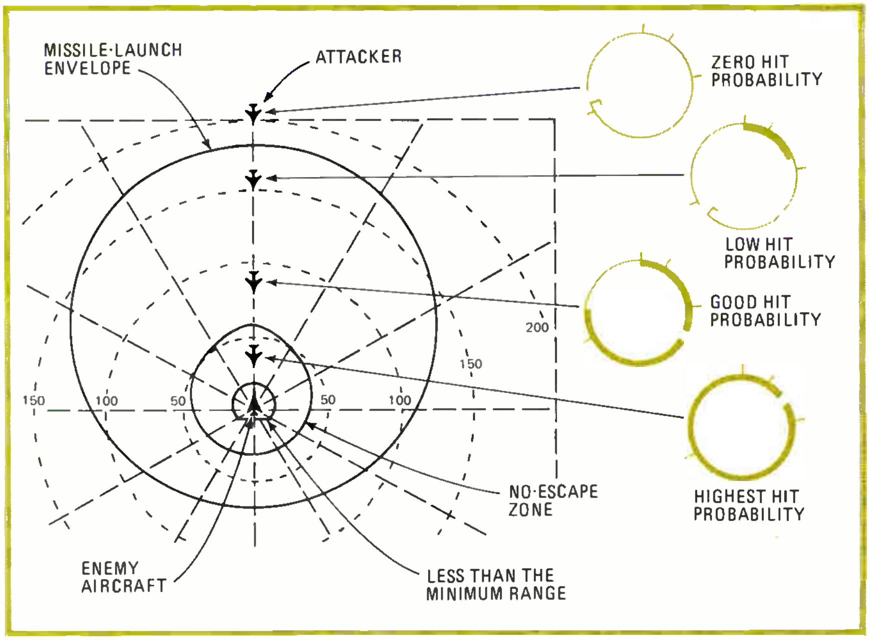
General Automation's Goshorn likely to remain out
Attempts by ousted chairman and president Lawrence A. Goshorn to regain control of General Automation Inc., the Anaheim, Calif., minicomputer firm are given little chance to succeed, industry and financial sources say. Directors of the company late in May voted Goshorn out of both posts, citing, among other things, buildup in inventory and accounts receivable.

The new chairman of General Automation is John B. Conlan Jr., an outside director since 1975. Noted "company doctor" Frank A. Grisanti, a Los Angeles management specialist, becomes the interim president.

Seven receive first 'Semmy' awards
The Semiconductor Equipment and Materials Institute bestowed its first "Semmy" awards to seven outstanding contributors to the semiconductor equipment and materials industry during the Semicon/West '79 exhibition late last month. Receiving the award were: Nicholas DeWolf, founder of Teradyne Corp.; Geoffrey Ryding, a leading designer of ion-implantation equipment; Walter C. Benzing, "the father of epitaxial reactors"; Henry W. Gutsche, developer of the Siemens process for producing semiconductor-grade silicon; Robert Lorenzini, a pioneer in silicon-crystal growth; Frederick W. Kulicke, contributor to advances in wire bonding; and the team of Abe Offner, David A. Markle, Jere D. Buckley, and Harold S. Hemstreet, developers of Perkin-Elmer Inc.'s Micralign projection mask aligner. SEMI, of Mountain View, Calif., says it does not plan to give the awards annually.

tion of the probabilities of a hit. It shows in real time how these probabilities are changing, allowing a pilot to attempt to improve them or to break off a potentially unprofitable maneuver or engagement.

MICF is an outgrowth of the Air Force–sponsored Misval program (for improved missile launch algorithm and display systems development). Administered by the Avionics Laboratory at Wright-Patterson Air Force Base, Ohio, Misval was the Air Force's thrust toward developing improved pilot cues for the air combat arena of the 1980s. MICF is



At a glance. Sequence of arcs shown to attacking pilot on heads-up display (right) indicates chances of scoring a missile hit as the attacking plane approaches an opponent.

General Dynamics' response to Misval.

Around an aircraft in level flight is an egg-shaped space called the missile launch envelope. From outside this envelope it is impossible to get a hit; either the range is too great or the target has too much maneuvering time. The shape and size of the envelope change with the missile used, the altitude, the airspeed, the speed difference between target and attacker, and the planes' maneuvers. In combat, the missile launch envelopes are anything but egg-shaped.

A smaller space surrounds the target intimately and is called the no-escape zone, or "heart"; a missile fired from within the heart will rarely if ever miss. There is a still smaller volume at the center of the heart within which ranges are too short for missiles and where cannon or machine guns must be used.

The goal of an aggressive fighter pilot is to penetrate the heart and fire his missile. His problem is that none of the constantly shifting boundaries of the various zones are displayed for him on a conventional system—and even if they were, their movement and complexity would be hard to interpret.

Enter General Dynamics' display, shown schematically at the right-hand side of the figure above, which the company hopes a pilot will be able to interpret rapidly. A short arc means long odds of a hit; a slightly longer arc means better odds; a full circle means that the pilot has maneuvered into the heart and can fire with confidence.

"The equipment is just about all there now except for reprogramming the computer and adding the display projection optics," says Charles M. Scott, MICF program manager at General Dynamics. "The fire control radar gives data on target range, range rate, and target attitude; the rest is computation."

The computer processes the radar data, adds altitude and airspeed information and missile time-of-flight data, plugs in the potential maneuvers the target might make with a missile approaching, and comes up with the confidence factor. This factor translates into the changing circular display with the circular line lengthening and shortening as the odds change.

"Our test pilots have flown the system," says Scott, "and they like it. It not only gives a feeling for the probabilities, it also seems to reduce pilot workload." —**James F. Brinton**

Packaging & production

Fiber-optic probe checks crystal melt

How do you determine how hot the molten material in a semiconductor crystal growing furnace is? Researchers at Hughes Research Laboratories are doing it by combining an old device and a new one. The old component is a graphite sensor designed to generate light whose magnitude is a function of temperature. The new part is a fiber-optic cable that conducts the sensor's light out of the melt to where it can be measured. Combined, the pair outshines the conventional equipment—a thermocouple connected to a metal cable.

The combination is smaller, offering less disturbance to the flow of material in the melt, and responds faster to temperature changes. It was put together by Douglas E. Holmes, a member of the technical staff of the Hughes facility in Malibu, Calif. He is particularly interested in measuring temperature at the boundary between the molten solution and its container and at other crystal interfaces.

Thermal inertia. Previously, thermocouples made of Chromel and Alumel and protected by quartz or alumina sheaths monitored temperatures in the melts, typically as hot as 800°C. But these had problems because the sheath made the probe so big that it interfered with the free flow of material in the crystal solution. The act of measuring actually deteriorated the process. Moreover, the sheath had a substantial thermal inertia and could not react quickly enough to temperature changes. Holmes's probe gets around these problems.

The sensor and its step-index fiber-optic cable are immersed in the melt; the fiber's other end goes to a photodetector and amplifier. The analog output of the amplifier feeds a chart recorder for a continuous temperature profile. The generated photocurrent is a nonlinear function

MICRO ANALYZER

Small size. Small price. Big features. It's Biomation's new 2710 Data Domain Analyzer.

Here it is, Biomation's new 2710, a versatile, desk top microprocessor data domain analyzer. It's a super software sleuth, with 27 input channels, each 64 bits deep. You can record data, address and up to three control lines to help debug 8-bit microprocessor programs. Or tackle data problems on any kind of logic circuitry.

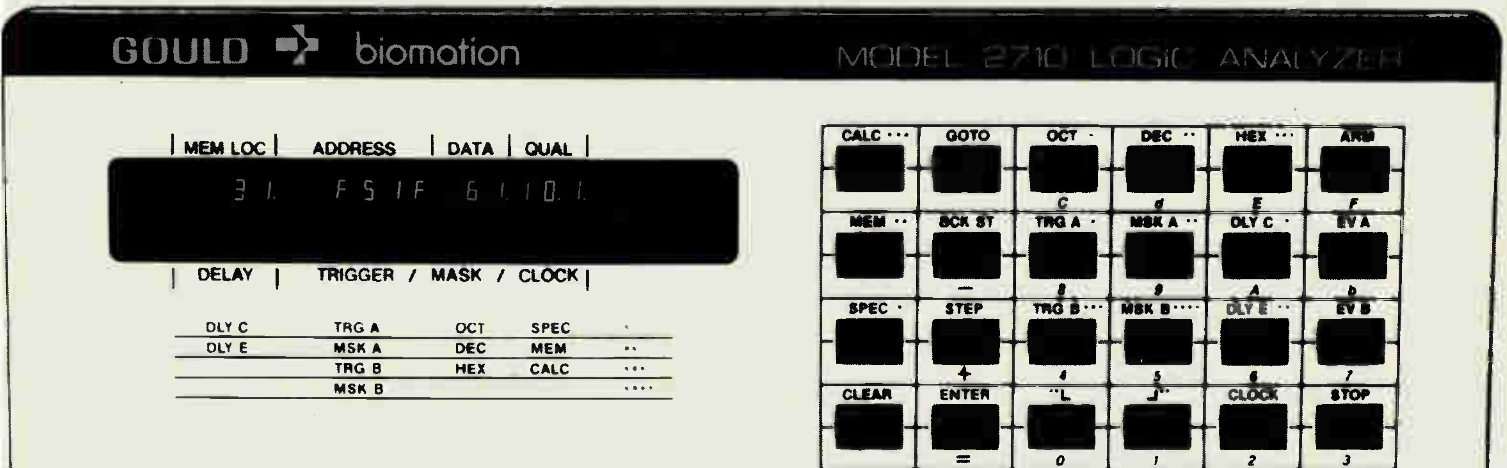
To isolate faults in program loops, use the 2710's two-level combinational triggers to do "nested" triggering.

Each trigger is 27 bits wide, user definable as 1, 0 or "don't care" by masking. To track down bugs in programs made up of repetitious routines you can delay recording of data by up to 9999 trigger events. Or recording can be delayed up to 9999 clock periods. You can even capture up to 31 words of pre-trigger data.

The 2710's 24-key control panel puts all this power at your fingertips. Enter and display in hex, octal or decimal notation. Controls for the 16 digit LED display enable you to scroll through recorded data word by word or to address a specific word. The keyboard even lets you add or subtract in hex, octal or decimal notation, or mixtures.

You can afford to put a 2710 wherever microprocessor data analysis is the task at hand. Your Gould Inc., Biomation representative, listed below, can arrange a demonstration. Or, for more information, write Gould Inc., Biomation Division, 4600 Old Ironsides Dr., Santa Clara, CA 95050. Phone 408-988-6800.

GOULD



BFA
Scottsdale, AZ (602) 994-5400
Creative Marketing
McLean, VA (703) 893-6612, 13

Crockett
Dallas, TX (214) 251-1776
DB Assoc.
De Witt, NY (315) 446-0220

Eastern Instru.
Cornwells Heights, PA (215) 245-6660
EQS
Chesterland, OH (216) 729-2222

Pat Jenks
Hamden, CT (203) 281-0810
Pivan
Chicago, IL (312) 539-4838

Radiation
Port Chester, NY (914) 937-2300
Showalter
Bellevue, WA (206) 455-4922
Beaverton, OR (503) 644-9164

W. A. Brown
Orlando, FL (305) 425-5505
Ward/Davis
Redondo Beach, CA (213) 973-7772

Circle #57 for information

of the sensor temperature, but it is an easy matter to calibrate the whole system by comparing its output with that of a standard thermocouple.

"We used a quartz optical fiber because it both was readily available and has little propensity to react chemically even with the hot materials in a gallium-arsenide crystal-growth setup," says Holmes. The fiber-optic probe has an output power of about 0.01 microwatt. "That was enough to yield an analog signal almost three times larger than that obtained by the usual probe," he says.

The signal-to-noise ratio is a very usable 71 decibels, but even better, the fiber probe responds almost 10 times faster to a temperature change. This speed is a result of the small sensor's low heat capacity—a measure of thermal inertia—and the fact that it need not be protected and separated from the solution by a heavy sheath.

Hughes is patenting the detector, and Holmes hopes to do further work studying the properties of crystal-growing melts and improving the device itself. He says that semiconductor manufacturers, concerned with precise temperature control, will be interested in his device because of its speed, chemical non-reactivity, and minimal disturbance of the mixture. **-Harvey J. Hindin**

Business

California girds against gas crunch

California's widely publicized gasoline crunch may be easing, but officials at companies there are redoubling efforts to come up with measures to ease problems if the crunch recurs. A group of southern California firms, for example, is petitioning authorities for better-balanced gas station hours, and the American Electronics Association in Palo Alto is pushing for relaxation of Federal overtime rules so that companies can go to a four-day week. Hughes Aircraft Co., the state's largest electronics employer, is starting a pilot bus run.

The gas shortage hit hourly production workers most severely. "The stations were open only during hours like from 8 to 10 a.m. and 3 to 4 p.m.," says Donald H. Fuller, chairman and president of Microdata Corp. in Irvine (Orange County). Absenteeism "hurt us."

Fuller asked his counterparts at other firms to badger authorities to balance gas station hours. The letter sent to local, state, and congressional levels by Ryal Poppa, president of Pertec Computer Corp., Los Angeles, was typical. "Productivity and morale among California workers is being negatively affected because of the capricious hours and arbitrary practices used by service station operators in Los Angeles and Orange counties," he wrote.

Already, minicomputer maker Microdata has turned to the four-day, 40-hour week, "something 90% of our employees voted for," Fuller says. Since it eliminates a day's driving to and from work, the move to this schedule could well accelerate. California Computer Products Inc., and Vector Electronic Co. have had the "4/40," as it's called in industry jargon, for several years with excellent results.

Roadblock. But there is a roadblock against this for firms working for the Department of Defense, which requires paying overtime for more than eight straight hours of work. Accordingly, the American Electronics Association asked President Carter to exercise his prerogative to waive the requirement.

Hughes starts its bus service this week from Canoga Park west of downtown Los Angeles to its Culver City headquarters, some 30 miles away. Sixty commuters signed to pay about $10 each per week for the initial run, which is heavily subsidized by the company. Hughes plans to run other routes soon.

Instead of busing, however, other firms are pushing the "Commuter Computer," a program that matches people who live near each other and travel the same routes to common car and van pools. **-Larry Waller**

THIS IS KONTRON

MPP 80S—Field service PROM Programmer from $1995.

We've got universal PROM programmers for your designers, field service technicians and production people. And they're extremely easy to use. Our MPP 80S, a completely self-contained service system, does it all. You've got to see it to appreciate it. A few salient features:

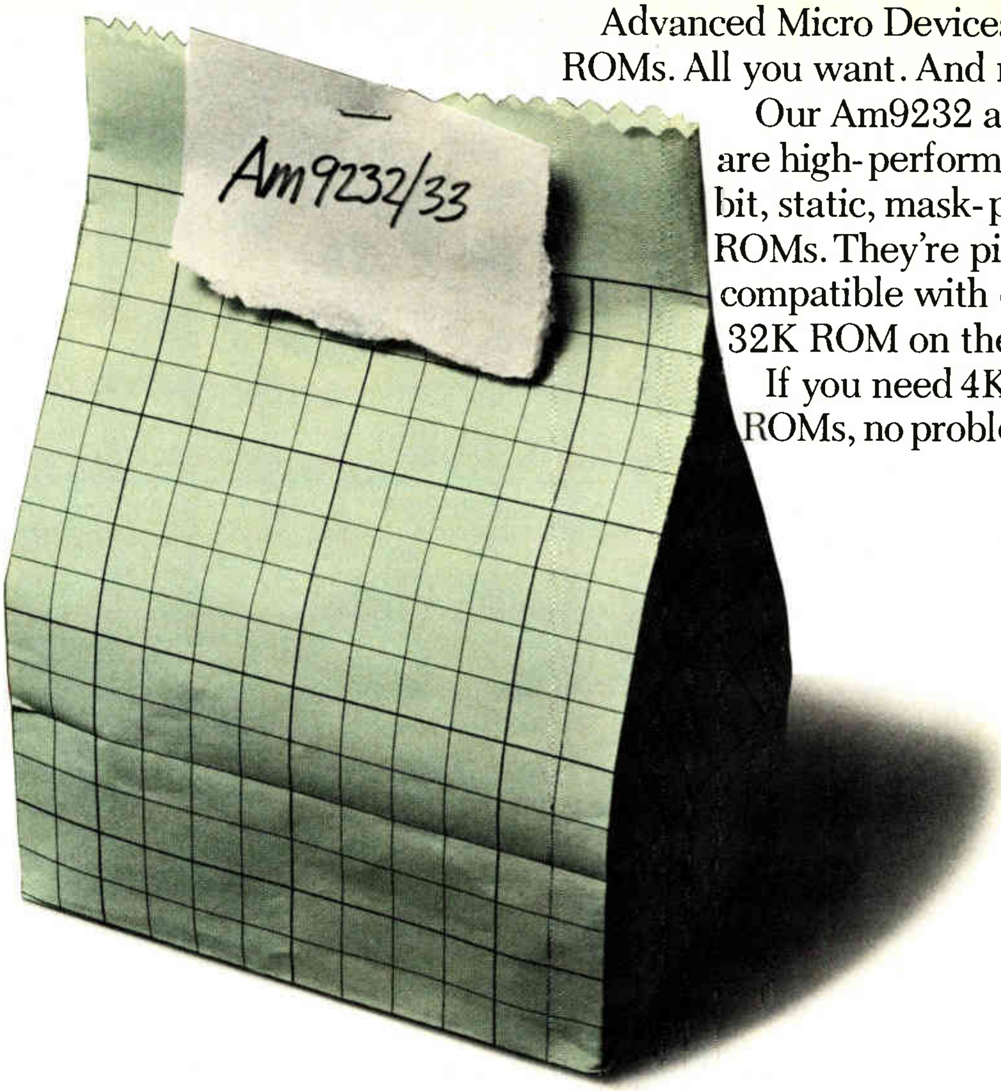
- μP controlled (Z80)
- Compact, easy-to-use personality modules
- Extra storage space for modules, master PROMs and power cord
- Built-in UV lamp

Get our data sheets for technical details and the name of a Kontron sales and service organization near you. Write or call Kontron Electronic Inc. 700 South Claremont Street, San Mateo, California 94402.

PROM PROGRAMMERS:

FOR DATA ON KONTRON® MULTIMETERS, COUNTERS, PROM PROGRAMMERS AND PRINTERS, CALL (800) 227-6854. IN CALIFORNIA CALL (415) 348-7291.

Circle 59 on reader service card



Advanced Micro Devices has 32K ROMs. All you want. And ready to go.

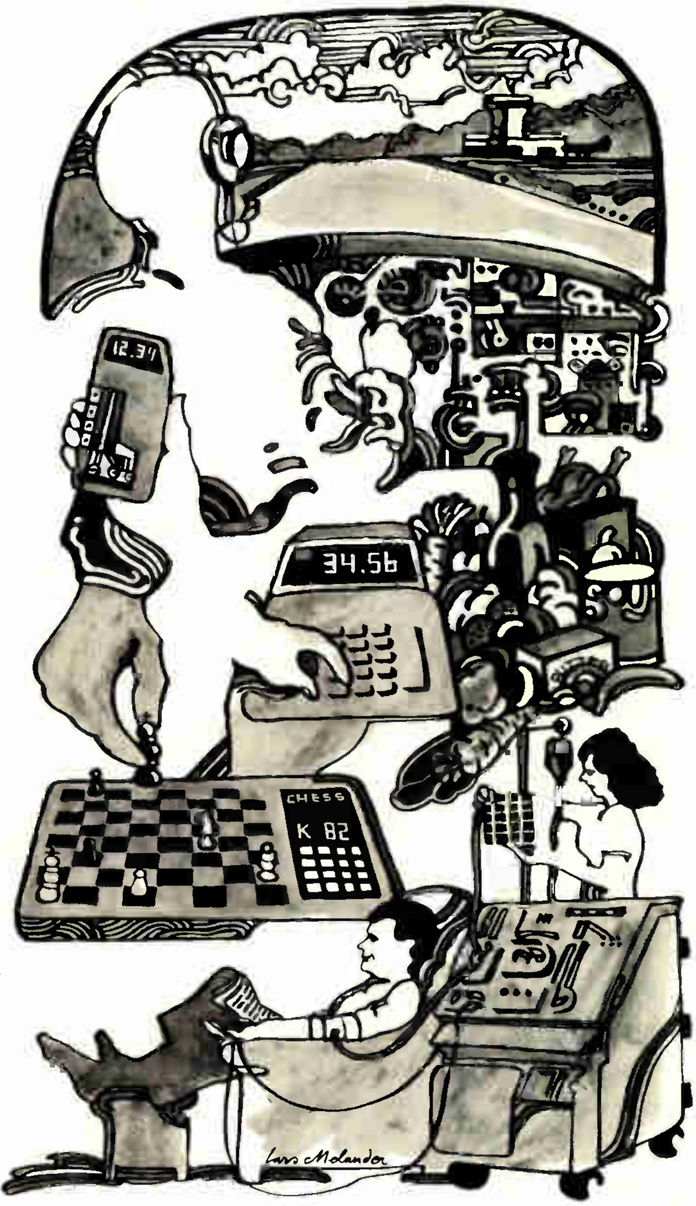
Our Am9232 and Am9233 are high-performance, 32,768-bit, static, mask-programmed ROMs. They're pin-for-pin compatible with every other 32K ROM on the market.

If you need 4K, 8K or 16K ROMs, no problem.

32K ROMs TO GO.

SYNERTEK PERFORMS

5101 CMOS RAMs. Now. In quantity.



Performance and delivery you can count on. That's what you get with our 5101 static RAM. Because one without the other leaves you out in the cold.

Contact your local distributor, or Synertek direct, and you'll get the 5101 RAMs you need. And you'll get them when you need them. With all the features that make the 5101 the industry standard 256 x 4 CMOS RAM— for any low power or battery back-up application.

50 Microwatts is all you need to cover standby power requirements with the 5101. It's pin for pin compatible with the power hungry 2101. Features include chip-enable standby operation, single +5V power supply, power down memory retention (2 volts), separate data inputs and 3-state outputs that are TTL compatible.

If you're not getting the deliveries you want when you need them, call on the people who perform. Contact your area Synertek distributor or Memory Marketing, Standard Products Division, Synertek, Inc., 3001 Stender Way, Santa Clara, California 95051. (408) 988-5611. TWX: 910-338-0135.

Synertek sales offices: **Eastern Region,** 400 Humphrey St., Suite 2, Swampscott, MA 01907 (617) 595-1170; **Central Region,** 4615 W. Streetsboro Rd., Suite 204, Richfield, OH 44286 (216) 659-4195; **Midwest Region,** 2805 Butterfield Rd., Suite 150, Oakbrook, IL 60621 (312) 986-8989; **Western and Northwest Regions,** 20863 Stevens Creek Blvd., Bldg. B3, Suite C, Cupertino, CA 95014 (408) 255-3941; **Southwest Region,** 1000 Quail St., Suite 290, Newport Beach, CA 92660 (714) 752-5535; **Europe,** Honeywell House, Charles Square, Bracknell, Berkshire, England, Rg 12 1Eb. Direct Dial: 011-44-344-24555.

Part Number	Access Time	Standby Current	Guaranteed 2.0 Volt Memory Retention
SY5101L-3	650nsec	200μA	Yes
SY5101L	650nsec	10μA	Yes
SY5101L-1	450nsec	10μA	Yes
SY5101-8	800nsec	500μA	No

Off-The-Shelf Delivery From These Synertek Distributors:

Arrow Electronics	General Radio	Advent Electronics
Kierulff Electronics	Alliance Electronics	Quality Components
Sterling Electronics	Parrott Electronics	Taylor Electric
Zeus	Summit Distributors	Western Microtechnology
Century/Bell	Lionex	Future Electronics
Sheridan Sales	Hall-Mark	Emitter Electronics
Technico	Intermark Electronics	R-M Electronics

SYNERTEK, INC.
3001 Stender Way, Santa Clara, California 95051
(408) 988-5600. TWX: 910-338-0135.

Circle 62 on reader service card

Postal Service pushes ahead with E-mail . . .

The U. S. Postal Service has cranked up its first test of Intelpost, an international facsimile service, with experimental transmissions between Washington, New York, and London. It has done so despite opposition by international record carriers, which oppose post office entry into international electronic mail services. Opponents were unable to get the Federal Communications Commission to stop the tests because the trial does not involve commercial traffic. The USPS's plans for domestic electronic computer-originated mail, or ECOM, a Mailgram-like service, are still stalled at the FCC. But that hasn't lessened Postmaster General Bolger's determination to go electronic: **the Postal Service has given a $2.9 million contract to RCA Corp. for the design and installation of an electronic message service test center** to be installed in Rockville, Md.

. . . while the opposition heats up

Expecting the White House to approve the U. S. Postal Service's plans to go ahead with development of a worldwide electronic mail-transmission system that could cost nearly $2 billion in the next 20 years, American Telephone & Telegraph Co. and other major phone companies gathered in **two emergency meetings in Washington along with their competitors from the computer industry, the specialized carrier services, and interconnection companies.** They drafted a common letter to President Carter objecting to the USPS's entry into electronic mail services.

From Congress, four key members of the Senate Committee on Commerce, Science and Transportation fired off a letter to the White House warning that the Postal Service, as a Government monopoly, should be banned from competing with private firms that are already providing electronic mail service. The cosigners, a foursome with clout, were: committee chairman Howard H. Cannon (D., Nev.), communications subcommittee chairman Ernest F. Hollings (D., S. C.), and Barry G. Goldwater and Harrison H. Schmitt, Republicans from Arizona.

Congress to get new trade rules this month

The Administration hopes to submit its controversial legislation implementing the Tokyo round of international trade agreements by mid-June and expects quick passage. Under the terms of the 1974 trade law, Congress must act within 90 days without amendment. **Antidumping provisions of the proposed bill are already drawing fire from importers,** who see the law as giving up too much to the protectionists.

The Administration's bill sets new standards for imposing countervailing duties when domestic producers can show they have been injured by imports enjoying foreign government policies that affect product standards, procurement, customs valuation, and import licensing, as well as direct subsidies. It also shortens deadlines for making antidumping findings and imposing countervailing duties.

Afcea panel will look at pos/nav systems

Battlefield position and navigation systems that can pinpoint anything from a backpack to a ballistic missile will be a major topic at the June 21 meeting of the Armed Forces Communications and Electronic Association (Afcea) in Washington. Texas Instruments Inc. has put together a panel from industry and the Defense Department to outline requirements for such systems in the 1990s that will meet the air and ground needs of the three services. **Panelists will cover functional needs for precise grid-positioning systems for battlefield use.**

Washington commentary

'Now that we have your ear . . .'

There is a growing consensus that the United States lead in innovative technology is being threatened by efforts in the rest of the world, primarily Japan and the Western European countries. That conclusion, long espoused by U. S. companies seeking Federal intervention, especially those in electronics, is finally being accepted in Washington. The difficult question remaining is what action can and should the Federal government take.

Now that Washington seems to have removed its earplugs, a concise summary of necessary actions was presented by three members of the U. S. electronics community at the recent Trends and Applications Symposium held at the National Bureau of Standards' headquarters in Gaithersburg, Md.

To start with, there is a strong view that the Government should tinker with the competitive environment. It must "overhaul and update the antitrust laws to curb and reverse the loss of competitive situations," said Gene Amdahl, chairman of Amdahl Corp., Sunnyvale, Calif. Large companies contribute, he says, "to the erosion of competition [that is] beneficial to U. S. corporations."

Amdahl pointed out that he is concerned primarily with smaller U. S. companies and not "worldwide companies that use worldwide markets to maintain a stranglehold on world innovations while masquerading as U. S. assets." Perhaps pessimistically, he concludes, "Symptoms show that the U. S. has already lost its lead."

Diffuse technological knowledge

Erich Bloch, vice president of IBM Corp.'s Data Systems division, general manager of its East Fishkill, N. Y., facility, and a member of the corporation's technical committee, says it is not too late to save the U. S. technological lead because the nation is still ahead in agriculture, jet aircraft, and semiconductor and computer technologies.

But examining the electronics areas, he agreed that America's lead is clearly threatened, especially because companies are now concerned with what he calls mature technologies. "The knowledge base is diffused worldwide. In semiconductors, for example, it may now cost more money to enter the field, but it is less risky," he says. Furthermore, he notes, the increasing longevity of computer-architecture families by major manufacturers allows the introduction of compatible equipment.

The question of protectionism kept bobbing up. Stressing a point made by all the panelists, Bloch said the Government must ensure that "trade barriers are equal on all sides." In addition, it should regain its role "as the sophisticated leader in semiconductor and computer technology. The Government is now behind industry when it comes to leading-edge applications of these technologies."

Policies to encourage capital flow did not go unnoticed, either. Reiterating a point made by the other members of the panel (and one made repeatedly by diverse members of the electronics industries) Bloch called for a change in the Government's general policies on taxation "to foster capital formation."

Innovation is more than R&D

But George Heilmeier, vice president for corporate research, development, and engineering at Texas Instruments Inc., in Dallas, said that more than the encouragement of capital formation is needed.

His view, first of all, is that it must be recognized that "research and development is not really synonomous with innovation. In Washington all they think about is R&D." He also prodded the Government to examine its regulatory practices and patent policies. "A more uniform patent policy should be encouraged between various Government agencies. On the surface, the Department of Defense and the Department of Energy have similar patent policies," when it comes to Government-funded developments, but in reality, he says, "they are entirely different."

Finally, Heilmeier feels that the Government must support research. "The Government has a major [responsibility] to support basic research, but it must tread carefully when it comes to applications of technology. One reason the Department of Defense has been so successful in support of market-oriented R&D is that [it's] not just the sponsor, but the consumer as well," he says. Rather than directly funding such development work, he believes that the Government should give tax credits.

All this has been said before. But repeated calls for action in taxation, trade, regulation, patent policy, and research are beginning to be heard, as the symposium illustrates. Still, industry must be wary, somewhere down the road, of too much kindness. As Heilmeier warns, "The Government should not have direct involvement in R&D. If you like what the Government did for Amtrak, Conrail, and the Post Office, you'll love what [it will] do for innovation."

-Anthony Durniak

For film capacitors in volume . . .

talk to the reel people.

SPRAGUE TYPE 192P

Plastic-sleeved PACER® Capacitors

Polyester film. Unique construction . . . extended foil sections terminated in metal end caps to which leads are attached . . . outer protection is tough plastic sleeve. Capacitance values from .0001 to .39μF. Voltage ratings from 80 to 600 WVDC.

Write for Bulletin 2066C or circle number 64

SPRAGUE TYPE 413P

Epoxy-coated FILMITE® 'E' Capacitors

Polyester film. Conformal epoxy coating and excellent lead concentricity permit automatic insertion. Preferred where size and cost are important. Capacitance values from .001 to .1 μF. Voltage ratings of both 100 and 200 WVDC.

Write for Bulletin 2061B or circle number 65

SPRAGUE TYPE 416P

Film-wrapped YELLOW JACKET® Capacitors

Polyester film. Extended foil sections protected against moisture by outer wrap of polyester or polyolefin film. Plastic resin end seals. This construction results in weight/space advantages. Capacitance values from .001 to 1μF. Voltage ratings, 50 to 600 WVDC.

Write for Bulletin 2063C or circle number 131

SPRAGUE TYPE 433P

Epoxy-coated METFILM® 'E' Capacitors

Closely-controlled metallized polyester film. Superior conformal epoxy coating. Low cost for use in entertainment electronics, yet dependable enough for industrial applications. Capacitance values from .027 to 1.0μF. Voltage ratings from 100 to 400 WVDC.

Write for Bulletin 2060A or circle number 132

For complete technical data on the capacitor type(s) in which you are interested, write for appropriate engineering bulletin(s) as shown above, to: Technical Literature Service, Sprague Electric Co., 35 *Marshall St., North Adams, Mass. 01247.*

4SP-8144

SPRAGUE®

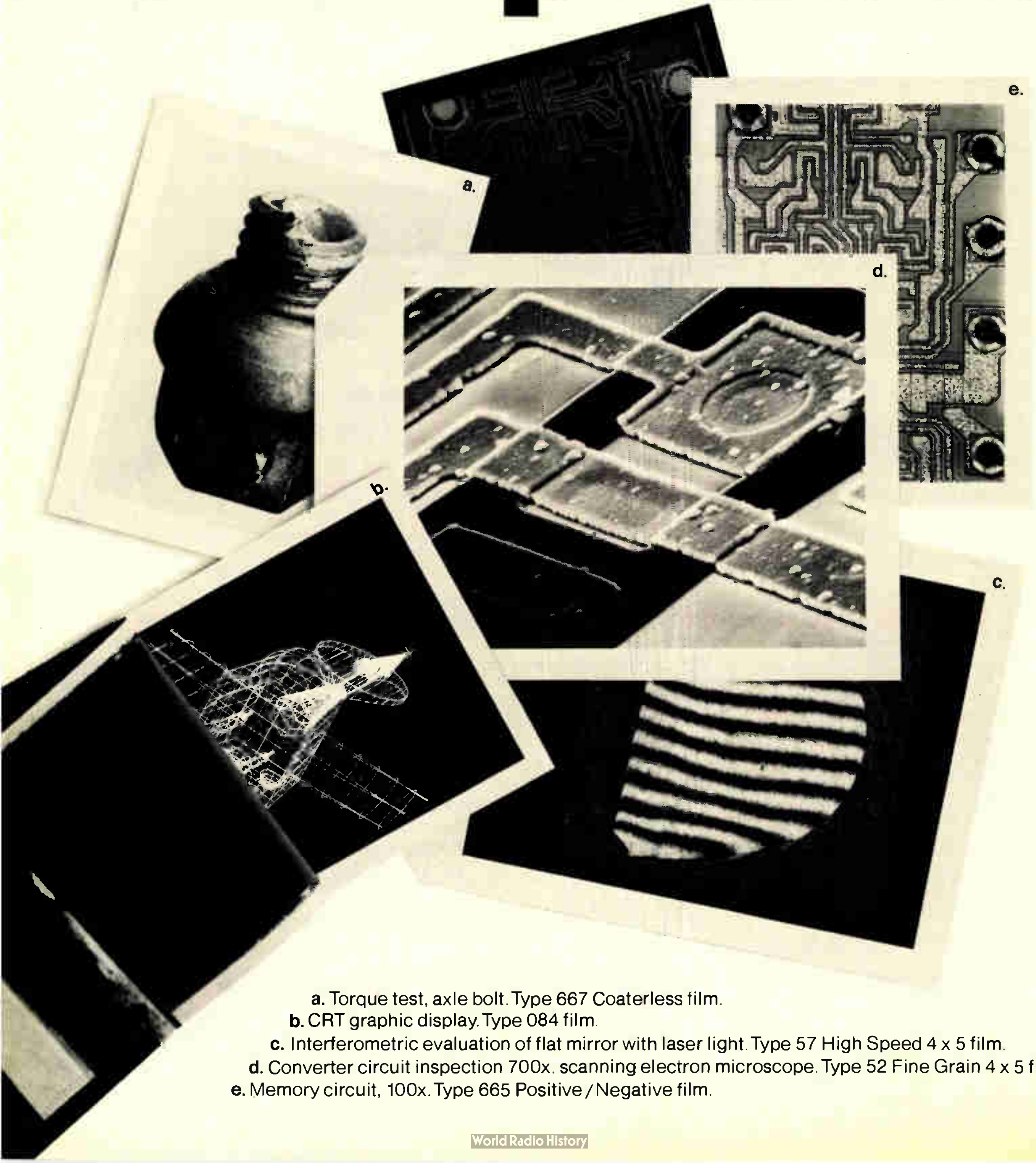
THE MARK OF RELIABILITY

THE BROAD-LINE PRODUCER OF ELECTRONIC PARTS

a General Cable subsidiary

'Sprague' and '②' are registered trademarks of the Sprague Electric Co.

Technical for impatient



a. Torque test, axle bolt. Type 667 Coaterless film.
b. CRT graphic display. Type 084 film.
c. Interferometric evaluation of flat mirror with laser light. Type 57 High Speed 4 x 5 film.
d. Converter circuit inspection 700x. scanning electron microscope. Type 52 Fine Grain 4 x 5 film
e. Memory circuit, 100x. Type 665 Positive / Negative film.

photography people.

If you need photographs of your work, why sit around waiting for them? With Polaroid instant photographic equipment you get immediate results.

Our wide range of equipment lets you record everything from microbes to metal stress tests. With Polaroid self-developing films you can have professional quality results in color in 1 minute, or in black and white (with or without a usable negative) in seconds. And our equipment is simple to use. So you can take the photographs you need without needing to know a lot about photography.

The MP-4 Multipurpose camera (1) is a versatile, self-contained photo studio anyone can operate. It uses 14 different Polaroid instant films to keep you out of the darkroom. And it copies, delivers close-ups, reductions, macrophotographs and photomicrographs, to bring your answers to light.

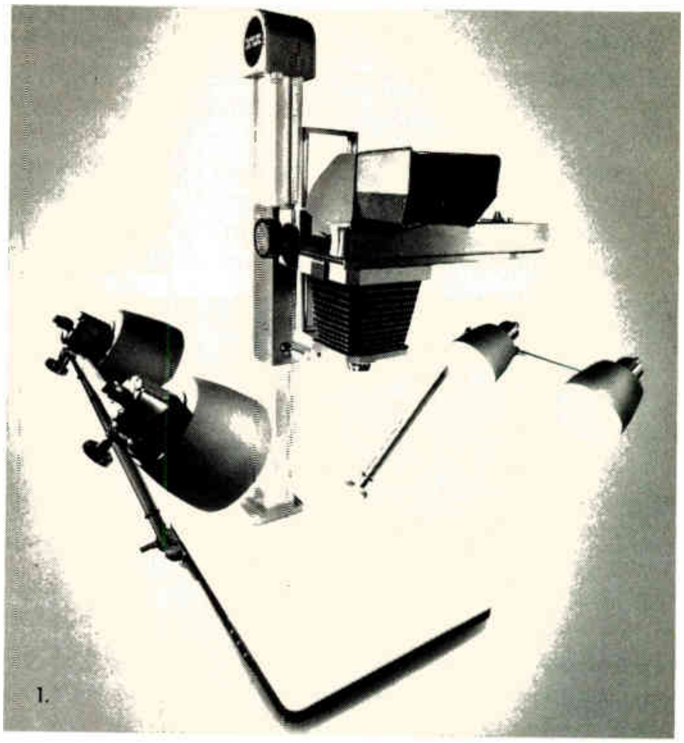
Our CU-5 Close-up camera (2) is a lightweight, hand-held system you can take almost anywhere and get instant photos from ¼ to 3 times life size. Exposure is easy to set, lighting is built in and framing is automatic. So all you have to think about is the picture. You can even use the CU-5 to capture a transient image on a cathode ray tube.

Many cameras and instruments can be adapted quickly and easily for instant photography with Polaroid film holders (3). They come in 3 models to handle 3 different sizes of Polaroid Land film (3¼ x 4¼, 4 x 5, and 8 x 10 in.), so you can get instant results in almost any format.

Many other manufacturers of cameras and instruments also supply Polaroid Land camera backs that adapt their equipment to instant photography. These backs use 9 different convenient Polaroid pack films, so you can see your project in a new light.

To find out how you can get instant results, mail the coupon below. Or if you're a *very* impatient person, call us toll-free from the continental U.S. at 800-225-1618 (from Massachusetts, call collect 617-547-5177).

And stop tapping your foot while you wait for your photos to come back from the lab.



1.

2.

3.

Polaroid
Instant Laboratory Pictures

Polaroid Corporation
Industrial Marketing, Dept. A435
575 Technology Square
Cambridge, Mass. 02139

I'm impatient. Please send me more information on how I can use Polaroid instant photography in my work.

Name____________________

Title____________________

Company____________________

Address____________________

City__________ State________ Zip________

Current camera or instrument____________________

Application or need____________________

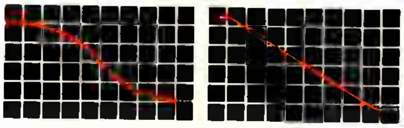
Now, a dual variable op amp that doesn't need extra devices for extended linearity.

Simply add 5 resistors to the circuit with the new RCA 3280 dual variable op amp and you get the same extended linearity (right) as with the more complicated circuit.

Costs are down, too. Because the 3280 is a dual, your "per device" costs are reduced about 25 percent over our previous 3080 design.

Other important features include low input offset voltage. (One fourth as much as previous designs.) And much lower noise which extends the range of applications by allowing operation with low input signals.

The new CA3280 also has a wide dynamic input voltage range, from 5mV to greater than 10 V.



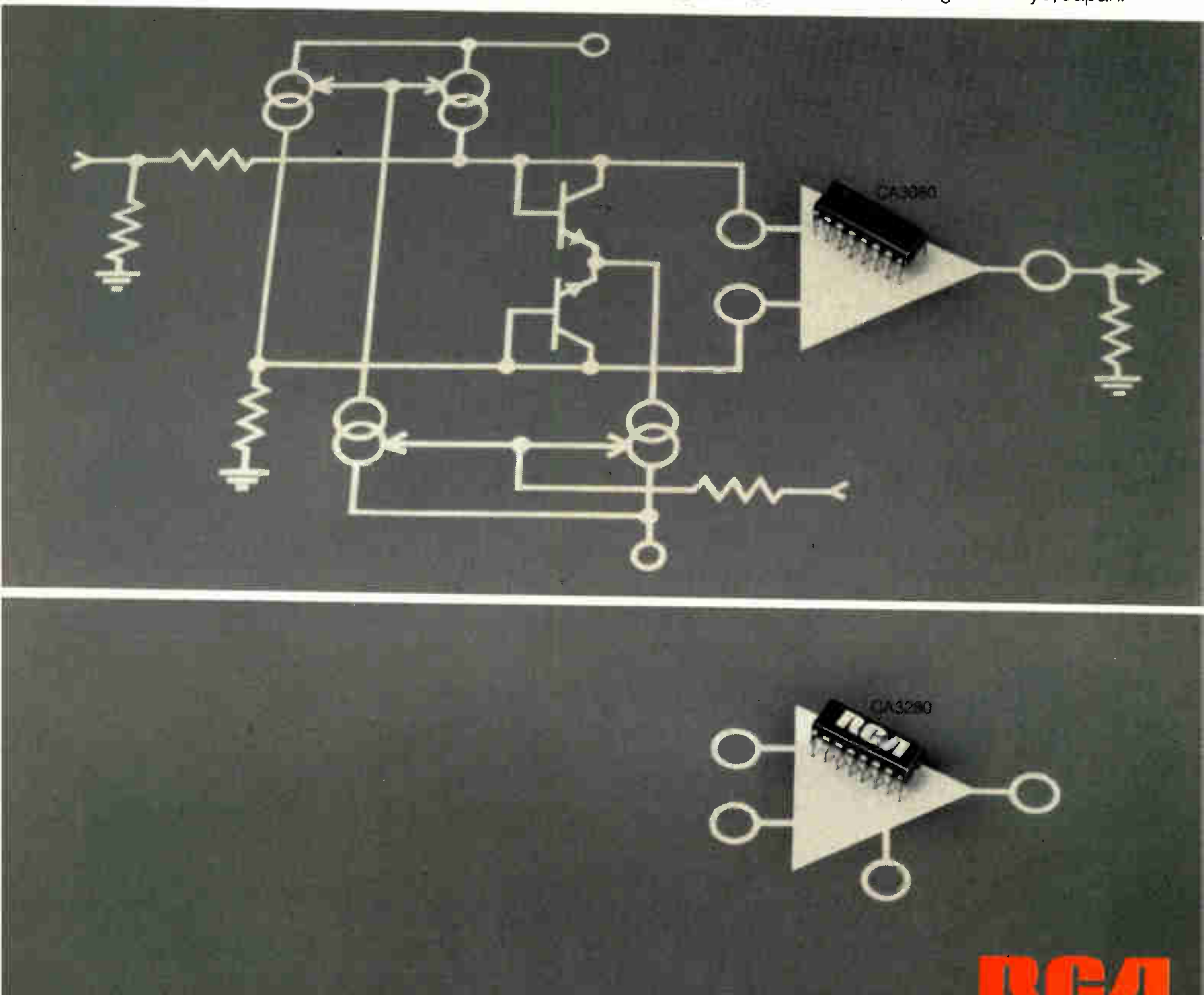
And a low offset voltage drift.

Produced with the Gold CHIP process, the CA3280 is in stock and ready for immediate delivery.

Price for 1000 and up is $0.89 (optional with distributors).

For more information, contact your local RCA Solid State Distributor.

Or contact RCA Solid State headquarters in Somerville, New Jersey. Brussels, Belgium. Tokyo, Japan.



Circle 68 on reader service card

Gain made in making electrochromic displays more stable

IBM Ltd. in England says it has made significant progress in overcoming the long-term chemical stability problems that have dogged electrochromic displays. The development is a proprietary liquid electrochromic material, which is sandwiched between a glass window and a silicon wafer 2½ in. in diameter, say researchers at IBM's Hursley Park Research Centre near Winchester. Such an approach has promise for the long-sought flat-panel display. **The researchers have put together a 64-by-64-element display producing violet characters on a 1-in.^{2} white background.** Each picture element is controlled by a field-effect transistor—all 4,096 FETs are formed in the wafer together with line- and column-address decoding circuitry so that only 20 leads are needed to drive the display. Switching time with a ±2-V read/write voltage is from 2 to 15 ms. IBM is working on improved switching times and has achieved ½ ms but with loss of image retention.

Laser diode features double heterostructure, V-groove design

Scientists at AEG-Telefunken's research laboratories in Ulm, West Germany, are perfecting a V-groove semiconductor laser diode. Specified for an output of 5 mW, it has a double heterostructure in which gallium arsenide and gallium aluminum arsenide are used as the active material on a GaAs substrate. **The light-emitting area measures only about 1 μm by 3 to 5 μm: the smaller the area, the smaller the resulting light spot** and hence the smaller the diameter of the glass fiber to which it may be coupled. A 1-gigabit-per-second pulse rate permits transmission of 15,000 telephone channels over a single-mode optical fiber, says Stefan Maslowski, head of the development team. Like the double-dovetail planar diode from RCA [*Electronics*, April 12, p. 52], the V-groove laser has better performance then conventional designs; for example, for outputs of up to 100 mW, there are no kinks in the power/current characteristic curves.

Weather radar from Thomson at Paris air show

Thomson-CSF's surface radar division is using the June 9–17 Paris air show to introduce the prototype of a C-band weather radar, the TRS 2730, for precision tracking of clouds and precipitation. It is the first meteorological system from the division. Four of them have been ordered by the French national weather service. **Thomson-CSF will also showcase its Weather Channel equipment.** Intended as an add-on for sophisticated air-traffic-control radars that cancel out precipitation echoes, the Weather Channel picks up those echoes and processes them digitally for remote display on air-traffic-control monitors.

Memory boards using plated wire aim at DEC units

Plated-wire memories for three models in the PDP-11 and LSI-11 computer families are bowing at this week's National Computer Conference in New York. Coming from a Japanese firm, Toko Inc., the boards are plug-compatible with semiconductor memory boards for the Digital Equipment Corp. computers and range in size from 4 to 64 kilowords (with an 18-bit word size). **The nondestructive readout mode inherent in plated-memory boards ensures data integrity,** an especially valuable attribute in control environments. For the LSI-11/2 microcomputer, the Tokyo firm offers the NDRO-11/2 in 4- and 8-kiloword versions; for the LSI-11, it has the NDRO-11 in 4-, 8-, and 32-kiloword versions; and for the PDP-11 minicomputer, Toko offers the NDRO-11P in 16-, 32-, and 64-kiloword versions. Sample-quantity prices range from $700 to $2,800.

C-MOS on sapphire slated for UK military aircraft

Complementary-MOS-on-sapphire circuitry will be taking to the air in future British military aircraft. Four custom C-MOS-on-sapphire large-scale integrated circuits will make up most of the circuitry **in a new data interface that will link each avionics package in a plane to a single high-speed data bus.** The LSI microcircuits will come from GEC Semiconductors Ltd. in Wembly, which will use a C-MOS-on-sapphire process from the neighboring General Electric Co. Ltd. research laboratories. The terminal, which is being developed by the British Ministry of Defence, will feature GEC Semiconductor thick-film hybrids during the early phases of its development.

Portable VCR weighs 6.8 kg with battery

A portable video cassette recorder significantly smaller and lighter than existing portable VCRs is coming this month from Hitachi Ltd. Moreover, in home operation it will provide five playback modes ranging from double speed to still picture. To be sold initially in Japan and by year's end in the U. S. under the RCA label, the V-7000 is 60% the size of the next smallest unit, says Hitachi. **Weight with the 1.1-kg battery is 6.8 kg, about 80% that of other portable VCRs.** Helping to pare down the VCR are direct-drive brushless motors for the head drum and capstan, more hybrid integrated signal circuits, and a 4-bit microcomputer system controller. A similarly sized tuner and power supply–battery charger that includes a 10-day programmable clock-timer convert the V-7000 into a line-powered unit; in Japan it will add $295 to the VCR's $1,036 price tag. To complete the system, the Tokyo firm is offering a $991 color video camera featuring its trielectrode color vidicon [*Electronics*, March 16, 1978, p. 72].

UK, U. S. firms joining to make disk memories

The long-planned British-American joint venture to make disk memories is about to emerge. The new English firm will be 76% owned by England's Data Recording Instrument Co. (DRI) and 24% by the U. S. firm Magnetic Peripherals Inc., itself 70% owned by Control Data Corp., 27% by Honeywell, and 3% by CII–Honeywell Bull. Magnetic Peripherals will provide technical and manufacturing know-how, and DRI will provide the funds, aided by $16 million from the British government. **Marketing of the disk memory systems will be by DRI and Magnetic Peripheral's parents.** The new venture may well be the last backed by venture capital funds from the National Enterprise Board; the new Conservative government may direct the board to leave such activities to private enterprise.

West Germans selling Moscow Olympics gear

The 1980 Summer Olympics in Moscow continue to generate business for West German electronics producers. The USSR has just placed an order for 39 professional video tape recorders with the television equipment division of Robert Bosch GmbH. Earlier, the ITT affiliate, Standard Elektrik Lorenz AG, won a contract to deliver 117 of **its coin-operated NT2000 telephones packed with microelectronics that allow users to dial anywhere in the world directly** [*Electronics*, Oct. 16, 1978, p. 111]. And Kalle, a subsidiary of Hoechst AG, is to deliver to the Soviets some 150 of its Infatec 6000 telecopying equipment, which transmits the information on a 8½-by-11-in. page in less than a minute.

YOURS FREE

New, hot off the press HEATHKIT® CATALOG

with the newest ideas in electronics

Read about nearly 400 exciting do-it-yourself kits including Amateur Radio Equipment, Personal Computers, Home Improvement Products, Stereo Hi-Fi, Programmable Color TV, Automotive, Aircraft and Marine Accessories, Test Instruments, R/C Modeling, Self-Improvement Programs and lots more! Something for everyone, and everything is easy to build and fun to use — it's the Heathkit way!

Send for your FREE catalog today.

Heathkit products are displayed, sold and serviced coast-to-coast at Heathkit Electronic Centers. (Units of Schlumberger Products Corporation). See the white pages of your phone book. If coupon is missing, write Heath Company, Dept. 510-540, Benton Harbor, Michigan 49022.

HEATH
Schlumberger

Heath Company, Dept. 510-540
Benton Harbor, Michigan 49022

FREE CATALOG

Please send me my FREE Heathkit Catalog. I am not currently receiving your catalog.

Name ____________________

Address ____________________

City ____________________ State ____________________

CL-699 Zip ____________________

LOW BOUNCE!

Low level switching for dry circuits

For years, EAO Series 01 and 31 Lighted Pushbutton Switches have been supplied for applications in control panels, instrumentation, telecommunications, computers and medical electronics.

Now both the 01 and 31 Series are available with low level switching elements that can handle the dryest of dry circuits . . . from micro-volts and micro-amps up to a maximum of 100 mA at 60 volts. This is made possible by our unique contact design . . . 4 gold plated contact fingers of different length . . . contact bounce less than 100 micro-seconds.

This low level, low bounce switch is perfect for direct interface with today's requirements of electronic circuitry. With 5 million operations and a price no higher than our standard 01, 31 units.

Low level lighted pushbuttons come with round, square and rectangular bezels, momentary or maintained action with universal terminals for soldering, P.C. board mount, or quick connect termination.

The original and still the finest Series 01 and 31 from EAO SWITCH CORPORATION.

EAO Switch, you can feel the difference.

EAO SWITCH CORPORATION

255 Cherry Street/Milford, CT 06460/(203) 877-4577/TLX-EAO SWITCH MFRD 964347

Data-access system searches by content, slashing response time

by Kevin Smith, London bureau manager

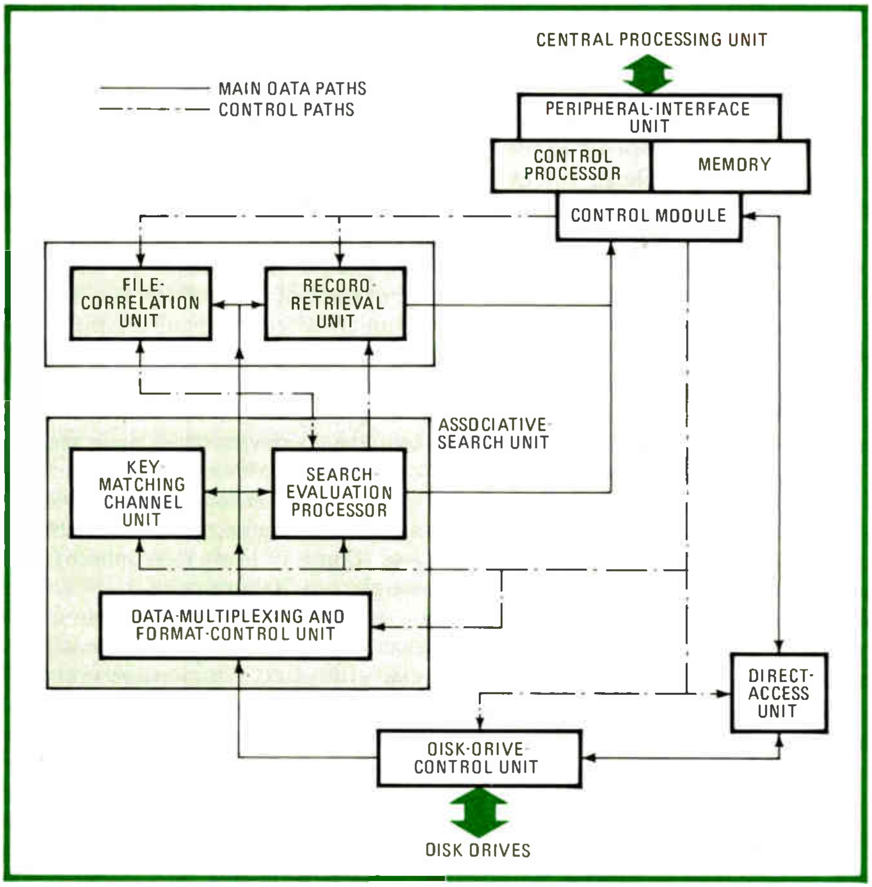
Content-addressable file store uses key index words and moving multihead assembly for 4-Mb/s data-transfer rate

Just as the use of computers is increasing, so, too, is the amount of information stored in peripheral devices such as disk drives. But the volume of information is so tremendous that it is beginning to overwhelm the capability of traditional storage devices to manage and access it quickly.

Hardware from International Computers Ltd.'s Research and Advanced Development Centre, Stevenage, may solve that problem by cutting the mainframe's workload by 90% or more and hence slashing the response time.

The brainchild of the late Roy Mitchell, the new hardware, called the content-addressable file store (CAFS), has been nursed along for over six years with funding from the government's Advanced Computer Techniques Project and will be commercially released soon. A prototype of the system, used to speed the telephone system's directory inquiry service, is being evaluated by the British Post Office [*Electronics*, Jan. 19, 1978, p. 61 or 63].

Keys. Content-addressable memory systems, as their name implies, access information filed on a disk drive not by the traditional numerical address, but by examining the contents of the files. Special logic circuits, told what key index word to look for, compare this reference with the information on the disk and transfer out the matching files.



Keying in. Content-addressable film store (CAFS) from International Computers Ltd. employs three search levels: the associative-search unit, the record-retrieval and file-correlation units, and the control processor. The use of key words unburdens the mainframe.

By relieving a computer of the chore of retrieving large numbers of files by numerical address and then examining the contents, such techniques allow it to perform more productive tasks. Furthermore, a single file can be accessed for multiple purposes using different key words.

Uses include data-base management systems, bibliographic applications, on-line interrogation systems, police files and military intelligence, and any others requiring fast searches of disk or secondary stores.

Many see content-addressable memories as necessary to managing the growing data bases. As a result, they are the subject of research both here and in the United States, but the ICL unit appears to be the closest to becoming a commercial reality.

Giving a prime example of the system's speed, Vic Maller, who now heads the CAFS project, says, "A frequently used file-tabulation program, say, of 60 million characters, would take 35 to 40 minutes on a conventional mainframe and some 35 to 40 seconds on CAFS."

CAFS is a disk-based file store incorporating a 16-bit-word minicomputer with 64 kilobytes of storage and a moving-head disk drive with an unusually large number of read/write heads. This gives a 4-megabyte-per-second data-transfer rate, sufficient to swamp all but the most powerful computers.

Multiheaded. In developing its system, ICL took a 60-megabyte disk drive and added up to 10 heads. Up to eight such multihead drives and six single-head drives may be connected to any one controller, giving a total storage capacity of 840 megabytes. However, the commercial system should come with standard 200-megabyte storage capacity. Three layers of control logic perform the searching (see diagram).

In the engineering development model, up to 12 disk-drive channels are multiplexed onto a byte-wide bus operating at 4 Mb/s. The lowest search level, the associative-search unit, processes this data stream on the fly without buffering. Its operating speed comes from a series of identical key-matching channels.

Matching. Each of the channels has programmed into it a key word and looks for a match between that word and the corresponding field in the record being examined. (Facilities for masking down to the bit level are also provided.) When a match is found, the search-evaluation processor is kicked into action.

This is a special-purpose Boolean logic processor microprogrammed to evaluate the logical relationships between terms—such as equivalence, greater than, or less than—in the selection expression. The unit is fast enough to operate without block buffering; the searching rate is therefore limited only by the number of channels simultaneously reading and the electromechanical properties of the disk drive.

This processor identifies those records of interest to the user. At the second level, the record-retrieval unit abstracts from each record only those data fields designated by the user, and the file-correlation unit automatically correlates information from different files with no need to sort and merge. The record-retrieval unit then sends abstracted data to the memory of the process controller—the third search level—for additional formatting before it is passed to the mainframe.

West Germany

Color TV camera pares down by using only one pickup tube

In electronic design, the pursuit of smallness is what it's all about—be it to achieve greater circuit density, lower power consumption, or more compact equipment. Mainly the last goal was on the minds of engineers at Siemens AG when they developed the Sicolor K80 color TV camera. The result of their efforts is what the Munich-based company claims is the smallest color TV camera available.

Built around a single 1-inch vidicon pickup tube, the camera is a cylindrical device that measures 5 centimeters (about 2 in.) in diameter, is 22 cm (roughly 8.5 in.) long, and has a volume of only 432 cm³—less than 1 liter (see photo). It weighs but 700 grams.

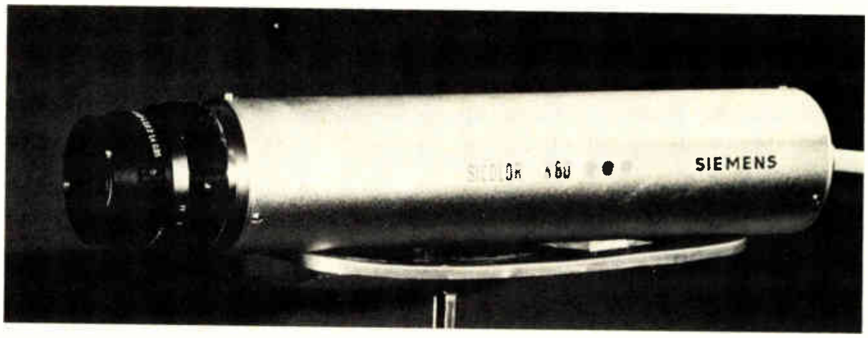
According to Josef Bohn, an engineer involved in its design, the K80 is also the first single-tube version made in Europe. It is designed primarily for medical applications where compactness is a key requirement. In microsurgery, for example, a normal-size camera would be in the surgeon's way. Other uses are in the industrial field.

Compactness was achieved essentially by three design considerations, Bohn explains. The most obvious is the use of just one pickup tube instead of the three—one for each color—commonly employed. The second is the use of printed coils for the camera's deflection system. Third, the camera incorporates only the tube, the deflection system, and the video preamplifier; all other circuitry needed to produce a picture on a screen is designed into a control unit to which the camera is connected via a 5- or 15-meter cable.

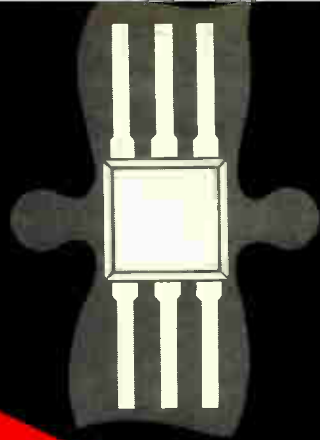
The camera's operation is based on Siemens' Interplex concept. This scheme involves two color filters each made up of two sets of stripes 22 micrometers wide. They are arranged so that the stripes of one are offset from those of the other by 45° to form an array of equilateral diamonds. The filters are mounted on a piece of film pasted onto the face of the tube and covered with a photosensitive material to form the tube's target.

The stripes of one filter block blue light and those of the other block red light; they alternate with clear

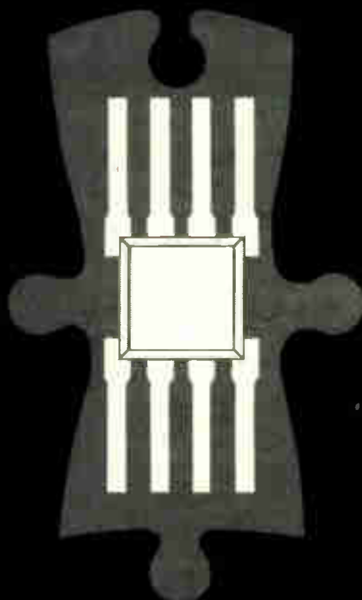
Shrunken. Siemens' Sicolor K80 color TV camera cuts down size by using only one tube. Placing part of the circuitry in a separate control unit contributes to a volume of only 432 cm³.

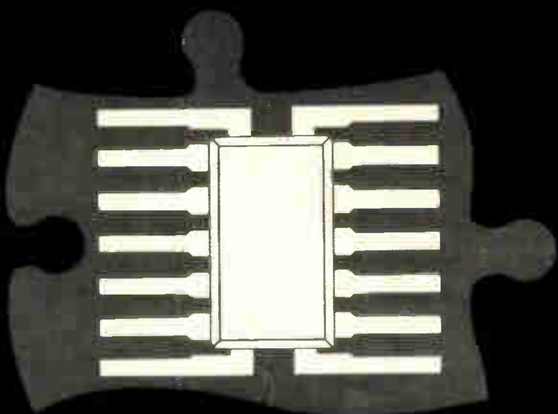


could our low voltage linears be the missing pieces to your puzzle?



If you have struggled with the problems of designing high quality audio amplifiers for 1 to 2 V operation, then puzzle no longer. We offer a wide range of integrated circuit amplifiers with linear and compression output features that might just fit your application. Our devices consume very little power, deliver high performance and come in sub-miniature packages. Contact one of our Sales Engineers today; he may have the missing piece to your puzzle.





Linear Technology Inc.

3435 LANDMARK ROAD, BURLINGTON, ONTARIO, CANADA L7M 1T4   TEL. (416) 335-2996   TELEX: 061-8525

(white) transmission areas. As the electron beam scans the target, an optically coded video signal is produced that is made up of a luminance component with the necessary color information and a chrominance signal component at 4.43 megahertz. This value, typical for PAL, is determined essentially by the stripe width and the scanning speed.

After passing through the camera's preamplifier, the coded color signal is fed to the control unit. There it is converted into a composite color signal that can be shown on any commercially available receiver.

Better. Interplex's big advantage over competing schemes is that it eliminates cross-color interference without reducing bandwidth. Other single-tube cameras eliminate cross-color interference with optical low-pass filters, cutting bandwidth for the luminance information, Bohn says, and hence reducing resolution.

Siemens' concept, on the other hand, uses a comb filter. Housed in the control unit, it has a delay of 64 microseconds, also typical for the PAL standard. The chrominance signal of one line is passed through the filter, and that of the next line bypasses it. Then, in a subtraction process involving the delayed and nondelayed signals, all signals with a phase shift of exactly 0° are eliminated. This results in cross-color suppression.

The Sicolor K80 camera comes with an antimony-trisulfide tube. Even operating at a daylight level as low as 340 lux, it takes an adequate picture. With an optional cadmium-selenide tube, the camera becomes three times as sensitive. To be delivered shortly, the camera will sell for $7,600 to $10,200, depending on accessories. **-John Gosch**

Canada

Government opens up phone access to a specialized private carrier

The Canadian government has ruled that Bell Canada must open up its telephone communication network to CNCP Telecommunications Inc., a specialized private carrier service, and CNCP is happy at the victory. But a Pandora's box may have been opened for both CNCP and Bell if other specialized carriers now find business lucrative enough to get in on the act.

The decision, by the Canadian Radio-Television and Telecommunications Commission (CRTC)—the equivalent of the Federal Communications Commission in the U. S.—says that Bell Canada, by far the largest of the Canadian telephone companies, must set up tariffs and hook up Montreal-based CNCP and its subscribers to local switching offices and provide what amounts to all the wiring they would need for total network access.

Industry observers say that the decision was to be expected given the trends in communication industry regulation and the fact that the CRTC has tended to make policy decisions similar to those of the FCC. The major difference seems to be that it lags behind by some years, since the policy issues are usually first raised in the U. S.

Looking. CNCP, a joint venture of Canadian Pacific Ltd. and government-owned Canadian National Railways, provides a gamut of services to its customers, including computer and private-line voice communication and transmission of various printing services such as facsimile. Thus it is clear that both Canadian and U. S. specialized carriers will now take a careful look at Canadian business opportunities. For example, untapped markets may well exist with small to intermediate-size users who will now have a dial-up access system already in place.

The decision does not impinge at all on Bell Canada's public-telephone business, which the CRTC was careful to protect. According to Raymond Cyr, executive vice president for administration, the company is pleased that the commission recognized the importance of its position in public telephones. It is considering whether to go along with the decision or pursue the issue through the courts or the executive branch of the government.

Tony Kuhr, president of CNCP, hailed the decision as a spur to his company's growth, since Canadian communication needs are increasing. He noted that CNCP is not getting something for nothing and will pay both tariffs and installation charges like any other Bell customer.

Flushed with this victory, CNCP is expected to pursue the same issue with the British Columbia Telephone Co., owned by General Telephone & Electronics Corp., and maybe even with the provincially owned telephone companies.

The latter has the potential for political and regulatory problems, since these companies are provincial Crown corporations ultimately responsible to their provincial governments. In contrast, the CN portion of CNCP is a federal Crown corporation. The outcome would of course strongly depend on what services the provincial companies' customers need. **-Harvey J. Hindin**

France

Thin film makes head read/write

Right now, 1 bit of semiconductor memory costs 1,000 times more than 1 bit of magnetic memory. And although the cost per bit of memory chips halves every 18 months, the same is true for magnetic storage, maintains Jean-Pierre Lazzari, head of the magnetic recording laboratory at CII–Honeywell Bull, the Paris-based computer company. So except where fast access times are mandatory, magnetic tapes and disks will continue to get the call for mass storage, as he expects the 1,000:1 ratio to hold for the next 20 years.

One key to maintaining that ratio

5 DAY DELIVERY

Microcomputer Analog I/O Systems

For:

DEC LSI-11 & LSI-11/2 (FORTRAN SUBROUTINES AVAILABLE for RT-11)

DEC PDP-11 UNIBUS

INTEL SBC-80 Series & NATIONAL BLC-80 Series

ZILOG MCB Series (Z-80)

MOSTEK/PROLOG STD BUS

COMPUTER AUTOMATION LSI 2, 3, & 4 Series

Precise analog I/O for any micro.

Data Translation manufactures the largest array of analog I/O modules and systems in the industry.

Standard interfaces for every major microcomputer. From isolated inputs to extremely high-speed inputs. Designed to meet your most stringent data acquisition needs in a wide range of measurement and control applications.

Highly reliable systems in only 5 days.

Our goal is to ship the most reliable analog I/O systems available anywhere. That's why we go to such great lengths to ensure the highest reliability.

Delivery? We doubt that you'll find any company faster than **DATA TRANSLATION.**

We assure five-day delivery. When you order on Monday, we deliver by the next Monday.

No excuses. No delays.

SEND for Full Technical Data or Call us.

GSA Contract No. GS-00S-64219

DATA TRANSLATION INC
4 Strathmore Rd., Natick MA 01760
(617) 655-5300 Telex 948474

Circle 77 on reader service card

U.S. SALES OFFICES: AL (404) 455-7222; AZ (602) 944-5400; CA (408) 244-5508, (213) 681-5631; CO (303) 371-2422; CT (203) 622-9191; DC (301) 636-1151; FL (305) 274-4899, (813) 725-2201; GA (404) 455-7222; ID (801) 466-6522; IL (312) 297-2616; LA (713) 780-2511; MD (301) 636-1151; MN (612) 488-1129; NC (919) 723-8102; NJ (516) 488-2100, (609) 428-6060; NM (505) 292-1212, (505) 523-0601; NY (516) 488-2100; OK (405) 528-6071; PA (609) 428-6060, (412) 327-8979; SC (803) 233-1469; TN (404) 455-7222; TX (512) 451-5174, (214) 661-0300, (505) 523-0601, (713) 780-2511, (512) 828-2251; UT (801) 466-6522; WI (414) 567-0444; CANADA (416) 625-1907, Authorized Distributor - First Computer, Chicago (312) 920-1050.

is new recording heads. As a step in that direction, CII–Honeywell Bull has devised a so-called "integrated" read/write head fabricated with thin-film techniques. Two other keys are thinner metallic disk coatings and new methods of storing magnetic flux blocks, on both of which CII-HB is also working, Lazzari says.

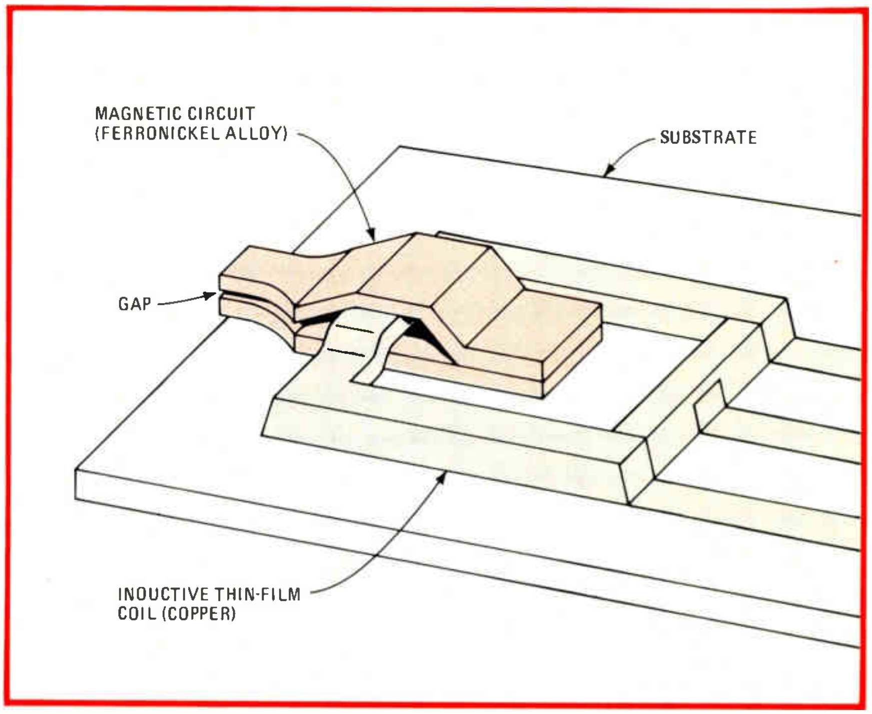
(Thin-film recording heads are under development at several disk manufacturers in the U. S. and abroad. IBM is apparently using such a head on its top-of-the-line 3370 disk drive [*Electronics*, Feb. 15, p. 85], but will not release details.)

By the year 2000, advances in all three areas will likely have pushed bit densities up to 5×10^9 bits per square millimeter. That is more than 1½ million times the density of IBM's industry-standard 3350 disk drive, for example.

Resemblance. The thin-film techniques used by CII-HB for its head are very similar to those used for semiconductor manufacturing. The main difference is that the integrated head is made entirely using a single–bell-jar process. Thus there is relatively little contamination and a high yield—better than 85%.

The heads, 912 per substrate, are made of 100 masked layers of copper, quartz, and an alloy of iron, nickel, and chromium. The copper is used for the inductive coil; the quartz serves as an insulator; and the ferronickel alloy makes up the magnetic circuit, replacing the ferrite body of conventional recording heads (see figure).

The final thickness of such a head, with 20 turns in the coil, is a mere 10 micrometers. CII-HB then coats the heads with glass to strengthen them mechanically. But the most significant dimension is the width of the gap between the two pole tips of the magnetic "nose," the part of the head that reads and writes the magnetic flux in blocks on the disk or tape surface.



Narrowing the gap. CII-HB employs thin-film techniques to make a recording head with a thinner gap between the magnetic-pole tips than is possible with ferrite technology.

Limits. The gap for conventional ferrite heads can be as narrow as 1 μm, but Lazzari says that that is just about the physical limit for such technology. Although he will not reveal the actual gap for the integrated heads CII-HB is ready to produce, he says that the theoretical limit is a single thin-film layer and that heads with gaps of 1,000 angstroms are entirely possible.

To further exploit their small size and at the same time to enhance their track-alignment accuracy, the company proposes assemblies of nine heads, with one head serving as a pickup for a servo-control signal and the other eight working as data read/write heads. Such assemblies would obviously require disks with servo zones for head positioning.

Not yet. Despite the merits of the new heads, the firm has not actually begun quantity production, mainly because high-density disks are a must for optimum use of the heads. It has, however, sold production know-how to Applied Magnetics Corp., a Santa Barbara, Calif., manufacturer of digital magnetic recording heads.

Lazzari says the CII-HB magnetics research team is experimenting with new metallic disk coatings only 0.1 to 0.2 μm thick, capable of sorting up to 10,000 bits per centimeter of track length. (The basic limitation of current oxide coatings is their thickness. The best available measure about 1 μm, good for up to 3,200 bits per centimeter of track length.) He believes that the thickness of metallic coatings can eventually be cut to 0.03μm. **-Kenneth Dreyfack**

HOW MAGNETIC RECORDING HEADS LINE UP

	Thin-film head	Ferrite head
Gap width (minimum)	1,000 Å	1 μm
Track density (radial)	300/cm	175/cm
Bandwidth	65 MHz	13 MHz
Track width	10 μm	40 μm
Flying height (distance from disk)	0.2 μm	1 μm

"Choosing Intel gave us a twelve month jump on the competition."

Dr. Wang: "We were first with a unique, new approach to word processing—using microcomputers to implement distributed intelligence in multiple station systems. That approach has enabled us to increase our market share 50% a year in a market that's growing 40% a year. This year our word processing sales will pass $100 million. In 1974 they were just $9 million.

"We decided on Intel's 8080 microprocessor for our distributed logic system. Only Intel offered PL/M, the microcomputer programming language we needed to get our software written quickly. So quickly that we introduced our system a year ahead of any competition. And Intel's tools for programming have continued to help us offer our customers the high quality software they expect from Wang."

Intel's extensive microcomputer design tools have helped hundreds of companies just like Wang Labs capture the marketing advantage with Intel microcomputers and semiconductor memory.

Our Intellec® Microcomputer Development System makes it possible and profitable for companies like yours to take full advantage of the promise and potential of the microcomputer. For example, the world's most advanced microcomputer, our new 16-bit 8086, is the first and only 16-bit microcomputer supported by a high-level programming language—PL/M, part of the total 8086 software development package available for the Intellec system.

To begin writing your own success story, contact Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA 95051 408/987-8080.

Intel's Intellec® Development System

Circle #79 for information

intel® delivers.

That's why we build a microprocessor lab like you'd design for yourself.

Tektronix microprocessor development labs now fully emulate the 1802. Both the 8001 and 8002A are GSA approved.

INSTRUMENTATION BUILT OUR REPUTATION

The chip builders have their own specialties. But ours is similar to your own: as one of the world's foremost instrumentation designers, Tektronix deals with your kinds of design problems and your kinds of deadlines. We've learned through experience how to maximize equipment versatility and reliability.

That's why our lab supports chips from a variety of builders. Including the 3870, 3872 and F8. The 8085A and 8080A. The Z80A. The 6800. The TMS 9900.

Based on years of experience with microprocessor designs, our labs include many other capabilities like you'd engineer for yourself.

REAL TIME ANALYSIS OPTION

Dynamic monitoring with dual 49-bit breakpoint registers enables quick isolation of timing and logic problems.

ENHANCED BASIC

This enhanced compiler version of BASIC supports the instruction set of the 8080A and can run on the 8080A, 8085A and Z-80A. The compiler produces optimized code. Extensions include facilities for modular programming, interrupt handling, memory I/O, bit operations, and access to I/O ports.

COMPREHENSIVE WORKSHOPS

Microprocessor design workshops are held for our customers monthly in several locations throughout the country. Programs include a 5-day design workshop and a 3-day course concentrated on the labs themselves.

From engineering to education, you get the painstaking quality you expect from Tektronix. Including expert service and consultation from nearby Tektronix field offices. Ask your Tektronix Sales Engineer for the full story, or contact Tektronix, Inc., P.O. Box 500, Beaverton, OR. 97077. In Europe, Tektronix Ltd., P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.

For immediate action, dial our toll-free automatic answering service, 1-800-547-1512. In Oregon, call collect 644-9051.

Tektronix
COMMITTED TO EXCELLENCE

Tektronix microprocessor development labs.

Designed by people on your side of the bench.

For 1802 information circle #81. For literature circle #265.
For fast reply call Toll Free (800) 547-1512.
(In Oregon, collect 694-9051)

IMAGINE

The Z8 will make you do a double-take.

Zilog's new Z8 takes advantage of the same, powerful, general register architecture as the revolutionary Z8000. It's the unprecedented, new micro that gives you the best of both worlds: a highly integrated microcomputer system on a single chip plus a fully expandable microprocessor for your more I/O and memory-intensive applications.

Pick the fireworks you need.

Used as a single chip microcomputer the Z8 delivers 2K bytes of internal ROM, 124 bytes of RAM, 4 I/O ports (8-bit), 2 counter/timers and a true asynchronous serial communication, interface.

Prefer to use it as a fully expandable microprocessor? In that role the Z8 can address up to 62KB of external program memory and 62KB of data memory. Plus, an almost unlimited amount of I/O is available to you by using a memory-mapped technique.

Frustrated with primitive instruction sets that fizzle?

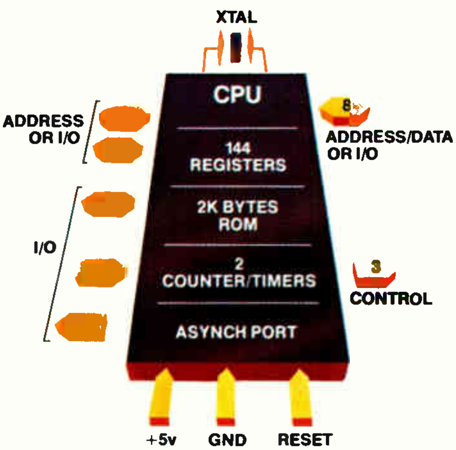
You'll be delighted with the Z8 instruction set. It contains the same type of power as found in advanced microprocessors such as Zilog's Z80 and Z8000. As a result, the Z8 can manipulate bits, bytes and words (16-bit) with ease. Combined with 9 powerful addressing modes, it can provide your programmers with a problem-solving tool of near-unlimited flexibility.

IMAGINE

A SINGLE CHIP MICROCOMPUTER THAT EXPANDS WITH YOUR NEEDS–ZILOG'S Z8.

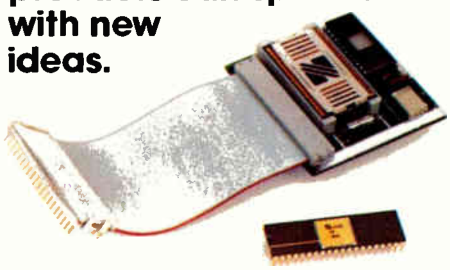
Explosive Performance.

The Zilog Z8 makes no compromises with speed. It is specified to operate off its own internal clock generator circuit at 4MHz. That's the same



speed as the famous Zilog Z80A! Instruction execution times typically range from 1.5 to 2.5 microseconds —fast enough for even your toughest application requirements!

Imagine how your products can sparkle with new ideas.



With the Z8 problem-solving instruction set, high-speed, and almost limitless expandability your products could easily become incredible not just excellent.

To help develop and debug these exciting ideas, Zilog has a complete set of tools for you. The software development package contains a Z8 Assembler and Simulator that runs on Zilog's Z80-based MCZ or ZDS Systems.

In addition there's also a special 64 Pin version of the Z8 that uses external PROM for hardware simulation to permit thorough debugging and testing prior to committing to mask-programmed ROM 40 pin Z8's.

Additional development tools soon to come include a prototyping board and a sophisticated systems analyzer.

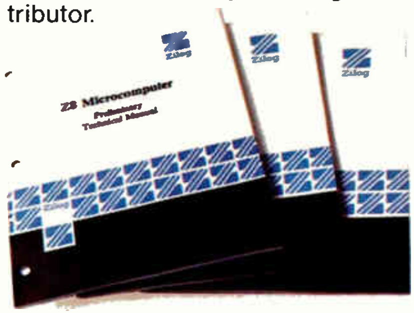
Zilog introduces the next generation with a bang!

The revolution in microprocessor technology that began with the Z80 and its supporting family of products, blazes on. Now its a soaring jump in architectural sophistication to the unprecedented Z8 and the incredibly powerful Z8000. And, there's a whole family of support products to come. It's what you expected from Zilog, the company that's pledged to stay "a generation ahead."

Get your own fireworks going today.

Join the excitement. Place your order today with your nearest Zilog distributor.

In the meanwhile, give your development staff a headstart by ordering the Z8 product manual set; order directly from Zilog in the U.S. Elsewhere contact your Zilog distributor.



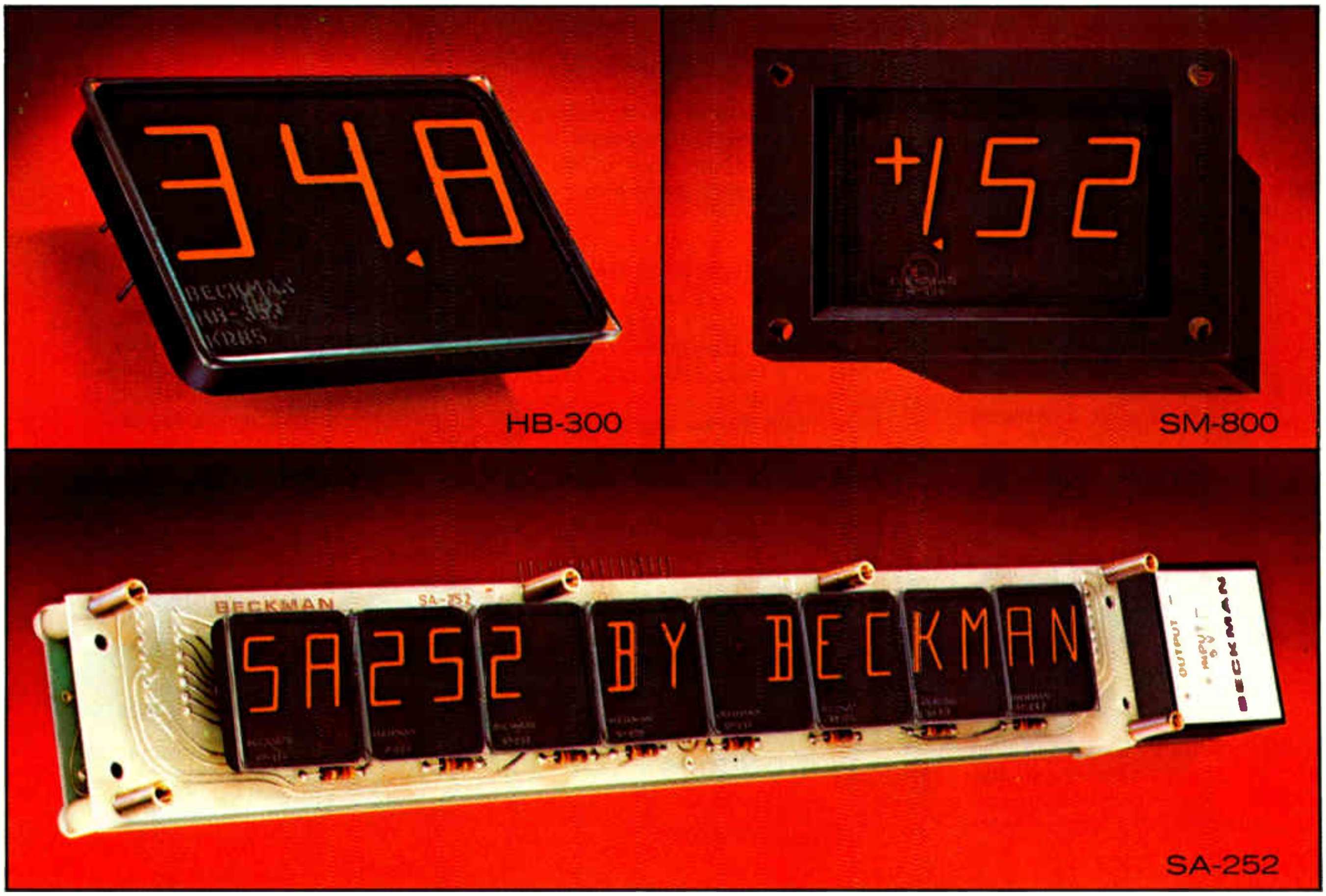
10460 Bubb Road, Cupertino, CA 95014
(408) 446-4666 TWX 910-338-7621
EASTERN REGION: (617) 667-2179
MIDWESTERN REGION: (312) 885-8080
SO. WESTERN REGION: (714) 549-2891
NO. WESTERN REGION: (408) 446-4666
EUROPE (ENGLAND): (0628) 36131/2/3
WEST GERMANY: (08106) 4035
JAPAN: 03-476-3010

An affiliate of
EXXON ENTERPRISES INC.

Zilog

Circle 83 on reader service card

DESIGN BECKMAN DISPLAYS IN. DESIGN PROBLEMS OUT.



The problem is no display vendor has a line that's broad enough to cover all of your requirements. Right? Wrong! That is, unless you need something other than Liquid Crystal Displays; Raised Cathode or Screened Image, Gas Discharge Displays; Microcomputer-controlled Display Systems; Display Modules, with built-in electronics; High-brightness Versions and Hi-Rel Versions. Accessories such as latch/decoder/drivers and converters. Unless you need something else, Beckman's the one! ■ SA-252. New. Self-contained, 16-character alphanumeric display system. Microcomputer-controlled with direct user access. Ideal for biomedical, process control and general electronics applications. ■ HB-300 series of high brightness displays. New, also. Same dimensions and package as time-proven SP-300 series. Plus, up to 500 footlamberts of brightness. Perfect for avionics, automotive and point-of-sale equipment. ■ SM-800 series of display modules. Combines the ease of assembly, made possible by self-contained electronics, with the flexibility to accommodate different message field lengths in your various models. Great for practically any low to medium volume application.

Beckman Displays.
The Visible Edge.

Beckman Liquid Crystal Displays provided the ideal solution for a new digital clock from DigiCal, Inc. General Manager Ron Rondas said, "Beckman LCD's are the best on the market. In a side-by-side comparison, any knowledgeable user would choose Beckman every time. Their contrast ratio is better. Viewing angle (at 3V rms or above) is almost double that of the others. Switching time is virtually instantaneous. And, besides, Beckman is a company you can rely on."

Stern Electronics, Inc., chose our Screened Image technology to add dynamic flexibility to a new pinball machine. Specifically, that display is now the SP-491, one of a growing line of Screened Image standard products. It's ideal for point-of-sale equipment as well as electronic games, because readability is assured at distances up to 50 feet by the 0.7 inch height of the six digits and 210 footlamberts of brightness.

For a new and different stand-alone, point-of-sale terminal. Data Terminal Systems chose to use a custom design in conjunction with our Screened Image technology. Purchasing Manager, Reg Brown said, "The Screened Image Display concept gave us the freedom of using just about any font, style or format that we wanted; and, by developing a custom design, we were able to maintain a unique position among competitive products."

The SP-300 line of raised cathode, gas discharge displays has been tested and field proven in literally thousands of designs. This stage of the learning curve has also seen substantial price reductions, as a direct result. This combination was the right one for a new cardiac monitor from Becton-Dickinson Medical Systems. "Beckman is the only consistent supplier of a display with the track-record of the SP-350 series," said Ralph Grabowski, Product Manager for Becton-Dickinson Medical Systems. "In this case, obviously, we couldn't settle for anything less. And, at the same time, we had to be price-competitive. Beckman helped make it happen."

Why Four Companies Designed Beckman Displays In - Problems Out.

For complete details about how you can, too, write:
Display Systems Division, Beckman Instruments, Inc., 350 N. Hayden Rd., Scottsdale, AZ. 85257. Phone: (602) 947-8371. TWX: 910-950-1293. In Europe write: Beckman Instruments (Belgium) S.A., 14, Avenue Hamoir, 1180 Bruxelles, Belgium. Phone: (02) 275.44.30. Telex: 23577.

BECKMAN

sights on small businesses. The small-business market, in fact, is soon to be the victim of a multi-pronged attack by the makers of chips, development systems, intelligent terminals, word-processing systems, and general-purpose small and large computers.

"The home computer market isn't here yet, and the hobbyist market is saturated," declares Phil Roybal, marketing manager for Apple. He says that the business market is ripe for two reasons: "The businessman knows computers because he's used them already, and he can justify spending as much as $5,000."

Apple's latest model, the Apple II Plus, which was brought to the NCC, is less expensive. In fact, a basic Plus unit costs the same as the Apple II: $1,195. For business use, the Plus sports four software options for accounting, inventory, automatic mailing, and stock evaluation. It now also offers two languages: Basic, in read-only memory, as usual; and Pascal, on disk, for $495.

Commodore Business Machines Inc., of Palo Alto, Calif., was first to address the low-end market with its $795 Pet. Radio Shack soon followed suit with its TRS-80 for $739—and the company has sold more than 100,000 units (some say over 370,000) in the 20 months since it was introduced. One glance at its new TRS-80 model II shows the direction it is taking, although it is difficult to call something the size of the model II a personal or home computer. Lifting the hood on the model II reveals a Z80A purring along at 4 megahertz, driving the machine at more than twice the speed of the older TRS-80, now called the model I.

Taking on the big boys. "This machine is aimed at competing significantly with units from Hewlett-Packard, IBM, Wang, and DEC [Digital Equipment Corp.]," declares Jon Shirley, computer division vice president at Radio Shack. Specifically, Tandy officials compare the II to the IBM 5110, a machine with the same maximum 64-kilobyte main memory capacity, but selling for considerably more.

Think about it. The Imagination Machine is from APF Electronics Inc. of New York. This home computer features 10 kilobytes of ROM, 9 kilobytes of RAM, and eight-color graphics.

Without optional extras, the model II sells for $3,450, which includes 32 kilobytes of random-access memory as well as one 8-inch double-density floppy disk that stores another ½ megabyte. The fully loaded version (see photo, p. 87) has 1.5 million bytes of disk storage, twice as much RAM, a desk, and a $7,998 price tag.

First deliveries of the model II are scheduled for July, when Tandy plans to have five software packages for general ledger, accounts receivable, inventory control, mailing lists, management, and payroll. A model II will initially be able to talk to two other TRS-80 machines, one at a time, over telephone lines.

Like the model I, the model II and associated new equipment will be marketed through the more than 6,500 Radio Shack stores and through the company's expanding chain of 38 Radio Shack computer centers. "We are in the computer business," declares Radio Shack president Lewis F. Kornfeld. "If we think there's a market for a home computer later on," he adds, "we're prepared to go downstairs too."

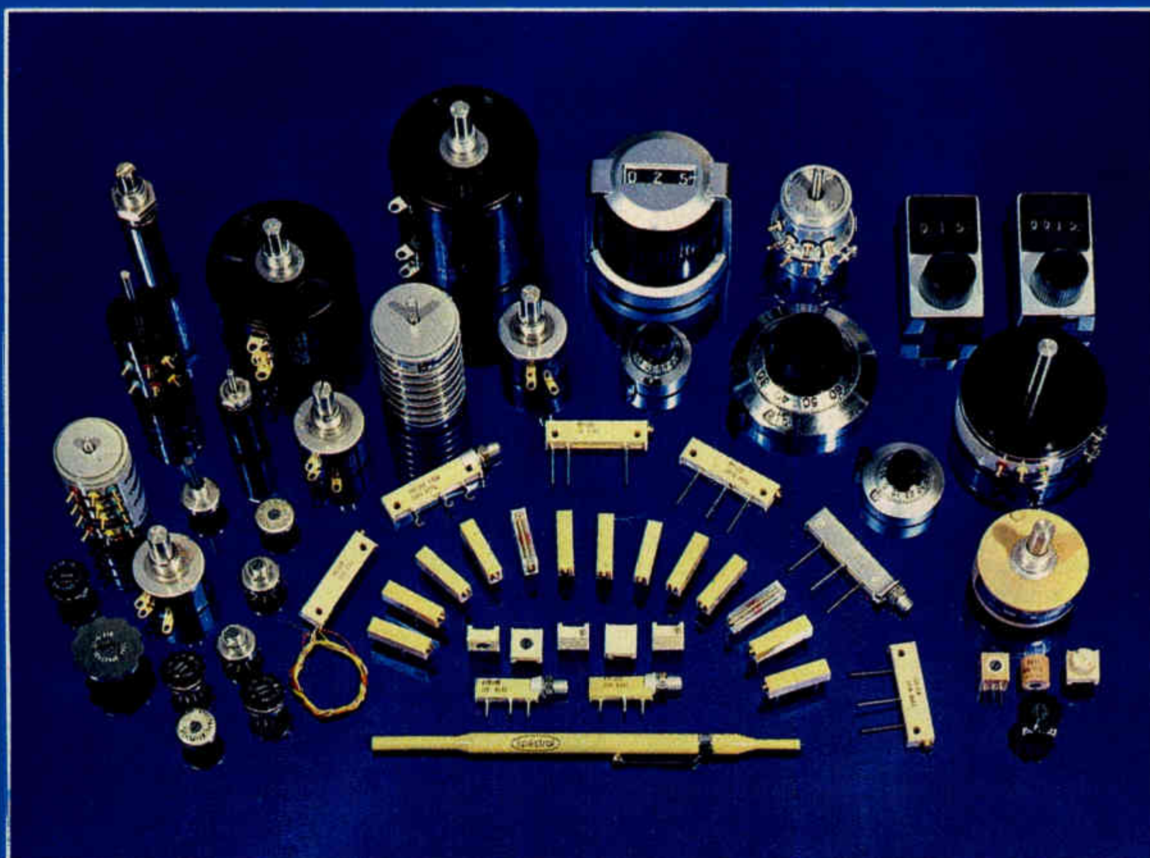
When Radio Shack descends those stairs, it will find Ohio Scientific. The Aurora, Ohio, firm has been aggressively pumping out microcomputers and software packages since the firm was started some four years ago. It now has a $5,000 machine, the C8P DF, at the top end of its Challenger line of personal computers that it is touting as the "home computer of the future."

Indeed, in the company's announcement made at the CES are many features that can be called futuristic. For example, the new unit has the ability to answer or place telephone calls via an acoustic coupler included with the computer. It will take messages or call the homeowner through its ability to decode Touch-Tone inputs and synthesize the human voice. Telephone numbers may be stored in memory; then, say, in the event of a problem in the home, the machine will call one of the numbers and explain the situation using a built-in, phonetically based synthesizer built by the Vortrax division of Federal Screw Works in Troy, Mich.

Ohio Scientific's home computer interfaces with a North American Philips Corp. home-security system that incorporates sensors for smoke, fire, intrusion, and ac power. Through the Norelco system, security, lighting, and other appliances like heaters and air conditioners can be under program control—even by phone—and the unit can run other application programs while monitoring and controlling.

"The growth of the home computer market depends a great deal on who gets into it," Cheiky says. "When Radio Shack started advertising, it helped us out immensely." She also feels that the economy has a marked effect on the business, but her opinion is different from most. "With the gas shortage, people will stay at home and they'll buy [home computers for] entertainment." □

A Line for All Reasons



Pots, Dials, Trimmers, Switches

Need standard or special precision pots for industrial or military applications? Turns-counting dials for your front panels? Trimmers for your minis, or miniature rotary switches for your peripherals? Whatever you need—we have a line for all reasons. In fact, the only thing we don't have are high prices. For more information on any of our four lines of "quality components", call or write.

Spectrol

SPECTROL ELECTRONICS GROUP

UNITED STATES **Spectrol Electronics Corporation** 17070 E. Gale Avenue, City of Industry, Calif 91745, U.S.A • (213) 964-6565 • TWX (910) 584-1314

UNITED KINGDOM **Spectrol Reliance Ltd.** Drakes Way, Swindon, Wiltshire, England • Swindon 21351 • TELEX: 44692

ITALY **SP Elettronica spa** Via Carlo Piscane 7 20016 Pero (Milan) Italy • 35 30 241 • TELEX: 36091

GERMANY **Spectrol Electronics GmbH** Oberauerstrasse 15, 8000 Munich 70 West Germany • (089) 7145096 • TELEX 05-213014

Circle 89 on reader service card

Careers

EE graduates' salaries soar

Good years bring intense recruiting competition around the U. S. with the result that starting BSEE can ask $18,000

by William F. Arnold, San Francisco regional bureau manager

The boom in the electronics industries is causing a stampede by companies trying to recruit electronics engineers graduating this June, according to companies and university placement centers across the country. The demand is so high that the average starting salary for a new BSEE is $18,000 or more, some 10% to 20% above what schoolmates received a year ago.

"It's very tough, much more so than we've experienced in the past," declares Roy Brant, vice president for human relations at National Semiconductor Corp., Santa Clara, Calif. "We still get the same percentage of people in terms of offers, but we have to bring in more people [recruiters] to do that," he says. Some competing southern California aerospace and electronics company recruiters call the situation "the toughest ever."

"It's the wildest spring we've ever seen," say engineering school officials at the University of Southern California. "The companies are really hounding us," confirms Kathleen Stanton, technological career adviser at the University of California at Berkeley's career planning and placement center.

The result is that companies are offering average starting salaries of between $1,500 and $1,575 a month. Average starting salaries for MSEE graduates vary over a wider range, however. University of Texas MSEE grads averaged $1,633 a month, according to Laura Rutledge, placement coordinator in the engineering career assistance center, compared with offers of $1,765 a month at the University of Illinois's Urbana–Champaign campus, states David R. Opperman, engineering placement director.

But these are just average starting salaries. Stanford University's career planning and placement center, for example, reports offers ranging from $1,434 to $1,700 a month for BSEEs and $1,542 to $2,000 for MSEEs. Those students who stayed on to get a doctoral degree can expect to start at $2,200 to $2,300 a month.

However, these salary figures may reflect rates in metropolitan areas highly concentrated with technology. A recent nationwide survey of 576 large and small electronics companies by the American Electronics Association showed lower average offers for BS candidates [*Electronics*, May 24, p. 46]. Anticipated offers to June graduates ranged from a low of $1,321, up 12% from 1978, to a high of $1,586, up 11%. But the AEA survey indicates a wider spread of offered salaries under the "company low" and "company high" categories than reported elsewhere.

Supply and demand. Fueling the salary surge is a classic supply and demand situation. There aren't enough electronics engineers being graduated, explains Jack Grout, corporate manager of employment and college relations, Hewlett-Packard Co., Palo Alto, Calif. "We're seeing across the U. S. a greatly increased need among technology companies, along with our own increasing needs," he says. "It's a seller's market this year." Nationwide, HP made 800 offers to BSEE, 200 to MSEE, and 60 to Ph.D. students after recruiting at 200 universities.

Most electronics areas seem to be affected, but it makes a difference what a company makes. For example, Hughes Aircraft Co., said to be the largest employer of EEs in the U. S., says that software engineers are the most difficult to find, a feeling shared by recruiters at Litton Industries' Data Systems division. Hughes foresees competition from the car companies, which are racing to beef up their electronics capability and are willing to pay up to 20% over the going rate, it says.

Mostek Corp. believes it will fill its quota, partly because "we don't have an intense Government product or aerospace reputation to live down," according to Pat Coil, employment manager for the Carrolton, Texas, chip maker. He feels that students are seeking jobs with secure futures.

Agreeing, W. P. Worley, an associate EE professor at Texas A&M University, College Station, says that microprocessing slots are sucking more and more EE grads away from some of the more traditional types of jobs. He finds that although utilities still seem to get their share, some geophysical and petroleum companies are having to recruit harder.

Working harder. Faced with tense recruiting environments, how are companies trying to get the grads they want? "We are simply making ourselves more visible," answers John Merit, personnel manager for the Zenith Corp., meaning that Zenith representatives from the personnel and engineering departments go to more schools, contact more students, and schedule more interviews.

Texas Instruments Inc., among others, has expanded its on-campus activity before the actual recruiting day by sending technical personnel to hold seminars and speak to local chapters of the Institute of Electrical and Electronics Engineers and other student professional groups. Bendix Corp. works closely with professors, deans, and placement center officials. The firm is also stepping up advertising and public relations.

Robert K. Weatherall, director of career planning and placement at the Massachusetts Institute of Technology, says that co-op programs help "students know about companies." He goes on, "Students are very savvy, and the grapevine at MIT is realistic without too much nonsense." His list of companies that seem to come out well when under close observation by students includes Digital Equipment Corp., Bell Labs, Hewlett-Packard, and IBM.

Weatherall notes that neither Burroughs nor Control Data has visited MIT in the past few years. "We get fewer [companies recruiting] from the Middle States. I guess they think they won't win enough students to go to the middle of the country. Most students stay here [in New England] or go to the Far West," he says.

"We saw Hughes Aircraft constantly," he notes with some humor. Of the 200 companies recruiting on MIT's campus this spring, Digital Equipment, Hewlett-Packard, Bell Labs, and Wang Laboratories also recruited aggressively, he says.

Nice living. At Mostek, "we also placed more emphasis this year than we have in the past on the Dallas area as a desirable place to relocate to," Coil says. Students visiting headquarters during the recruiting season this year were taken out for sightseeing and a night on the town. That may give Mostek an edge over some of its California competitors, who report that students are well aware of the Golden State's notorious high cost of living and use it as a bargaining wedge.

If the salary surge for graduating electronics engineers continues next year, how will companies handle this year's grad then? Based on merit, an HP engineer could expect to earn 7% to 10% more at the end of his first year, on average, Grout reports. National's Brant says that 3-, 6-, and 12-month reviews could mean increases of up to 18%. □

Communications

FCC speaks on data communications

Decision that AT&T may enter the market under separate-company concept is designed to aid competition within present restraints

By Harvey J. Hindin, Communications & Microwave Editor

In what it considers a landmark decision, the Federal Communications Commission has satisfied itself that it has finally settled a long-standing controversy between the communications and computer industries. That much is clear; less clear is how the affected parties see the meaning of the decision.

The FCC intends to encourage broad competition in data communications and the provision of new services. It also believes that it has cleared the way for American Telephone & Telegraph Co. to enter the data-communications market within existing legal constraints.

"We are inclined to regard this action favorably, but we can't tell exactly what it will mean to the Bell System until we have had a chance to study the full written proposals," declares William G. Sharwell, AT&T's vice president of planning and administration—but nothing formal has been written yet. The lack of a written statement, in the face of a meeting and press conference, and given the potential impact of the decision, has caused chagrin in the data-communication community.

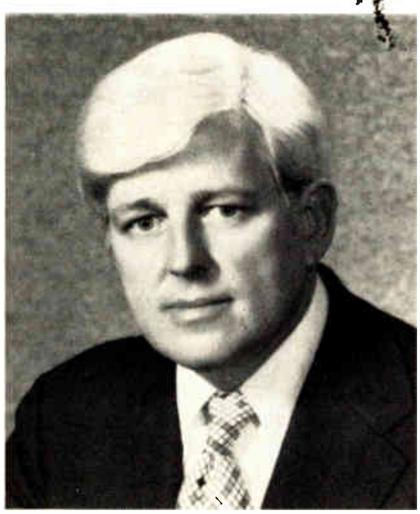
It is clear that the FCC, after a three-year effort on Computer Inquiry Two, has come to a conclusion about regulating the industries created by the explosion of new communications technology. This is what the FCC itself claims.

Yet, even the usually talkative industry consultants are issuing little more than general statements. Everyone has learned that the final resolution of FCC pronouncements takes a long time—and with nothing in writing, things are more confused than usual.

The gist of the FCC's tentative decision—tentative because the commissioners have not agreed on the exact language of the written document—is that AT&T will be allowed to provide a wide variety of computerized communications services if it does so through separate subsidiaries. The separate-subsidiary approach is a must since separate accounting procedures create too many credibility problems.

Competition. The filing of tariffs for these services would be optional and decided by the supplier, based on its competitive situation. Yet electing to do so would allow Bell to compete within the restraints of the 1956 consent decree, which prohibits its entry into unregulated data-processing markets.

Why the trouble? In great part the problem lies in the blurring of the distinctions between voice service, data service, and data manipulation or processing. Before the extensive development of large-scale integrated chips, which permit the use of digital technology inexpensively, and the advent of microprocessor and stored program control of switching centers, it was relatively easy to distinguish between voice, data, and data processing. Furthermore, these jobs were done by separate companies.



Leader. Charles Ferris heads the FCC, which says that AT&T should set up separate organizations to keep competition fair in the data-communications industry.

That is no longer the case. It is hard to tell the difference between an intelligent terminal and a small-business computer. Technology has been racing ahead of the regulations and whatever basis they had. In the past, for example, tariffs were filed for communications services but not for data processing. How then should AT&T handle its proposed Advanced Communications System (ACS), which some claim will perform data manipulation?

The FCC has given up trying to define data-communications and data-processing equipment and instead wants to divide AT&T services into well-defined slots. These would be labeled by the end markets and users rather than by category.

So it appears that what AT&T can do is set up a separate ACS subsidiary and sell the ACS service. At the same time, that subsidiary could buy connection services from AT&T itself, which would provide only these. But what the new decision will mean in practice or how it will be implemented is uncertain and demands a detailed inquiry. The FCC will begin the study and get comments from interested parties after the written decision is issued.

So far, specific service categories

Probing the news

have been established. Standard voice transmission remains a regulated monopoly service. Nonvoice transmission traveling straight through but unprocessed, although possibly switched, is regulated.

Enhancement. The "enhanced nonvoice" category is most interesting. This is any service that includes data processing, such as changing message content or format, or uses complex terminals (more than simple transducers). These services will be split off according to the separate-subsidiary concept.

"You can take this move seriously," says FCC chairman Charles Ferris. "We are well on our way to rejecting accounting as a solution to separation of costs. We are saying there has to be separation between carriers and resellers of services."

The FCC, then, is moving to increase competition in agreement with an overall Federal policy. It almost preempted part of the rewritten version of the Communications Act of 1934 that was recently introduced by Senator Ernest F. Hollings (D., S. C.). "Rather than have congressional intervention in the enhanced data communication business, it looks as if the industry will get a modernization of the rules," says Philip Niborg, general counsel of the Computer and Communications Industry Association.

If there remains an argument over whether or not a given service is enhanced or if definitions are too elusive, the matter will probably end up in the courts. In fact, there are many questions still to be decided even by the commission.

For example, it has said nothing about whether or not the new subsidiary sales structure has to be applied to all vendors or just to monopoly carriers like AT&T. And is it possible that the newly proposed way of doing things will hinder technological innovation?

The FCC will deal with these and other questions later this year. It will also ask whether small carriers should be regulated to the same extent as the large ones—an issue on which the commissioners and their staff disagree. □

At stake: an enormous potential

Everyone wants to get into the information-handling business. There is AT&T with its Advanced Communication System, International Business Machines Corp. with its Satellite Broadcasting System, Xerox Corp. with its Xten System, and many lesser-known common carriers that offer specialized services. Why? It's all a matter of money.

The world's information output doubles every 10 years. Worse, the distribution problems are growing at an even greater rate. In the United States alone, more than 60 billion pages of Government and business information are passed around each year. But less than 1 out of 100 of these is handled electronically, potentially the most efficient way.

Centralized electronic distribution can overcome the principal problems that piecemeal systems have. First and foremost is price. For example, a typical facsimile transmission costs up to $3 a page—not including the cost of the transmission device itself. Quality is often inadequate because of the limitations of transmission lines. Time—up to 6 minutes per page—is a problem, especially for multipage transmissions, and costly human attention is usually necessary. Furthermore, many devices, even of the same generic type, cannot communicate with each other because of protocol differences and other difficulties.

Xerox estimates that data transmission in the U. S. is now a $2 billion business that is still growing rapidly. Yet problems of availability, cost, and compatibility, in the view of the communications giants, are not being adequately met. What's more, they say, the future will be characterized by ever increasing amounts of information exceeding the capacities of current networks to distribute it both economically and effectively.

This rather substantial pie is up for grabs. Up to now, all concerned have insisted that the public interest would be best served by their approach. Now the FCC says that everyone has a chance.

Zeiss stereos highly resolve to give you...

...finest image quality

Zeiss stereomicroscopes give you the highest resolution that stereomicroscopy can achieve. You get a truly flat field with no distortion, no globe effect. All Zeiss stereomicroscopes have separate light paths for each eye, rather than just one objective as in most others. You get the finest image quality, the finest detail, in both transmitted and incident light.

...greatest convenience

Every Zeiss stereomicroscope offers convenience unmatched in its class. The DRC Camera Stereomicroscope and the economically priced DR allow you to mount two objectives at once, so that, at the touch of a finger, you can go from low to high power without losing focus. The 1:4 zoom system of the DV4 covers a magnification range of 2.5-200X. **Nationwide service.**

The great name in optics

ZEISS

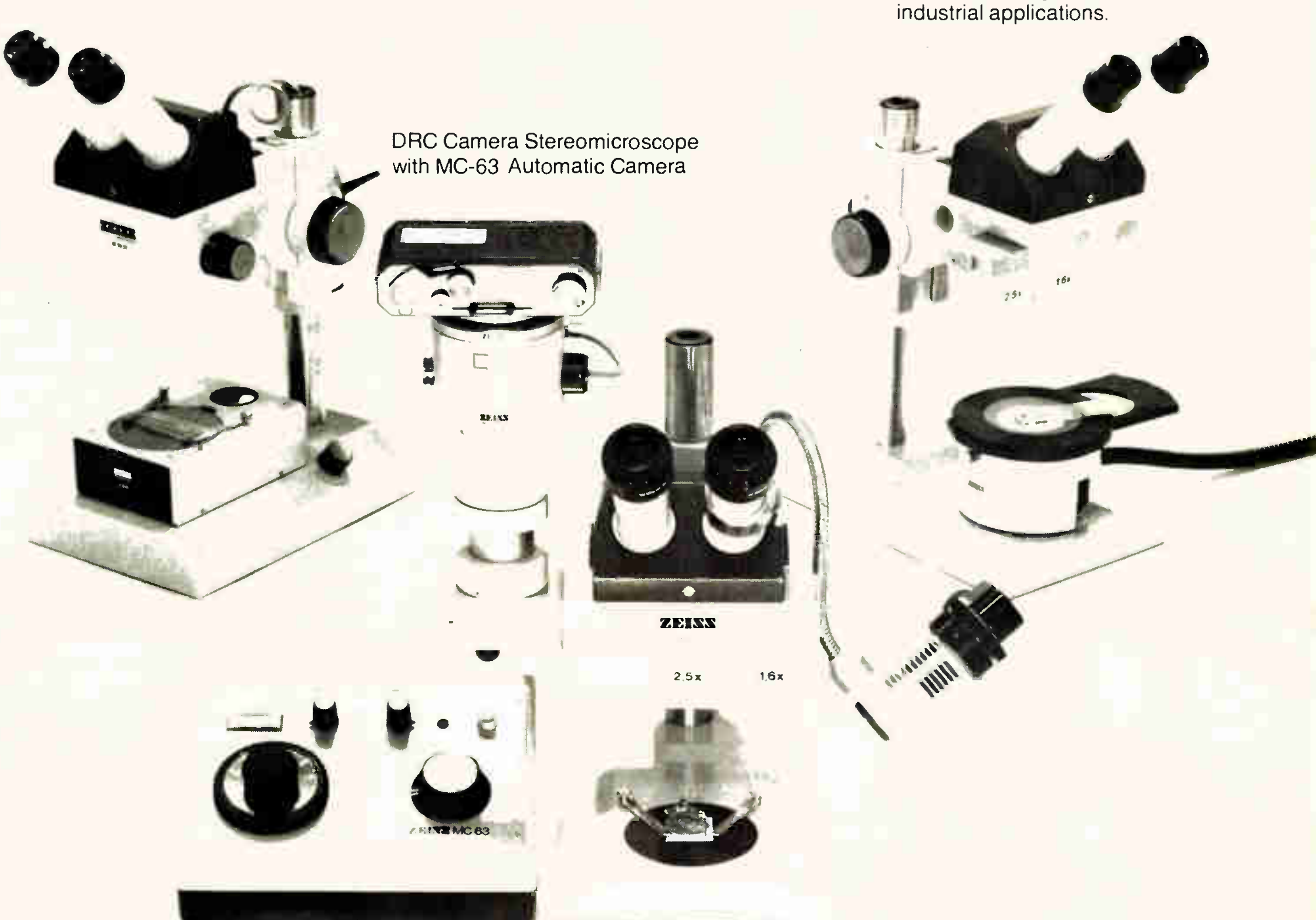
West Germany

Carl Zeiss, Inc., 444 5th Avenue, New York, N.Y. 10018 (212) 730-4400. Branches: Atlanta, Boston, Chicago, Houston, Los Angeles, San Francisco, Washington, D.C. In Canada: 45 Valleybrook Drive, Don Mills, Ontario, M3B 2S6. Or call (416) 449-4660.

DV4 Zoom Stereomicroscope

Stereomicroscope DR: Low cost for routine teaching, lab, and industrial applications.

DRC Camera Stereomicroscope with MC-63 Automatic Camera



Circle 95 on reader service card

Companies

Telefunken swings toward new markets

$150-million-a-year semiconductor operation will concentrate on solar cells, thermal-imaging devices, and optoelectronic parts

by John Gosch, Frankfurt bureau manager

"The economic and technical optimum for a semiconductor producer is attained not so much by big efforts across the whole components spectrum but by excellence in selected areas." That's the credo of Reinhard Dahlberg, general manager in charge of AEG-Telefunken's worldwide semiconductor activities.

In line with that philosophy, Dahlberg and his associates are beginning to restructure their central facilities in Heilbronn, West Germany, gradually shifting the emphasis there from mass-produced standard devices to special components with big market potentials. Not that the company is foresaking standard products in its $150-million-per-year semiconductor business. But the assembly of run-of-the-mill items—particularly if their labor content is high—is increasingly being handled at the firm's foreign plants, notably in Manila, where wages are less than 10% of those at home.

At the 2,100-person Heilbronn facilities, Telefunken is gearing up for three special activities. One is terrestrial solar cells, for which a pilot line is being built. The object is to find a technology that by 1985 will result in mass-produced 1-watt solar cells costing less than 50 cents. With these cells the firm plans to develop generating plants with outputs of up to 100 kilowatts by the mid-1980s.

Diffusion. At Telefunken's Heilbronn plant, 10-by-10-centimeter raw polycrystalline cells are inserted into a quartz magazine. The next step in the process is diffusion in the oven.

The second focal point is on devices for use in thermal-imaging equipment. Drawing on its development expertise in long-wave infrared technology, the company aims at becoming a major force in thermal components for the military and civilian sectors, Dahlberg says.

Finally, to put more thrust behind its optoelectronics activities, Telefunken is starting up a high-output plant for gallium-arsenide, gallium-arsenide-phosphide, and gallium-phosphide pellets. This is because the company has more than 30% of West Germany's optical components market, says Dahlberg. The plant will meet the firm's needs for GaAs, GaAsP, and GaP pellets well into the 1980s.

Eyes on the sun. In this energy-conscious era, it is the solar-cell work that is likely to attract the most attention in the years ahead. "Until the 1973 oil crisis the solar cell was known only to specialists in space engineering," comments Horst Fischer, head of the optoelectronics department at Heilbronn. "Now it is gaining appeal as the key element for tapping the sun's energy with earthbound solar generators."

At present, however, such generators are far from economical, according to Fischer. Because of the large number of production steps and the high material and energy consumption involved, their manufacturing costs come to about $28/W. Of that amount, the cells account for roughly $20/W. Half of that, in turn, goes for the single-crystal silicon wafers. "These costs must be drastically reduced if solar generators are ever to be used on a large scale," he says.

Making photovoltaic energy conversion economically viable is Telefunken's declared goal. It aims, within the next five years, to cut the cost of solar generators, including components and silicon material, to at least one thirtieth of what it is now. The firm is cooperating in this effort with the silicon producer Wacker Chemitronic GmbH in an eight-year project that the West German government is funding with some $75 million through 1985. An additional $20 million is being put up by Telefunken and Wacker.

Taking the first step toward a drastic cut in the cost of silicon, Wacker has developed a silicon-processing technique that radically departs from conventional methods. Replacing the relatively costly and slow single-crystal-pulling processes, it produces the much less expensive polycrystalline silicon by a faster and more economical method similar to metal casting [*Electronics*, Oct. 26, 1978, p. 68].

Poly cells in lab. Using the Wacker material—called Silso, for silicon for solar cells—Telefunken is already producing terrestrial polycrystalline cell samples on a laboratory scale—"far in advance of other companies working on similar projects," Fischer says. The 10-by-10-centimeter devices have an efficiency of better than 10% and produce 1 W.

Currently, Telefunken is producing the cells by a specially developed technique optimized with respect to the polycrystalline structure of the new material. The technology is being tested on the pilot line with, for the most part, highly mechanized and automated equipment. A single vacuum chamber, for example, can metalize in one operation a batch of cells with a combined area of almost 1 square meter. The diffusion oven used can process as many as 400 10-by-10-cm cells in an hour.

This year, Fischer's group expects to produce some 120,000 polycrystalline solar cells with a combined area of 300 m^2 and an equivalent power output of 30 kW. A number of them will be used in solar-power plants that are being built on the Mexican peninsula of Baja California, where the Bonn and Mexico City governments are sponsoring a big sun energy conversion project.

Next year, Fischer says, his company will produce cells with a total output of 70 kW. The output will consume as much silicon as the firm will use in all other semiconductor products in 1980. The medium-term targets are a cell production equivalent to 370 kW by 1983 and to 500 kW by 1985. The company expects to enter the market with commercial cells in 1985.

Eyes on the top. In its second major endeavor—involving thermal-imaging devices—Telefunken has its sights set on becoming a technological leader outside the United States. Although still in its early stages, the effort has already resulted in prototype detectors, light-emitting-diode arrays, image preamplifiers, and Stirling coolers. Large-scale production of these and other devices will begin in 1981.

The company sees good sales potential for thermal imagers. It is, of course, difficult to assess Europe's, let alone the world's, market for such equipment because the military is still the dominant customer. But in West Germany, Joachim Hesse, who is in charge of optoelectronic development and technology at the Heilbronn facilities, estimates that sales of semiconductor modules alone will be $85 million between 1981 to 1985. Add another $125 million for optical devices and other nonelectronic components and the thermal imager market in West Germany becomes a substantial one.

Telefunken expects increasing long-term civilian applications for the imagers. Such applications include: in the construction industry, spotting heat leaks from buildings; in the electronics industry, detecting unwanted heat sources in circuits and equipment; and in medicine, determining the location of cold body parts caused by insufficient blood circulation and pinpointing blood clots.

But if a big market for solar cells and thermal imagers is still a few years away, that for classic optoelectronic components is already well established. Worldwide, some $600 million worth of the devices were sold last year, according to Hesse. West German firms alone produced more than $50 million worth, about half Europe's total, he says. □

Electronics abroad

Paris air show rings with cheers

Avionics makers poised for period of heavy buying for both civil and military aircraft programs

by the European editors of Electronics

If Europe's major aerospace electronics makers were to send up a skywriter this week for the opening of the biannual Salon International de l'Aéronautique et de l'Espace—the Paris air show—at Le Bourget airfield, their message might well be "Hallelujah." For they seem on the threshold of one of the best of all possible eras—one where heavy production of passenger planes will coincide with solid programs for military aircraft. Some satellite programs will also bolster business.

All this means a heady change of altitude for avionics companies. At the last Paris show, they were a somewhat anxious group. Business was not bad; exports of military aircraft were high and major domestic procurement for the Tornado multirole combat aircraft and the F-16 was in sight. But few civil aircraft were coming off production lines.

Now, however, the wide-body European Airbus has blossomed into a bestseller. By the end of May, Airbus Industrie had logged 218 firm orders for its A-300 and A-310 planes, plus options for another 127. And that is just the beginning. Some aviation industry forecasters figure as many as 1,000 Airbuses will be sold. That would add up to something like $1 billion of business for avionics producers.

France. The euphoria, from the rash of announcements by Airbus Industrie that still another of the world's airlines has ordered a batch of Airbuses, has been tempered in France by a fairly stagnant domestic market for military aircraft. So much so that Electronique Aérospatiale, a subsidiary of the nationalized airframe maker Société Nationale Industrielle Aérospatiale (SNIAS), is making a major move away from military avionics, reports its commercial director, Jacques Dupré.

The next big program on the slate of the French air force is the Mirage 2000 air-superiority interceptor, built by Dassault-Breguet Aviation. Volume production, though, is not slated to begin until 1983. The main avionics benefactors will be Thomson-CSF, Electronique Marcel Dassault (EMD), the Société d'Applications Générales d'Electricité et de Mécanique (Sagem), and SFENA. EMD will build the main computer and collaborate with Thomson-CSF on the radar for the interceptor version. Sagem has the contract for the inertial navigation platform, and SFENA for the autopilot. Looking ahead toward the time when the Mirage 2000 will be sold to foreign countries as a multirole aircraft, Thomson-CSF has developed a multifunction radar for that version.

West Germany. Avionics people in West Germany, except for a few long-range planners already concerned about things like the tactical combat aircraft of the 1990s, are flying high. Along with the Airbus, they have going for them the Tornado fighter, the Franco-German Apha-Jet trainer, and some strictly West German projects as well.

Of military aircraft, the Tornado, a joint project of West Germany, the United Kingdom, and Italy, is the mainstay. The three countries have built 16 prototypes and started volume production. The West German air force has ordered 322 of them, which should keep the assembly lines busy for some time to come. Substantial business will come from the Apha-Jet trainer, too; some 200 of them are in the offing.

National projects are also keeping the industry hopping. Of note is the hot-selling BO105 helicopter. Messerschmitt-Bölkow-Blohm GmbH (MBB) has delivered more than 400 worldwide. Although several years old, the BO105 project is still going strong. MBB has a firm order on hand from the West German armed forces for some 400—200 for observ-

Taking a hard look. When it comes to radars, France's Thomson-CSF is a European leader. This radar-control facility is located at the Eurocontrol center in Karlsruhe, West Germany.

Traffic Control for GPIB

Intel's new Talker/Listener and Controller give you the green light for simplified IEEE-488 systems.

Microprocessors are revolutionizing the instrumentation marketplace. Thanks to GPIB, systems manufacturers have the first standard interface that allows intelligent instruments to communicate with each other. Now the leading supplier of microprocessors delivers two peripheral chips—a Talker/Listener and a Controller—that make it even easier to get on the IEEE-488 bus.

Instead of building your own interface logic, use Intel's 8291 Talker/Listener or 8292 Controller. They'll save you time, space and money. Used together they let you implement all the IEEE-488 Standard bus functions without additional hardware or software. There's no more efficient traffic control for microprocessor-based systems.

Implement the full interface standards

Our 16-register Talker/Listener operates within a 1-8 MHz clock range, so you can use it with a wide variety of microprocessors. It performs all the interface functions described by the IEEE-488 Standard: programmable data transfer rate, handshake protocol, talker/listener addressing procedures, device clearing and triggering and both serial and parallel polling schemes.

But the 8291 gives you even more control.

For flexibility beyond the call of duty, Intel's Talker/Listener has three addressing modes. According to your application, you can address 8291 as either a major or minor talker/listener with either primary or secondary addressing.

Selectable interrupts and EOS

8291 lets you initialize interrupt conditions, too. Any of 12 interrupt status bits can be enabled, giving the Talker/Listener full status communication with the microprocessor.

Finally, the 8291 is the only LSI device to offer EOS (end of sequence) message recognition. Working with a GPIB controller device, this EOS capability means added control in handling multi-byte transfers.

First GPIB controller-on-a-chip

Now the GPIB control function is in LSI form, too. Our 8292 Controller communicates with the Talker/Listeners in your system to complete implementation of the IEEE-488 Standard, including transfer control protocol. It also executes service routines as indicated by interrupts and allows for seizure of control and/or initialization of the bus without destruction of ongoing data transmission.

Intel gives you the go ahead

You can depend on Intel for the latest advances in microcomputer technology. Everything you need for tomorrow's instrumentation systems is here today, from microcomputers to the broadest range of memory and peripheral components available.

Now you can build with Intel's new IEEE-488 Talker/Listener and Controller chips. For detailed information, contact your local Intel sales office or write: Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA 95051.

intel® delivers.

Europe: Intel International, Brussels, Belgium. United States and Canadian distributors: Arrow Electronics, Alliance, Almac/Stroum, Component Specialties, Cramer, Hamilton/Avnet, Harvey, Industrial Components, Pioneer, Sheridan, Wyle/Elmar, Wyle/Liberty, L.A. Varah and Zentronics.

ation and liaison purposes and another 200 for use as antitank helicopters. By the end of this decade, "we expect to have sold around 1,000 of them," an MBB spokesman says.

Other mainstays at Munich-based MBB are the French-German missile projects Hot, Milan, and Roland as well as the West German air-to-ship missile Kormoran. In addition to that comes the business that MBB expects to do in connection with the European Space Agency (ESA) satellite Exosat and with the Intelsat communications satellites.

Great Britain. Like their counterparts in West Germany, Britain's avionics makers have the advantage of a strong roster of multinational projects and national projects. On top of that, they have very heavy export business. "We are extremely buoyant and tremendously optimistic," explains Malcolm Moulton, a marketing executive for Marconi Avionics Ltd.

Behind the upbeat mood at Marconi are two major national programs. The AQS-901 antisubmarine system has meant orders worth well over $200 million. And Marconi has a money machine in the Nimrod airborne-early-warning system, Britain's version of the U. S.'s Advanced Warning and Control System; there are more than 100 avionics units on each of the Nimrods Britain will build. Marconi's successes abroad include the heads-up display for the F-16 going to the U. S. Air Force and four members of the North Atlantic Treaty Organization.

Smiths Industries Ltd., too, has success in the U. S. to add to its momentum. The company's automatic throttle controls are standard on Boeing Aircraft Co.'s 727 and 737 jets; Smiths hopes that at a time when fuel economy has become of prime importance it can get a share of the engine-control and flight-control business for the A-310. At the Paris air show, Smiths will display a microprocessor-based fuel-control system accurate to within ±1%, compared with only 2.5% for conventional controls, it says.

Italy. Prospects for Italian aerospace electronics range from moderate to satisfying, with most companies predicting sales gains between 10% and 12% for avionics gear. However, Selenia, the country's top producer of radar equipment and missile systems, figures to do better than most. "We expect an increase in turnover of about 20% over the next 18 months for terrestrial systems," says Peter Jorgenson, a marketing manager at the company.

To make that mark, Selenia is counting on exports, as are other Italian avionics companies like CGE-FIAR and Telettra SpA. But there is a key domestic customer, as well: airframe manufacturer Aeritalia SpA. Owned by the government, it has a piece of Boeing's 767 medium-range passenger jet.

Government indecision on spending for space programs has industry officials in Italy a bit uncertain about what to expect in this field. There is political wrangling over how much should go toward European programs and national programs. "I think it is safe to say," says trade association official Enzo Brancaccio, "that we can expect to see govern-

Pointed effort. Thomson-CSF and Engins Matra have a ground-to-air defense system with a range of 10 km. Called Sica, a French word for dagger, the system has had three successful firings. In the test shown, the missile passed within 1 m of a towed target.

ment spending of roughly $50 million a year for the next five years on national programs for TV satellites and roughly $60 million a year, for the same period, on ESA projects."

Up north. Belgium, Denmark, the Netherlands, and Norway are fitting out their air forces with F-16s and the big business in avionics, of course, is their share of the subcontract work for the General Dynamic fighters. When the papers for the sale of the century, as it was called, were signed in 1977, this avionics offset was estimated at $400 million; inflation will bloat the figure.

One big chunk is the radar system—$55 million in subcontracts from Westinghouse Electric Corp.'s Defense and Electronics Systems Center to companies in all four countries.

Among other F-16 systems, the inertial navigation set is in production. Danish firms have contracts for the fire-control and the flight-control computers.

In Sweden, the parliament has put a very low ceiling on the long-term outlook for avionics producers. A clear majority there wants a major cutback in funds for development of military aircraft, so there will be no follow-on to the Viggen, the air force's current mainstay aircraft. Missiles are something else. Saab Bofors AB, formed last year to purvey missiles of its parent companies—Saab-Scania AB and Bofors AB—now has its first order, for $150 million worth of long-range, sea-to-sea missiles for the navy. The company expects the air force to order a similar batch of air-to-ground missiles. □

NOT SINCE DARWIN HAS AN EVOLUTION BEEN SO REVOLUTIONARY.

Fairchild's Xincom 5582 25 MHz memory test system is a revolution in semiconductor testing. The 5582 is designed to test the new generation of RAMs and ROMs that require cycle times down to 40 ns, pulse widths of less than 10 ns, and corresponding fast rise and fall times.

What makes the 5582 so revolutionary is the fact that it's really an evolution. It's the latest in a long line of Xincom memory test systems. Like all Xincom systems, it's based on proven distributed architecture. And unlike most new systems, it won't make you suffer through long, expensive software development. That's because it's fully compatible with the existing Xincom III software base. This is part of Fairchild's commitment to protect your software investment. That's a big savings when you consider that 75% of your total testing cost is software-related.

The 5582 can handle functional and parametric testing and can be used in both engineering and production. It can test up to four devices in parallel or can be used with one or two test heads in a time-multiplexed mode.

The Xincom model 5582 gives you a true 25 MHz. It has no limitations or compromises that reduce test speed. Its fully digital timing system gives you inherently stable and accurate pulse definition. The 5582 is the solution to your high-speed testing needs for today and for tomorrow.

The Xincom 5582 is backed by the largest service and support team in the industry. Worldwide training. Over 20 major field service centers in the U.S., Europe and Asia. And a global network of applications specialists to help you get the most from your Fairchild system.

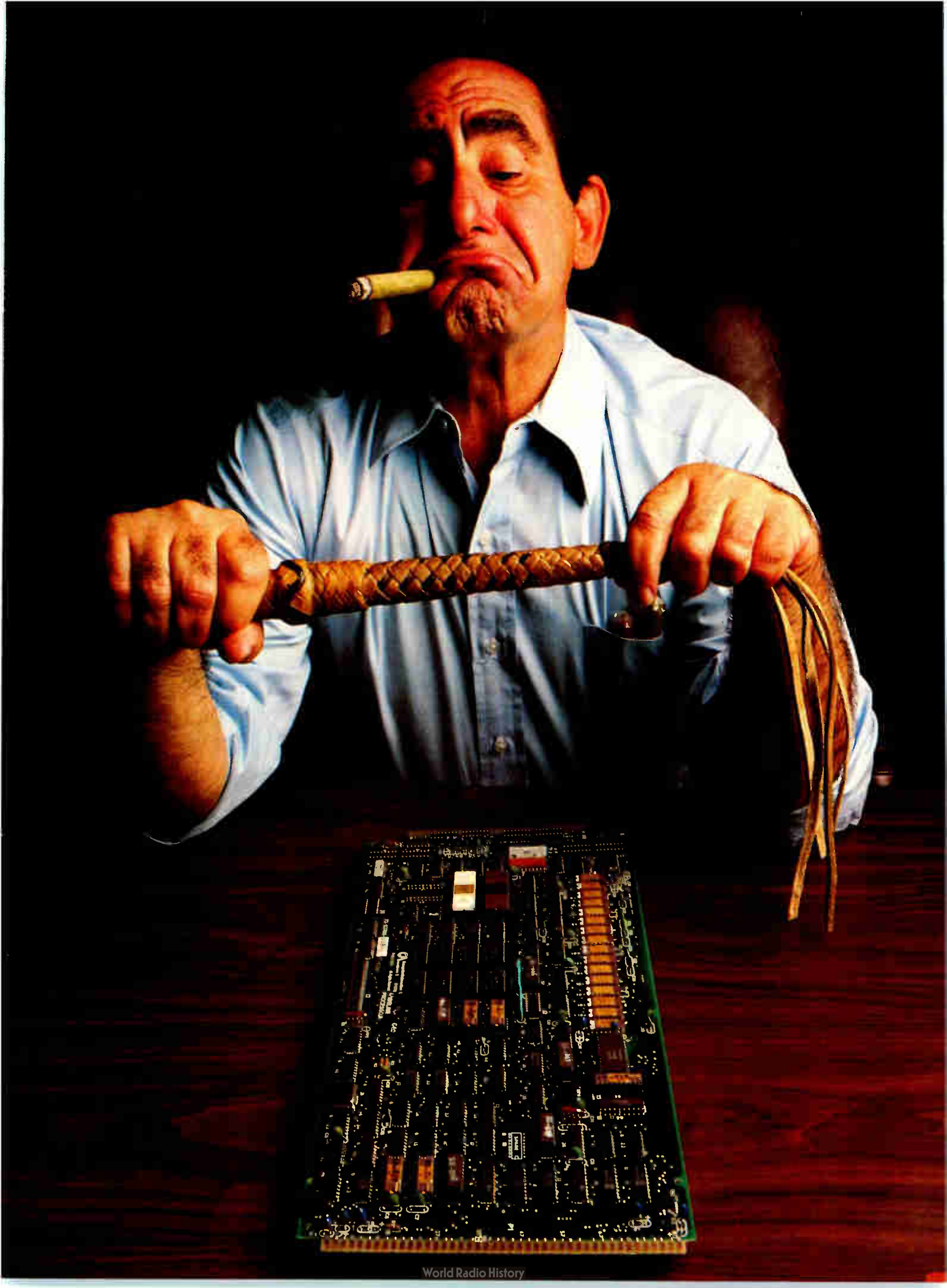
No one else has such an evolutionary 25 MHz memory test system. And no one else can offer as thorough support. But then, no one else has such a good reputation to maintain.

For more information about the Xincom 5582 25 MHz memory test system, just contact your nearest Fairchild sales office today. Or write Test Systems Group, Fairchild Camera and Instrument Corporation, 1725 Technology Drive, San Jose, Calif. 95110. Tel: (408) 998-0123. TWX: 910-338-0558.

FAIRCHILD

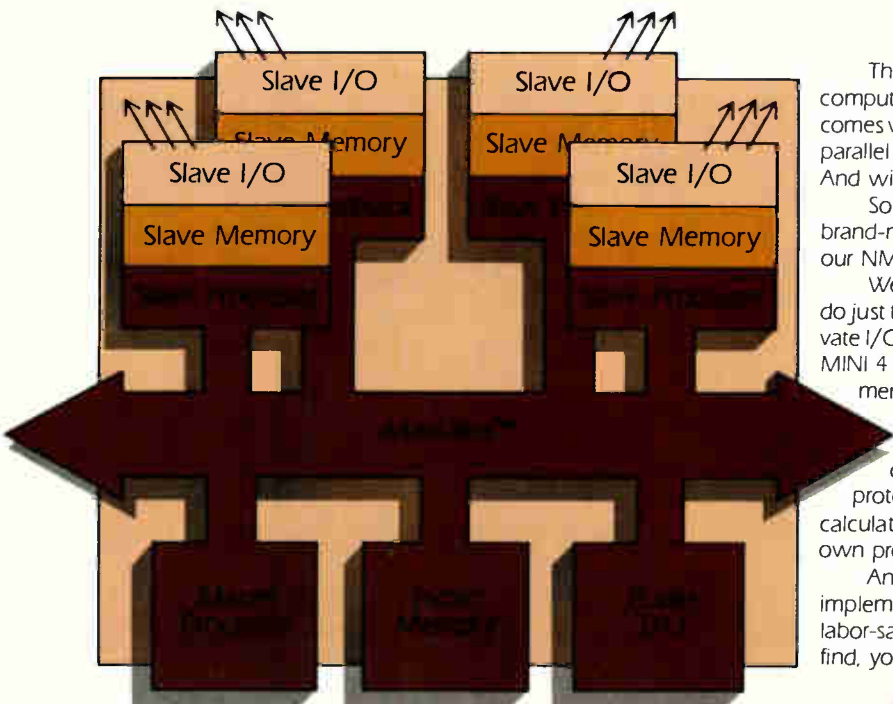
TEST SYSTEMS GROUP

The first family of ATE.



INTRODUCING "SLAVE COMPUTING."

Finally. An innovative alternative to multi-processing.



There is a powerful difference between slave computing and multi-processing. A slave computer comes with its own memory and I/O. And it operates in parallel with the host processor. On the same bus. And with minimal software headaches.

So we've implemented this concept with our brand-new 4/10S (the "S" stands for slave) to work with our NM4 and LSI-2 as masters.

We made sure the 4/10S is well-equipped to do just that. A private, 32K byte RAM memory. Four private I/O ports. A real-time clock. An extended NAKED MINI 4 instruction set. Plus, full access to its master's memory and peripherals.

Working in parallel with a master, up to four 4/10S computers can process all kinds of off-loaded tasks. Like communications protocol jobs. Process control work. Even complex calculations. All without slowing down the hosts' own processing chores.

And our system's software makes it easy to implement. Contact Computer Automation for the labor-saving details. With good help getting harder to find, you can't beat it. Not even with a whip.

ComputerAutomation
NAKED MINI. Division

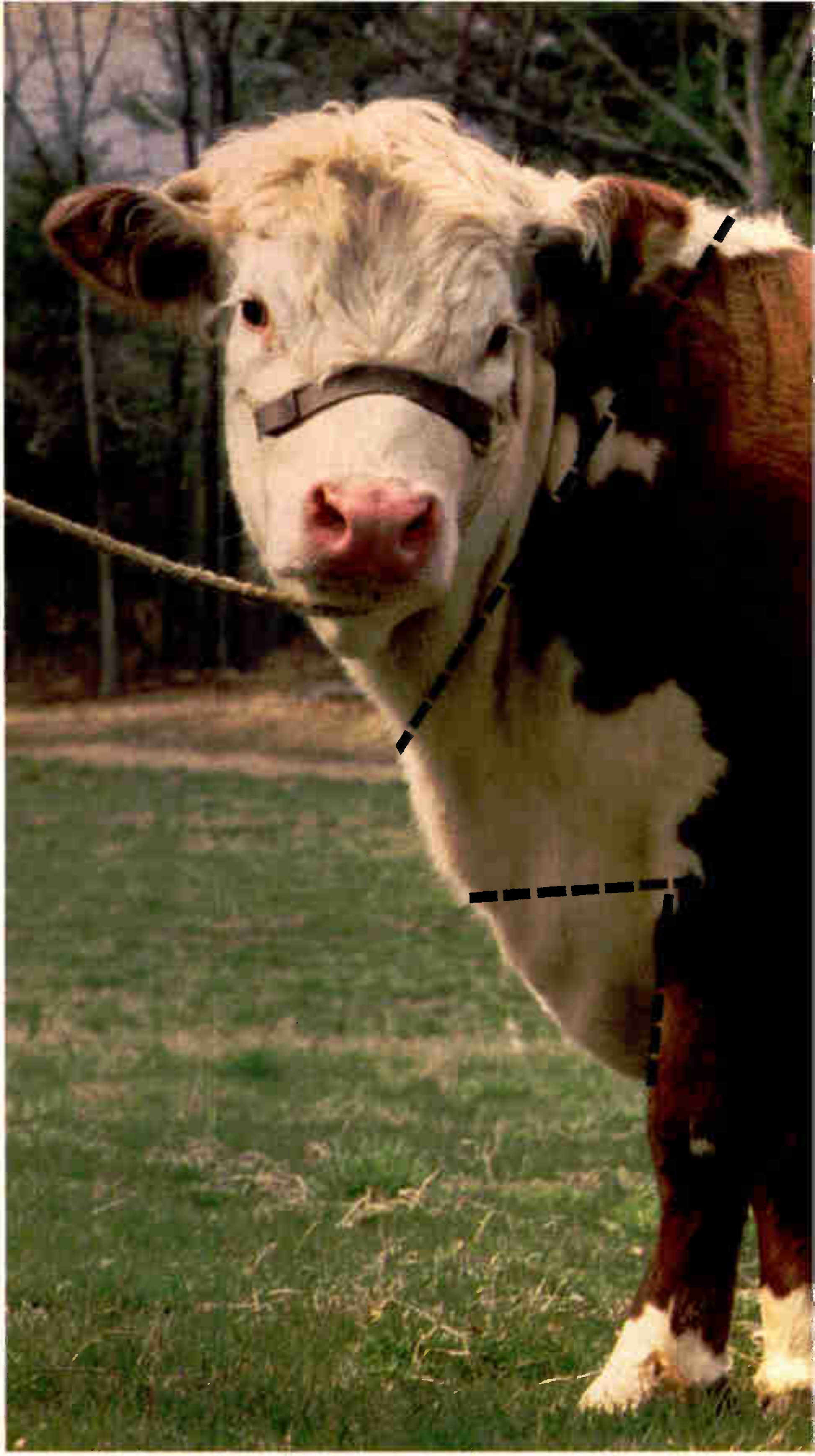
WHERE OEM'S COME FIRST.

18651 Von Karman, Irvine, California 92713 • Telephone: (714) 833-8830 TWX: 910-595-1767

Or contact any of our local offices: Santa Ana, CA • Santa Clara, CA • Denver, CO • Orlando, FL • Atlanta, GA • Bensenville, IL • Waltham, MA • Livonia, MI • Bloomington, MN • Bloomfield, NJ • Greensboro, NC • Cincinnati, OH • N. Olmstead, OH • King of Prussia, PA • Pittsburgh, PA • Nashville, TN • Dallas, TX • Houston, TX • Bethesda, MD • Norfolk, VA • Bellevue, WA • Toronto, Canada.

Circle 18 on reader service card

IF OUR NEW LSI LINEAR TESTER CAN'T MEET YOUR NEEDS YOU'LL HAVE A LEGITIMATE BEEF.



Free steak for a year.

If you buy Linear IC test equipment for your company, and you can prove to us that our new LTX Space Saver, the revolutionary LLSI Test System, can't test your devices better than any other system, then we'll deliver an assortment of selected prime steaks to your home every month for the next year. The same goes for proving that our LTX Space Saver is not forward or backward compatible with the high performance LTX you already have.

We don't care whether you're talking "jelly beans" or complex LLSI devices. The LTX Space Saver can simplify and optimize the testing of linear/analog circuits today, and tomorrow.

Our challenge stems from the incredible accuracy, flexibility and throughput of the LTX System. Our confidence stems from our extensive experience in LLSI applications.

The LTX Space Saver is as different from other linear (or, digital) testers as the vacuum tube is from the semiconductor. It's unique modular architecture integrates hardware and software into a single system designed to speed up payback by speeding up throughput and improving yield. (In some cases, 20X to 30X that of the competition.)

You don't need specialized computer knowledge or experience to program, debug or update job plans thanks to LUCID, our own simplified version of Extended BASIC. In addition, LTX can integrate into its system the most precise laser positioning equipment available. This allows testing and functional trimming of thin film circuits to be performed concurrently.

Technological leadership.

Most functions on the in systems. The MC6801

Power, speed and the unique design flexibility of multimode operation put Motorola's MC6801 single-chip microcomputer in a class by itself. It's general purpose in application, high in performance and packs more function on the chip. All 'round, it's unequalled.

An unprecedented combination of on-chip functions with the CPU includes 2K bytes of ROM, 128 bytes of RAM, 31 parallel I/O lines, a serial communications I/O port, a clock and a 16-bit programmable timer.

User-selectable operating modes.

Each of the operating and self-test modes is built-in and user-selectable, for either testing or shipping.

In the single-chip mode, all ports are configured for I/O, with a total of 29 I/O and two control lines.

In the expanded non-multiplexed mode, no external logic is required to directly address 256 external locations including any and all M6800 family peripherals. Thirteen to 20 I/O lines are still available.

The expanded multiplexed mode enables an impressive 64K-byte addressing capability.

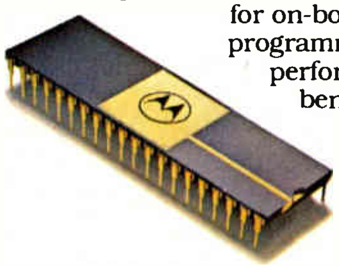
Other modes facilitate testing and other special operations. It's an unparalleled state-of-the-art advance in design convenience. In all of these modes, the on-chip 16-bit timer can count or time events and generate or measure pulses.

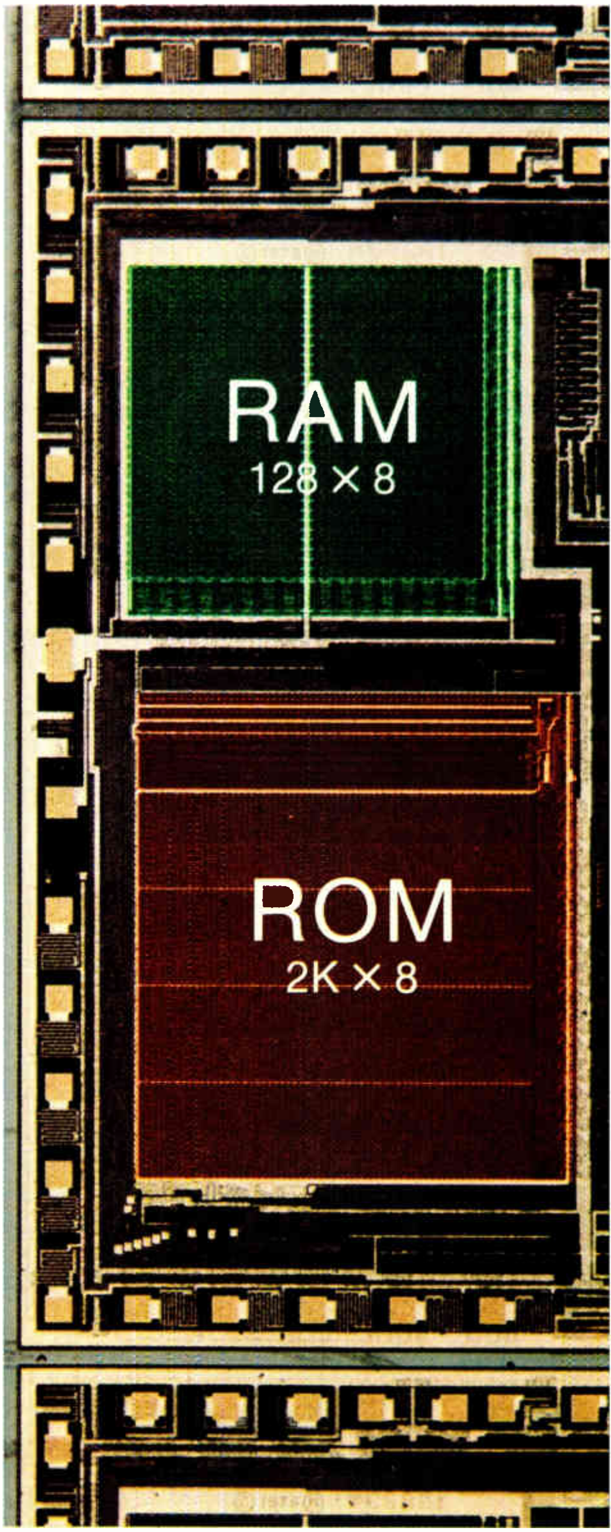
The on-chip fully-buffered serial communications interface offers operation at four baud rates—full duplex asynchronous formats. The SCI operates at over 75K baud, and other special features—such as wake-up, NRZ and biphase—promote efficient multiprocessor system configuration.

The CPU of the MC6801 is an enhancement of the highly-capable MC6800, which puts seven addressing modes at the designer's disposal. An MC6800 machine code-compatible instruction set is expanded by new 16-bit instructions, including a 10 μs hardware multiply. Execution time of most instructions has been reduced to increase throughput.

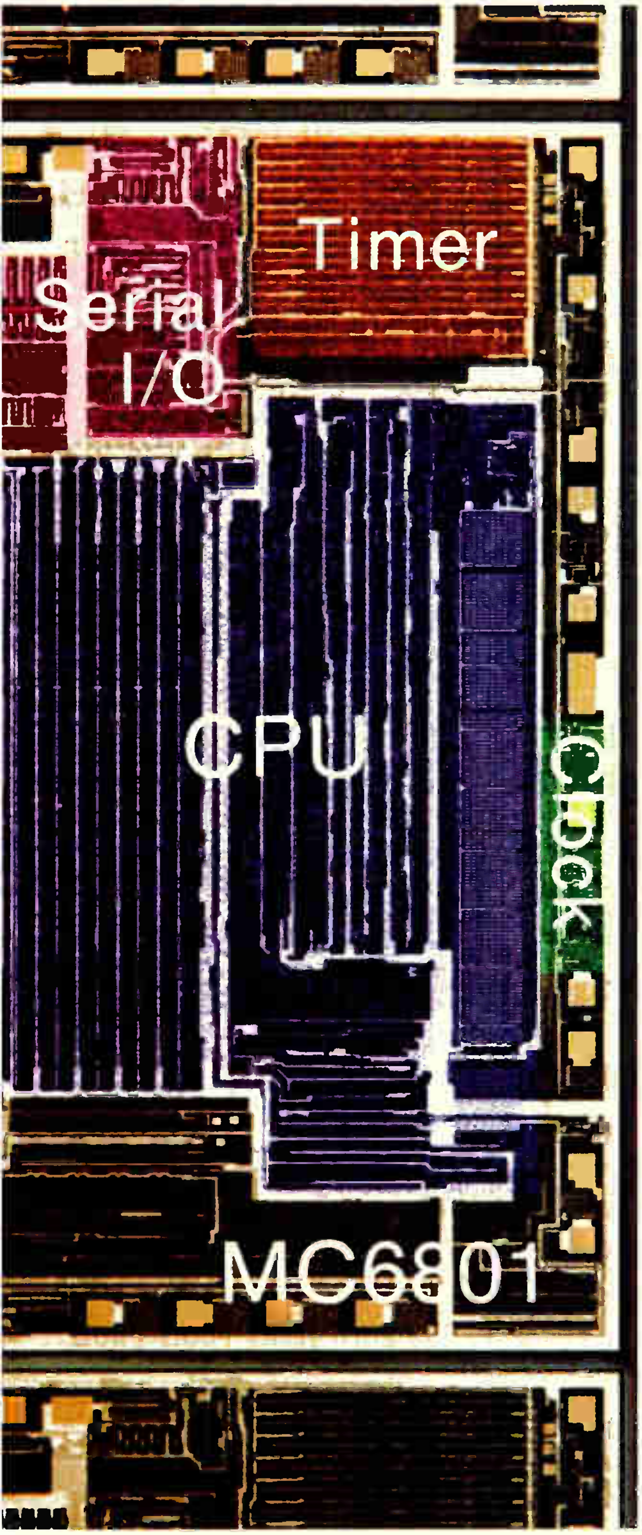
Gets you to market faster

Compare the MC6801 with any other general-purpose single-chip microcomputer available today for on-board hardware capability, programming ease and system performance. Do whatever benchmarks are appropriate for your application or just take our word for it: the MC6801 can get you to market faster with more aggressive designs.





chip, most performance one-chip microcomputer.



Watch for user-programmable version.

MC6801 Microcomputer users will soon be able to do their prototyping with EPROM right on the chip.

The world's first high-performance single-chipper with EPROM on board, the MC68701, is an MC6801 with 2K bytes of MCM2716-equivalent EPROM instead of mask-programmable ROM. The MC68701 is ideal for low-volume systems, initial production field test units of a user system, or those which may require reprogramming in the field. It especially aids prototyping because the control program is easily evaluated and changed during development.

Watch for the availability announcement soon.

MC6803 for larger applications.

If your control program requires more capability than the on-chip 2K ROM of the MC6801 can handle, the no-ROM MC6803 is available at a reduced price. Operating only in the expanded multiplexed mode, the MC6803 still offers 13 programmable I/O lines, the program timer, the serial communications interface and 128 bytes of RAM. (At a further reduced price, the MC6803NR has no on-chip RAM or ROM.)

Total MC6801 support.

Motorola supports the MC6801 in every way. The entire, fully-compatible M6800 family provides a broad range of microcomponents and memories for system expandability. EXORciser™ development systems and Motorola development software support all M6800 family units, including the MC6801, with real-time emulation capability.

For additional information, contact your Motorola sales office or authorized distributor, write to Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, AZ 85036, or circle the reader service number.

Motorola's MC6801 is the world's most versatile single-chip microcomputer. It is representative of Motorola's dedication to product excellence in all phases of its discrete and integrated circuit operations supporting the designers and manufacturers of

Innovative systems
through silicon.

MOTOROLA INC.

When your design calls for SCR's or triacs...no one gives you the choice that Teccor does.

And — our electrically isolated packages are U.L. recognized.

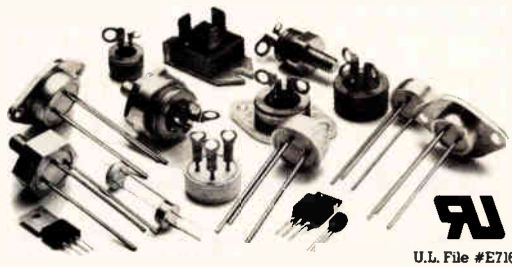
Teccor is a name you can specify with confidence. It's the company that pioneered electrically isolated SCR and triac packages. Teccor was well ahead of the times in development of thyristors for use in energy efficient applications — long before energy became a major design consideration.

Glass passivated device junctions insure long-term reliability. Devices are available with current ratings from 800 mA to 40 amps and voltage ratings up to 1000 volts.

And, when you specify Teccor, you know the products will be readily available when it's time for production runs. About one out of every three triacs made this year . . . will be made by Teccor.

So, no matter what case style best fits your design — chances are Teccor has it. Get your free copy of the Teccor catalog. It'll make it quick and easy to get the device you want in the package you need to fit your design.

How about SSR's in your choice of "normally open" or "normally closed" configurations? You'll find those in your Teccor catalog too.



U.L. File #E71639

Circle 21 on reader service card

TECCOR

TECCOR ELECTRONICS, INC.
P.O. Box 61447 Dallas, Texas 75261
214/252-7651

Putting Pascal to work, Part 1

Language extensions, utilities boost Pascal's performance

More versatile data structures, tighter statement definitions, and system software promote program reliability

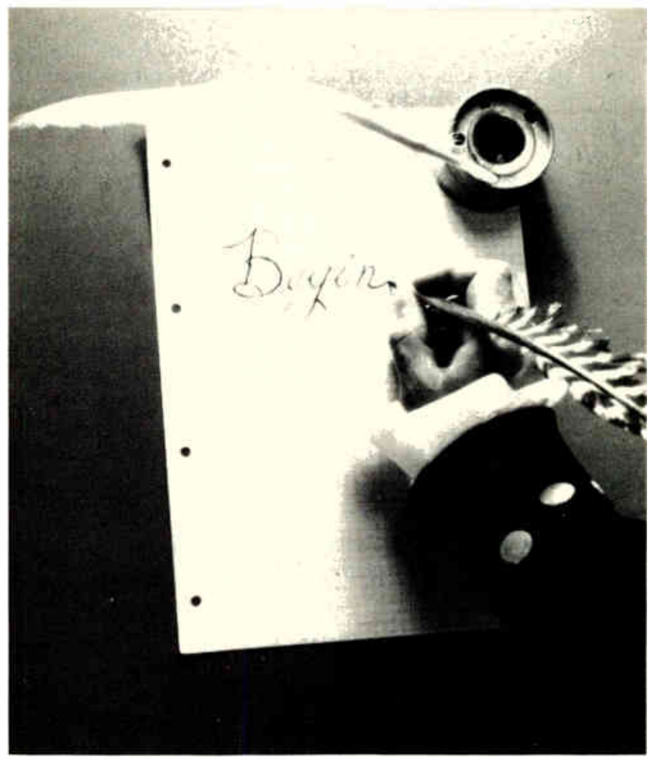
by Roger R. Bate and Douglas S. Johnson, *Texas Instruments Inc., Dallas*

Before Pascal emerged from academia, Texas Instruments Inc. was going over the language with a fine-tooth comb. Niklaus Wirth's brainchild was chosen for this scrutiny partly because it is easily understood and maintained—and partly because of the paucity of alternative choices.

Once Pascal was singled out, a working group proceeded to experiment with it in an attempt to extend its applicability across the entire spectrum of the TI computer product line. Efforts were also made to increase its usefulness in environments where a large number of users seek solutions to varied, complex problems.

This two-part article traces Pascal's three-year evolution at Texas Instruments. Part 1 focuses on TI's first crack at massaging the language to meet its corporate goal. The result, TI Pascal, retains the flavor of the original version, but has features that aid in program design, make it more successful in multiprocessing applications, and keep an even closer watch on sloppy programmers.

Part 2 is concerned with the most recent product of the continuing evolution of Pascal at TI: Microprocessor Pascal. This streamlined version of TI Pascal has some features removed and others added for users of the 16-bit 9900 family. A number of software tools accompany the firm's announcement of Microprocessor Pascal on June 1—a compiler, two executive programs, a text editor, a debugger, and a code generator. **-John G. Posa**



□ There is no longer any question that Pascal is an important language for the future of programming small and large systems alike. If the academic community gave it a warm welcome, industry's more deliberate reaction is turning out to be even more enthusiastic. Adoption by industry, not surprisingly, has dictated various modifications to the standard Pascal as codified by Niklaus Wirth over a decade ago.

Not long ago, Texas Instruments Inc. completed an extensive study of existing high-level languages in order to settle on a standard corporate systems language (see "The history of Pascal at TI," p. 112). Pascal emerged as the language of choice; a program was then undertaken to enhance the language's abilities.

Part 1 of this two-part article looks at Pascal's advantages for system programming and the facilities TI has added to it, including executive and utility programs introduced to aid in the software development process. Part 2, beginning on page 117, focuses on TI's Microprocessor Pascal and its two executive program packages.

A preliminary version of Pascal was drafted in 1968 by Wirth and associates, leading to a first compiler in 1970. After some evaluation and evidence of growing interest in the language, a revision was published in 1973 and a user's manual, describing what is now known as standard Pascal, in 1974. The original purpose of Pascal was to provide a language suitable for the teaching of programming as a systematic discipline. It was also hoped that reliable and efficient implementation would be possible on existing and future computers. It is based

The history of Pascal at TI

In 1976, Texas Instruments conducted an extensive internal study of existing high-order languages with the intent of adopting a standard system programming language. A series of selection criteria were adopted by a study committee to pit the spectrum of TI programming against the characteristics of existing languages. The most significant considerations were:

- Maturity—the language should have experienced several years of use to establish its limitations, range of applicability, user acceptance, and training ease.
- Reliability—the language should support testability, error detection, and error prevention. The most significant features that enhance reliability are strong typing of data, structured code, and structured data.
- Efficiency—its compilers and generated code should waste neither time nor space, for the sake of implementation on minicomputers and microprocessors.

Twenty languages were examined during this study. Fifteen of them were dropped fairly quickly when it became apparent that they were a long way from meeting the requirements or had compilers too complicated to implement on small machines. The features of five languages were examined in depth, and the final evaluation phase narrowed the field to two: Pascal and C.

Both are modern languages, with relatively little past use in comparison with languages like Fortran and Cobol, but both are being widely accepted in educational institutions and in some system programming projects. Pascal and C were carefully compared with the requirements in mind and, although they are quite different in their approaches, they turned out to be fairly equally matched as system programming languages.

However, TI had considerable experience with a Pascal-based language called Process Design Language II (PDL-2), which was designed for the Ballistic Missile Advanced Technology Center as a language for ballistic missile defense real-time software. PDL-2 extended standard Pascal, adding vector operations and capabilities for multiprocessing and synchronization. The language was implemented on the TI Advanced Scientific Computer and later transported to the CDC 7600. The very favorable experience with this language in reducing the cost of software development and in improving the readability of complex real-time programs resulted in the decision to adopt Pascal as the standard language for TI.

A steering committee met on an irregular basis to oversee the work of a full-time working group that defined a language based on Pascal but had adequate extensions for multiprocessing in a real-time environment. After agreement was reached on the definition of the language, a compiler was written to run on the TI 990 and the IBM 370. The TI Pascal compiler was made commercially available in 1978 by the TI Digital Systems Group as part of the standard software for the TI 990 minicomputer.

After the release of the TI Pascal compiler, it became clear that the language would be extremely useful for programming microprocessors for industrial and control applications. For that reason, a variant called Microprocessor Pascal has been designed. The language has fewer extensions than TI Pascal and is therefore somewhat more easily implemented on small computers. The Microprocessor Pascal compiler, in fact, will run on an FS 990 floppy-disk system that uses a TI 9900 microprocessor as its central processing unit.

on the language Algol 60, from which most of its control mechanisms are drawn. But it includes a number of innovations in the way data structures are defined. Algol 60 is not a subset of Pascal, although in much of its regularity and style the younger language is very similar to the older one.

Simple and structured statements

The actions described by a Pascal program are contained in the language's underlying statements. These statements are of several kinds. Simple statements, such as the assignment statement, allow the value of an expression to be assigned to the value of a variable. Procedure statements cause code located outside the currently executing sequence to be invoked. And goto statements force program control to jump to a labeled statement located elsewhere. (In hand-written Pascal programs and examples, word delimiters—reserved words—are generally underlined.)

Structured statements provide a degree of control over which of the simple statements are executed. The conditional if and case statements select a group of statements based upon the value of an expression that is computed prior to the selection. Repetitive statements such as while, repeat, and for permit repetitive evaluation of a statement or group of statements, depending upon the value of an expression. This value is altered during the execution of the controlled statements, thus allowing the statements to be repeated a desired number of times. In these respects, Pascal differs little from Algol and other Algol-like predecessors.

It is Pascal's data-structuring facilities that set the language apart from its forerunners and make it attractive for serious programming. Pascal greatly expands the concept of the data type. Although some of the primitive types are also in Algol 60, Pascal allows the construction of more complex types from the primitives. Furthermore, the language allows the user to define new data types and to name these with his own identifiers.

Each variable must be declared to have a type. When variables are used, the compiler checks to make sure that they are used consistently. This strong type checking, as it is called, pervades the language. It increases program reliability because the user is forced to define the intended use of each variable and because the aid of the compiler is enlisted to make an exhaustive check of his program to assure compliance with his stated intent. In this way, the benefits of an extremely flexible data-definition facility are provided along with automatic checking to insure correct use of complicated structures.

The simple data types primitive to Pascal include the scalar type and the subrange type. The scalar types defined in standard Pascal are integer, with values in the subset of whole numbers defined by the implementation; real, a subset of the real numbers; Boolean, with the values true and false; and char, the set of characters

TABLE 1: THREE OF PASCAL'S STRUCTURED DATA TYPES

	Arrays	Records	Sets

Definition	A: array |0. .99| of real;
	B: array |color| of integer;
	C: array |Boolean| of array |color| of char;
		R: record
		name: packed array |1. .10| of char;
		age: 0. .120;
		married: boolean;
		eyes: color
		end;
			type
			S = set of 0. .15;
			days = set of (mon, tue, wed, thu, fri, sat, sun);
			prim = set of color;
			var
			week, work : days;

Access	A |13| : = 3.14159; B |green| : = −1; C |true, blue| : = 'B';	R .name : = 'Pocahontas'; R .age : = 16; R .married : = false; R .eyes : = green;	work : = mon. .fri; week : = work + sat, sun;

recognized, again, by the particular implementation.

Additional scalar types can be defined by the user as ordered sets of elements, each assigned an identifier and consisting of an enumeration of other identifiers, thus:

color = (red, orange, yellow, green, blue);
error = (overflow, index, parity, protect);

Subrange types are user-defined subranges of other scalar types, such as:

percent = 0..100;
byte = 0..255;

Easy access

Pascal's complex or structured data types include arrays, records, sets, and files. An array is a data structure consisting of a fixed number of components, all of the same simple type. Access to an element of an array is provided by giving an expression for an index. This expression is evaluated to give a value of the proper type; the value is then converted into an integer that is the index of the desired array element. The resulting element value can be used in further operations consistent with its type.

A record consists of elements with a fixed number of components, defined by the programmer. In records, however, the components may be of different types. Each component or field is accessed by a name, called the field identifier. Fields of records are accessed by giving the record-variable identifier and the field identifier. The resulting value has the type specified for that field in the record definition.

The set type is a structure that represents a collection of objects of a given base, where the base is an enumerated simple type. For instance, the base may be a subrange of integers or a list of identifiers. A variable that is declared to be of the set type takes on values that are sets of elements of the base type.

One representation of the set type is a bit string of length equal to the number of elements in the base type, each bit being 0 or 1 depending upon whether the corresponding element is a member of the set or not. Set types are manipulated by operations that test set membership and return a Boolean value. Other set operators that apply are union, difference, intersection, and assignment. Table 1 gives examples of the array, record, and set types, as well as examples of references to the variable elements of the arrays, fields of the records, and the variables of the sets.

A file comprises a sequence of elements, all of the same simple type. It is accessed from one end and elements are added on the other end. Thus the number of elements in a file can change dynamically. A typical use of files is for input and output.

File elements are accessed by a read statement that names the file variable and the variable into which data is to be entered. Similarly, data values are added to files by a write statement that names the file variable and gives an expression to be evaluated. The compiler checks to make sure that the variable and the expression are of the same type as the components of the file.

Finally, the pointer type and the capabilities it provides are worthy of special mention. Declaration of a pointer yields a type which is associated with some other variable, such as a record. The statement new (pointer variable) creates a new instance of the type pointed to and sets the pointer variable to the address where the newly created data object is located. Data structures such as lists, trees, and graphs can thus be defined by linking their elements together with pointers. Each element in one of these structures may have one or more pointers to other elements in the same structure.

There are several major advantages to these data-defining capabilities of Pascal. First, the user may describe his data structures precisely to a compiler in order that his use of variables may be checked for consistency with their definitions. Second, the user may define very complex data structures to suit his needs without concerning himself with the actual implementation of the structure. He simply accesses it by indexing or by naming the part he wants. He does not, for example, have to remember (as he would in Fortran) which elements of an array represent "age" and which represent "social security number" since he can define the fields of a record with appropriate names and types.

A third advantage of data-structure definitions is that they may be changed to add new fields or to rearrange fields in records without a corresponding change in the source code where these elements are accessed. The consequences of changes in data definitions are automatically propagated by the compiler into object code. These capabilities are not only convenient, they are important

PROGRAM 1: USE OF DYNAMIC ARRAY, CASE EXTENSIONS, AND ESCAPE

```
PROCEDURE SCAN
    (VAR A: ARRAY [1..?] of CHAR;  VAR I,L: INTEGER);

{This procedure scans for the next identifier in the string A.
 I is the current index in the string, and L is the length of
 the identifier found. If next non blank in A is not a letter,
 a length of zero is returned.  An identifier is a letter
 followed by any sequence of letters and digits.}

Begin {SCAN}
     While I < UB(A) and A[I] <> ' ' do              " skip blanks
          I := I + 1;
     L := I;                                     " save initial index
     If A[I] in ['A'..'Z']     " if first char is letter, continue
          then
          begin
LOOP:          While I < UB(A) do           " scan letters and digits
                    Case  A[I] OF
                         'A'..'Z':   I := I + 1;
                         '0'..'9':   I := I + 1;
                         otherwise   escape LOOP;
                    end {Case};
                    L := I - L + 1;     " length of scanned identifier
          end
          else
               L := 0;        " if first char not letter, return zero
end {SCAN};
```

in increasing the reliability of programming efforts and reducing their cost.

In Pascal the primitive types all have imposed on them the usual arithmetic and logical operations seen in other languages—for instance, assignment, addition, intersection of sets, and disjunction of Boolean expressions.

Extensions

While standard Pascal has most of the features needed for system implementation in general, some characteristics of the language make it awkward in environments where a large number of programs are written by many people. This is particularly true in an atmosphere where libraries of general utility programs must be provided. For this reason, a number of extensions and modifications to the language are included in TI Pascal to make it more suitable for industrial use.

Standard Pascal defines only sequential fields that are read from one end and to which elements can be added on the other end. In many data-base applications, however, it is desirable to access elements of a file by index. Such random access is equivalent to indexing into an array, but the array cannot be dynamically extended. This desirable combination of facilities is implemented by giving an additional parameter to the read and write statements: an expression, evaluating to an integer, that describes a position in the file.

Standard Pascal does not provide statically allocated variables in the way Fortran's common and Algol's own declarations do. Memory space for statically allocated data is computed and fixed when the program is compiled. In Algol or Pascal, on the other hand, the underlying machine model is an idealized stack-based computer. The local variables of a routine appear while it is executing and they disappear when the routine is exited. The stack used for the variables collapses.

In other words, Pascal variables are restricted in scope. The scope of any item defined within a routine or procedure is that portion of the program in which its definition is recognized.

So standard Pascal cannot extend the definition of a variable in one routine into another routine in the way Fortran's common statement and Algol's own statement do. Many programmers feel this is essential, so Fortran's common statement is implemented in TI Pascal. This permits external (Pascal, Fortran, or Cobol) subroutines called from a Pascal program to share variables and also yields the equivalent of Algol own variables. Control over access to these variables is provided by requiring that such access be in the scope of the appropriate common declaration and that it be specifically allowed by an access declaration in the calling program module.

The restriction to fixed-length arrays and sets in Wirth/Jensen Pascal makes it extremely difficult to write general utility routines that are compiled separately from the user program, such as sorts and searches. For this reason, TI Pascal permits the upper bounds on arrays and sets to be variable values, determined at run time.

Some modification to the syntax of procedure and function parameters is required to pass array and set variables dynamically: the size and upper-bound information is passed at the same time as the array is passed. Dynamic bounds have a cost in terms of extra overhead, but this feature is designed so that the penalty is not paid when constant bounds are used. This extension does of course add somewhat to the complexity of the compiler.

More data types

Much of the system programming in an industrial environment is done on computers that do not have built-in floating-point operations. A data type is therefore included in TI Pascal that permits the user to declare the scaling of variables and to have the compiler construct the necessary shifts for operations on these variables using the integer arithmetic built into the machines. Where such arithmetic is appropriate, it can return very large savings in time over floating-point software subroutines.

In many business applications, Cobol programmers have become accustomed to the arithmetic provided by decimal machines or instructions. This data type was also included to make TI Pascal more appropriate for this utilization. Multiprecision integer and real variables were added to allow the programmer to control the precision of arithmetic and results.

The repetitive constructs in standard Pascal are somewhat inconvenient in certain searching and testing loops where there is a need to escape upon detection of some condition other than the normal termination condition. Pascal provides the goto statement that can solve this problem, but goto control opens up other possibilities for unreliable code if it is not used judiciously. An escape statement was added to provide for explicit exit from a labeled structured statement by branching to the statement immediately following the labeled one. This feature eliminates most of the reasons for the goto statement, but it remains in the language.

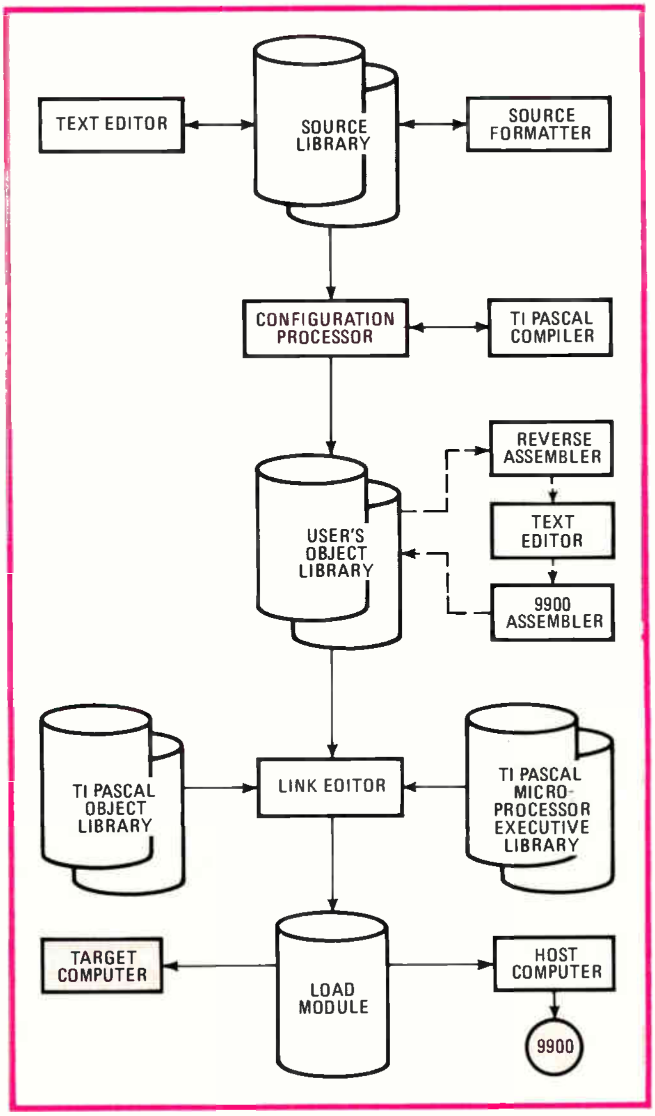
The strong type checking of Pascal is of great value for most application programs, as it provides a great deal of security for the programmer and enhances the reliability of the code. However, in a few cases—most frequently arising in systems programming—there is a need to get around the strong type checking. In standard Pascal this is awkward and error-prone. For that reason, an explicit operator (double colons::) is added to override the declared type and specify the variable to be of another type. Thus, the compiler allows an otherwise illegal operation.

This localized and explicit overriding is much more reliable and convenient than the other techniques. Obviously, such operators are extremely dangerous if they are not used judiciously, and they may seriously decrease the ability to transport programs from one implementation to another.

A few modifications to Pascal are incorporated primarily to tighten up rather loose definitions in the original Wirth implementation. These changes may make some Pascal programs incompatible with TI Pascal

TABLE 2: EXTENSIONS AND MODIFICATIONS IN TI PASCAL

- Random-access files
- Common (statically allocated) storage
- Dynamic upper bounds on arrays and sets
- Multiprecision real and integer variables
- Escape statement for explicit exit from a labeled repetitive statement
- For statement control variables are confined to have local scope
- Otherwise clause added as default case statement alternative
- Explicit type override operator
- More standard Boolean operator precedence



Tools. Shown here are some of the tools provided in the TI Pascal system. The configuration processor selects which source-library routines will be complied. The reverse assembler, which converts machine code into assembly language, is helpful for debugging.

TABLE 3: THE SCOPE OF NESTED PASCAL PROCEDURES

Scope of:	A	B	C	D	E
Procedure A;	•				
variables for A;	•				
Procedure B;	•	•			
variables for B;	•	•			
Procedure C;	•	•	•		
variables for C;	•	•	•		
body of C;	•	•	•		
Procedure D;	•	•		•	
variables for D;	•	•		•	
body of D;	•	•		•	
body of B;	•	•			
Procedure E;	•				•
variables of E;	•				•
body of E;	•				•
body of A;	•				

in minor ways. Nevertheless, the resulting language seems to be much more capable of being precisely defined.

For instance, the control variable in a standard Pascal for statement is presumably undefined outside the for statement, yet no restriction on using the control variable is enforced by standard Pascal. A restriction was added to the TI compiler that confines the control variable's use to its for statement.

Another example concerns side effects, or alterations in a function's operational environment caused by the function itself. Side effects are generally considered undesirable, but they are not all eliminated by the standard Pascal compiler. A side effect is an action that is extraneous to basic execution of a function; this action may or may not be defined in the language. For example, if a square root routine is passed an argument x, it should not change the value of x in the process of returning a value for the square root of the number.

TI Pascal does not allow any function to change the value of a parameter it is passed. Nor does it allow any function to alter the value of global variables or to call other procedures.

The capability of Pascal's case statement was enhanced by providing an otherwise clause. The otherwise clause is a default alternative, selected if the case index doesn't match any of the case labels. Subrange case labels were also implemented: these allow the programmer to specify a range of values for a case alternative. If the same alternative is to be indicated by values 1, 2, and 3, standard Pascal requires a label for each value. TI Pascal allows a single label for the three, using the expression 1. . 3. These case statement extensions are illustrated in Program 1. It also illustrates the use of a dynamic array and an escape label.

One of TI's more controversial changes is a return to the precedence for Boolean operators used in Algol and Fortran. Wirth Pascal's precedence for Boolean operators was unlike that of either Algol or PL/1—it defined a whole new choice in this important area.

This tightening up of the language may inconvenience some programmers, but program maintenance and reliability is substantially improved. And the resulting code is more readable: it contains few if any hidden surprises. Table 2 summarizes some of the modifications and extensions in TI Pascal.

As might be supposed from the number of extensions in TI Pascal, the compiler is somewhat larger than the standard compilers and does run more slowly. Nevertheless, the optimization that has been included provides for reasonably compact and efficiently executed code.

The TI Pascal compiler has three phases, which may be roughly described as a lexical-analysis phase, a translation into an intermediate language, and code generation, in which the intermediate language is translated into the code of the target machine. This structure was chosen in order to maximize transportability of the compiler; that is, to make it possible for programs written in the language to be carried from one machine to another. This portability has been extremely successful. TI Pascal compilers and other Pascal programs have been transported between IBM's 370 and TI's 990 and 980 minicomputers without significant problems. An added benefit has been the simplicity of designing cross-compilers.

The environment

The introduction of a new language requires more than the writing of a compiler. There is a set of associated software tools that must go along with any compiler to help the writer use the language efficiently and to increase his reliability and productivity. Several of these tools are included in the package distributed with the compiler, because they are essential or highly desirable for Pascal programming.

The most significant tool is a configuration processor, depicted in Fig. 1. This automates most of the clerical work associated with the coding of a very large program, which may consist of many modules. The user defines a hierarchy of modules in libraries to match the hierarchy of declarations in the Pascal program. (Table 3 shows the scope of routines and their variables in a typical program.) The configuration processor is then able to select, in proper order, the declarations of global variables and routines that must be included for successful compilation of one or more modules of a program and to retain control over the object modules that are produced.

These declarations make all the necessary type definitions and variables available when the module body is being compiled. In this way, the minimum amount of information is handled for each compilation. In addition, separate compilation in a scoped language becomes a very feasible and reliable activity. This clerical tool has been found to be essential for large Pascal programs.

Also provided is a program that accepts Pascal source-program text and prints it with standard indentations to display its structure. This is useful for documentation, to show the programmer the structure that he has actually created, and as a debugging tool. It is also possible to print out an assembly language representation of the machine code generated by the TI Pascal compiler, if it is required for specific debugging activity, with a reverse assembler program.

Putting Pascal to work, Part 2

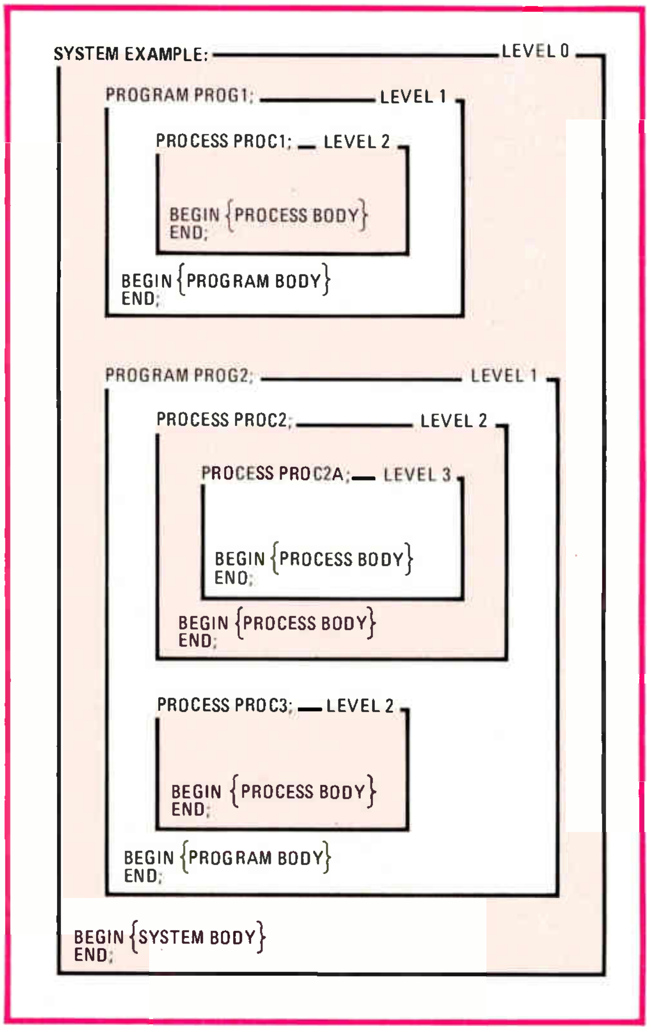
Pascal software supports real-time multiprogramming on small systems

by Roger R. Bate and Douglas S. Johnson,
Texas Instruments Inc., Dallas

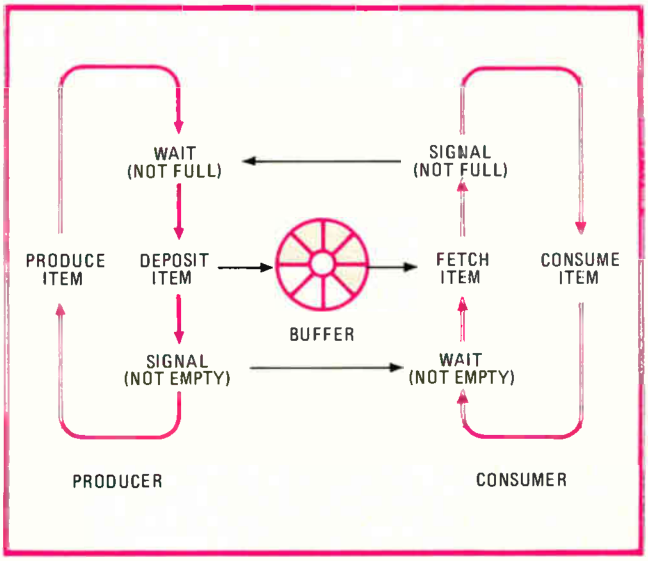
☐ Industrial and other real-time control situations call for special software support to implement a high-level language on a small system. If the system does not include a general-purpose operating system, some sort of multitasking executive is needed if a language like Pascal is to be exploited.

Texas Instruments Inc. has developed support of this type for a subset of TI Pascal (see Part 1 of this two-part article) called Microprocessor Pascal. A superset of standard Pascal, Microprocessor Pascal has features that allow multiple sites of execution (called processes), synchronization among processes via semaphores, and access to the communication-register unit of TI's 9900 family of microprocessors.

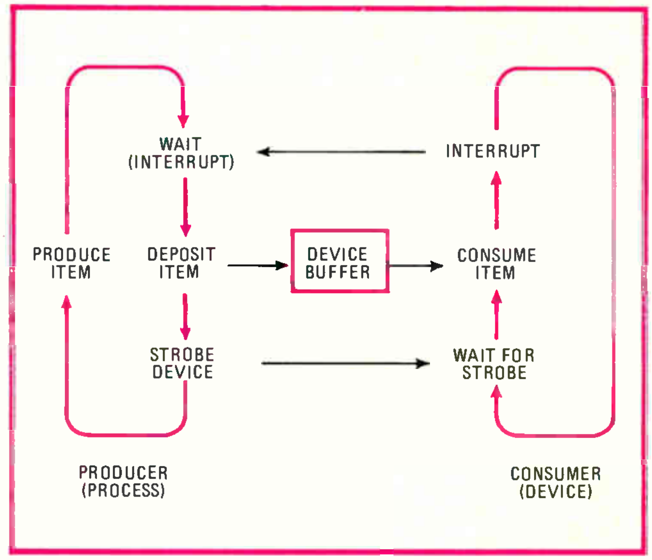
A user of Microprocessor Pascal may develop software for general-purpose applications using one of two host computer systems: the single-user FS 990 floppy-disk–based minicomputer, or the multi-user DS 990 hard-disk–based minicomputer. The Microprocessor Pascal system comprises a variety of software support tools, including an intelligent interactive editor for



1. Nesting. There are two special types of Microprocessor Pascal processes: programs and systems. A system is a process in which execution begins; it initializes global variables and starts up its constituent programs. A program may contain nested processes, and multiple programs may execute concurrently within a system.



2. Semaphores. A semaphore represents some event upon which processes synchronize. These exist as a variable with a counter and a queue of suspended (waiting) processes. Semaphores provide flexible, efficient, user-controlled synchronization.



3. Interrupts. A hardware interrupt is a stimulus from the outside world, generally used to pass a signal from a device to a process. Correspondence is established between an interrupt and a semaphore; the signal elicits response from a waiting process.

source preparation, a compiler that generates intepretive code, a code generator that supplies native object code, and an interactive debugging interpreter.

There are also two powerful executive programs which support the execution of the user system on the target processor. These memory-resident executives provide for multiprogramming, interrupt handling, interprocess communication through input/output files, dynamic creation and reclamation of processes, and multiple-priority process scheduling.

Executive benefits

A major benefit of Microprocessor Pascal and either of its executive kernels is that the system designer need not specify system-wide standards and conventions for intermodule parameter passing, register allocation, or task management. These design decisions are automatically made in the way the Microprocessor Pascal system is mapped onto the architecture of the 9900 family.

The input/output facilities of the system provide a standard high-level intermodule interface that permits the development of modular software libraries from which users can select exactly those components needed for a particular application. The executive kernels, too, emphasize software modularity; their components are provided in a form that permits the user to include in his applications only those features that are essential.

The executive components are provided in two versions that correspond to the two types of output from the compiler: interpretive and native object code. The Microprocessor Pascal interpretive executive is generally used for applications where the program-code compactness achieved with language interpretation is more important than the associated decrease in execution speed. The second Microprocessor Pascal executive supports the execution of native code and can therefore be used in time-critical applications. Both versions of the executive provide a user with identical capabilities.

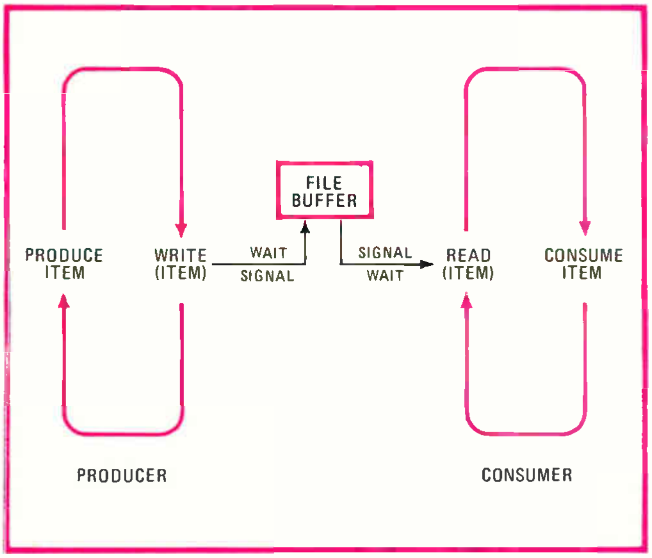
A conventional Pascal program consists of a main program along with zero or more subprograms, called procedures or functions. Execution of such a program is done serially, from one statement to the next; at any time, execution occurs at a single point in the program. However, the practice of having several sites of concurrent execution within one program is often desirable. To permit this multiprogramming, the concept of a process has been introduced into Microprocessor Pascal. A process is a separately executing entity having its own run-time environment for its data.

Within the framework of the Microprocessor Pascal system, the design of a multitasking application is to a great degree reduced to the assimilation of various processes, each of which is basically a sequential Pasal program. Well-defined techniques and executive components manage the time-dependent interactions among these processes. The user can therefore concentrate on the algorithms that comprise an application without concern for the construction of the executive under which they execute.

Multiprogramming

In a stand-alone situation, multiprogramming and interrupt handling are often desirable and in some cases essential. An industrial process-control problem, for example, could be solved by preparing a process to oversee each type of device in the system. In very complex systems, process allocation could be even finer: several processes could be used, one for each mode of operation of each device. With processes the user may also write programs to service interrupts and devices, and thus realize more general multiprogramming.

Microprocessor Pascal processes are synchronized so they can communicate with each other. They are scheduled (selected for execution) based on process readiness and process priority. Readiness indicates whether a process may proceed or if it must wait for some condition



4. Logical I/O. Interprocess communication is treated as logical input/output. A process may read data elements written asynchronously by another process. The executive performs wait and signal operations to facilitate the communication.

to be satisfied first. Priority indicates the relative urgency of the process. The lower its priority number, the more time-critical a process is.

There are two special types of Microprocessor Pascal processes: programs and systems. A program is a self-contained process. It is declared with the Pascal keyword program, and has no external data available to it except possibly through common variables. A program may contain nested processes, and one or more programs may execute concurrently within a system.

A system is the process in which execution begins. It bootstraps itself by initializing the global parameters it needs (parameters defined in all processes used in the system) and by starting up its constituent programs. A system may not have any variables of its own, except those defined through common declarations. Figure 1 shows programs and processes nested within a system.

Every program or process has associated with it two dynamic data structures to manage memory. One of these is called the stack, and the other is called the heap. The stack is an area allocated to the declared variables of the program or process and its procedures. The heap holds dynamically allocated data structures, which are not declared but are created and destroyed by the two procedures new and dispose. With these features, all processes (and the routines within them) are naturally re-entrant. A re-entrant routine's code does not change during execution. A process using re-entrant code can be stopped at any point and the program re-entered by a different user or process.

Microprocessor Pascal extensions are designed to aid the user in the following ways:

- Process declaration is distinct from the declaration of a Pascal procedure or function.
- Process declarations may be nested, and the Pascal scope rules of global variables are enforced as usual.
- Processes, like procedures, may declare parameters. The start statement allows the passing of process parameters with full type checking at compilation time.
- Variables within the scope of a process are guaranteed to exist even if the processes that are its higher-level ancestors have terminated.
- The program construct is a special case of a process that has no variables global to it. Its resources are given special treatment by the executive.
- Any process or program that is within scope can be concurrently executed with the start statement. To allow all program declarations (declared at level one) to be in scope, the system construct (at level zero) must contain all program declarations.

Interprocess communication

Real-time programming concerns the control of events in the physical world. The central problem in any real-time environment is that the computer must be able to receive and react to events as fast as they arrive, lest it fall behind the real world. The stimuli of externally generated events are passed to processes within the computer by means of hardware interrupts.

When an event occurs, the process may service it, proceed, or take some other action. Until the event happens, however, the waiting process is suspended and does not compete for a processor's time.

The event upon which a process waits may be generated by another process. For example, consider processes that have related responsibilities; ones that must communicate with each other, either through shared memory or some form of message-passing protocol. Successful communication from one process to another requires synchronization between the processes to ensure that they do not interfere with one another. If a sending process wants to place an item into the next available space in a buffer, for instance, it must ensure that the receiving process does not modify pointers to the buffer until the transfer is complete.

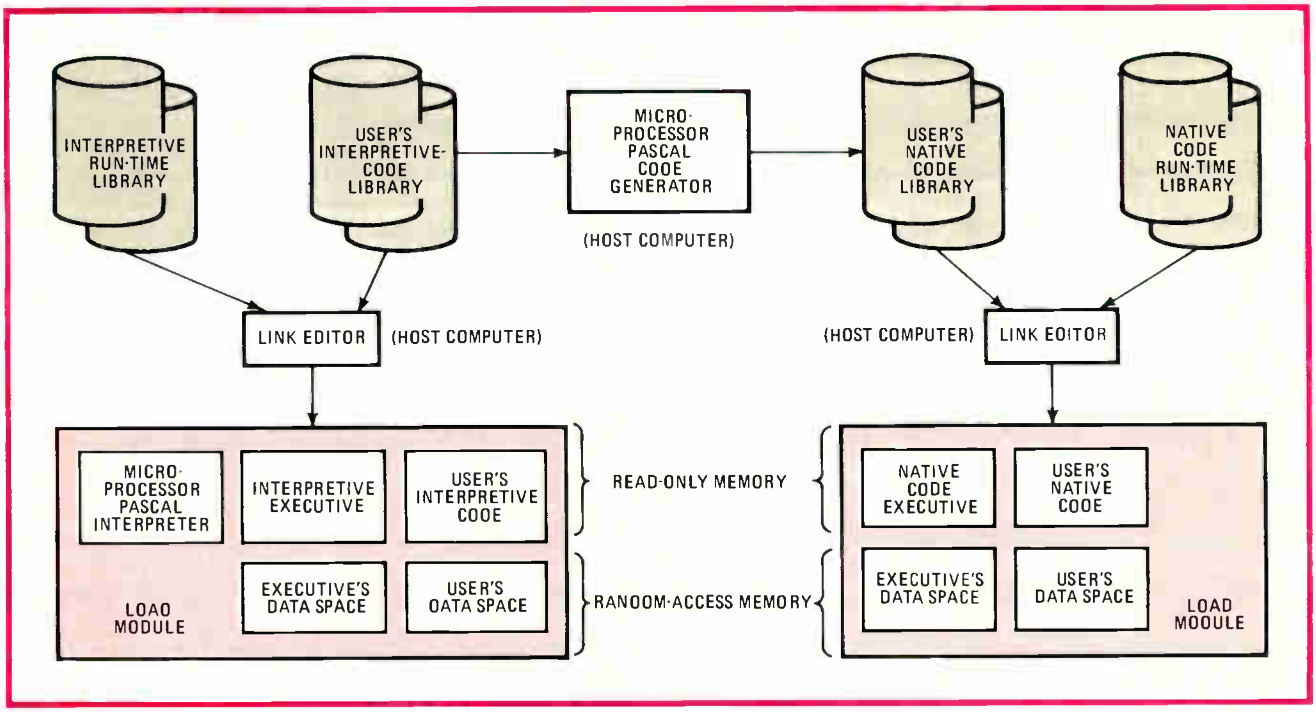
In general, a system designer cannot determine *a priori* the progress rates of the individual processes, and some low-level primitive structure must be provided for the synchronization of otherwise asynchronous processes.

Synchronization of process actions with other activities is achieved by means of an event that causes all actions to concur or agree in time. The Microprocessor Pascal executive provides two mechanisms for synchronizing external events: semaphores and interrupt handling. These mechanisms may be used to synchronize several concurrent processes on a single processor or on multiple processors if shared memory and interrupt circuits are provided.

Semaphores

The term semaphore stems from the semaphores of railroading that are used to synchronize access to sections of track. A semaphore represents some event upon which processes must synchronize, and is implemented in Microprocessor Pascal as a variable consisting of a counter and a (possibly empty) queue of suspended processes. The two basic operations performed on a semaphore are wait and signal.

A process may ensure that an event has occurred before proceeding by performing a wait operation on the



5. Two routes. For the interpretive environment, the user's code is joined with modules from the interpretive library and linked to a load module. Alternatively, the user's code can be run through a code generator, and the interpreter omitted from the load module.

associated semaphore. If the event has already occurred, the process continues execution; otherwise, the process is suspended by the executive until the event occurs.

A process may signal the occurrence of an event by performing a signal operation on the associated semaphore. If another process is waiting for the event, the executive makes that process ready for execution; otherwise the occurrence of the event is recorded by incrementing a counter in the semaphore until a subsequent wait operation occurs for that event. In either case, the process that performed the signal operation remains in the ready state.

Microprocessor Pascal implements semaphore counting in such a way that an occurrence of an event is not lost even if no process is waiting when an event occurs. The executive keeps a count in a semaphore of the number of events that have occurred (by signals), but have not been received (by wait operations).

Semaphores provide efficient user-controlled synchronization among processes and are flexible enough to be useful in the solution of complex application-dependent problems such as resource scheduling and interprocess communication. An example of a communicating pair of processes is given in Fig. 2. The relationship between synchronization and data flow through a shared bounded buffer is illustrated.

Interrupts

A hardware interrupt is a stimulus from a processor's external environment to pass an event to a process within the processor. Interrupt handling can be viewed in various ways that differ primarily in the type of interface used. The Microprocessor Pascal executive technique for interrupt handling uses the event mechanism of semaphores. A correspondence is established between an interrupt and a semaphore such that when the interrupt occurs, the executive interrupt handler performs a signal operation on the semaphore, thus activating a waiting process, if one exists, to respond to the interrupt. Figure 3 illustrates the relationship between a producer (a process) and a consumer (a device such as a printer). The producer waits for an interrupt to show that the device is ready, then deposits data in a buffer. The device, running at its own speed, reacts to the strobe by consuming the data, then signals the producer with an interrupt. This device-handling technique is just one special case of the general semaphore mechanism shown in Fig. 2.

Logical files

Files are usually associated with storage media such as disk or magnetic tape. However, many operating systems also allow devices to be treated as files in a consistent manner. Therefore, the term logical file is used to indicate any communication medium with which processes can perform logical input/output; that is, I/O that is device-independent. With this definition, a logical file can be a disk file in a directory, a video display terminal, a keyboard, a card reader, a line printer, etc. Due to the uniform interface used in logical I/O, programs do not have to be aware of the unique characteristics of devices or storage media.

In Microprocessor Pascal, logical files are manipulated through variables of the file type, described in Part 1 of this article.

Allowing logical files to include interactive devices such as video display terminals (VDTs) permits the sequence of data elements to be generated in real time by an intelligent source, such as a person at a keyboard, rather than by simply reading previously-generated data from a storage medium. The generation of this data may also be influenced by a program's output, which is produced in real time and displayed on the screen of the VDT. In essence, both the program and the person are influenced by each other in their real-time interactions, thus forming a system of two cooperating processes.

Figure 4 shows the Microprocessor Pascal approach to interprocess communication. It is treated as a form of logical I/O; that is, cooperating processes may communicate with each other using logical files. One process may read data elements that are being written concurrently by another process in conjunction with the executive-handling wait and signal operations. This is very similar to the interaction described above because the input is generated and the output consumed in real time by the processes rather than being stored on or retrieved from some storage device.

Logical file I/O provides a consistent interface between system components, which include both hardware devices and software programs. This allows systems to be constructed from modular components, each of which is understood in terms of its inputs and outputs. In this way, the interfaces between the components form a nearly complete definition of the system. Each component can be designed, implemented, and tested independently, isolated from other units to verify that it performs its required functions.

Software tools

The Microprocessor Pascal editor is designed to help with the creation and modification of program source files. It is interactive and uses a video display terminal. Changes may be made to the file simply by typing over the old text with new text or by adding or deleting complete lines. Commands that may be invoked from the editor cause a limited form of syntax checking of the Pascal statements that are in the current file. Detected errors are marked by the cursor and described so that the user can make an immediate change to correct the error. Syntax checking is fast enough so that it does not significantly delay the programmer. In addition, as the programmer creates his source text, the editor helps by providing the correct indentation of structured statements. Figure 5 shows how the editor is used to fashion load modules.

The Microprocessor Pascal compiler translates source code into interpretive code for an abstract stack computer. This code may be executed interpretively using the debugger or it may be used as input to the code generator. This interpretive code has several advantages. It consumes roughly half the memory required for 9900 machine code and it can be created very quickly by the compiler. Since it is executed interpretively, debugging aids such as breakpoints and symbolic lookups can be readily incorporated.

The Microprocessor Pascal code generator accepts the interpretive code from the compiler as input and converts it into 9900 object code. It attempts fairly sophisticated optimization and allocation of registers to variables, and generates efficient code for references to the address space of the communications-register unit through which peripheral devices are controlled. The generated code is re-entrant and position-independent; that is, the code can be loaded at any address without modification.

The Microprocessor Pascal debugger supports symbolic references to module names, file names, and common names. Statements can be referenced by Pascal statement number. Either single processes or sets of processes can be debugged at one time. Breakpoints can be used to stop the execution at any point by specifying the Pascal statement number of a particular module. When execution is suspended, the status of execution can be examined and data can be modified at this point if desired. Traces of the current execution of the process scheduling level, module entry and exit level, or statement level are also available.

Standardization

Since Pascal was first released, many implementations have been developed at universities and in industry. Many of these versions differ by taking full advantage of the looseness of the standard Pascal definition, and some contain extensions. In an attempt to deal with this proliferation of versions of Pascal, the Pascal Users Group (PUG) has supported a working group with the International Standards Organization, which appears to be espousing little change from the original language.

A different point of view was represented by a workshop conducted in July 1978 by Dr. Kenneth Bowles at the University of California at San Diego. At this meeting, members of PUG and industry attempted to define a set of standard extensions. However, this workshop was unable to arrive at any sort of agreement.

Recently, the American National Standards Institute (ANSI) has organized the X3J9 committee on Pascal standards, and the Institute for Electrical and Electronic Engineers (IEEE) has formed a subcommittee that now cooperates with that effort [*Electronics*, May 24, p. 98].

These efforts should be supported by industry in order to achieve a language that will serve the needs of industry and at the same time provide a degree of standardization that will make efficient use of Pascal possible. The advantages of Pascal over other existing languages in common use merit a substantial effort.

Pascal was the basis for all four of the proposed languages accepted for contract by the Department of Defense for the development of its common high-order language, now called Ada [*Electronics*, May 24, p. 64]. While it is true that Ada departs significantly from Pascal and makes some unnecessary changes in the syntax, most of the good features of Pascal have been retained. Extensions that provide the capability for systems and real-time programming are likely to be included in the final product.

It appears that the DOD effort has the potential of producing the long-awaited successor to Fortran. If sufficient momentum is maintained by DOD and industry, this can provide a great boon for software development, in the form of a powerful modern language useful for the bulk of programming tasks. However, it will require considerable effort to get over the critical-use threshold such that it can be regularly taught in schools and considered a part of the equipment of programmers and software development facilities everywhere. □

Reappraising CCD memories: can they stand up to RAMs?

Improvements in random-access-memory technology have dimmed prospects for CCD domination of high-density, low-cost storage

by W. Milton Gosney, *Mostek Corp., Carrollton, Texas*

☐ For the last several years, semiconductor manufacturers have promised large, low-cost serial memories based on charge-coupled-device technology. But the projected pricing of CCDs—at a third to a quarter the cost per bit of semiconductor random-access memories—has assumed that CCDs have inherently greater densities, higher yields, and simpler processing than RAM counterparts.

It's time to take another look at those assumptions, many of which have been invalidated by advances in RAM processing. Today, CCDs have little inherent density advantage over RAMs, since both are made to the same design rules. The process is at best no simpler, and yields are in fact worse. Today, the cost per CCD bit and RAM bit is nearly equal and estimated at about 35 millicents.

Second thoughts

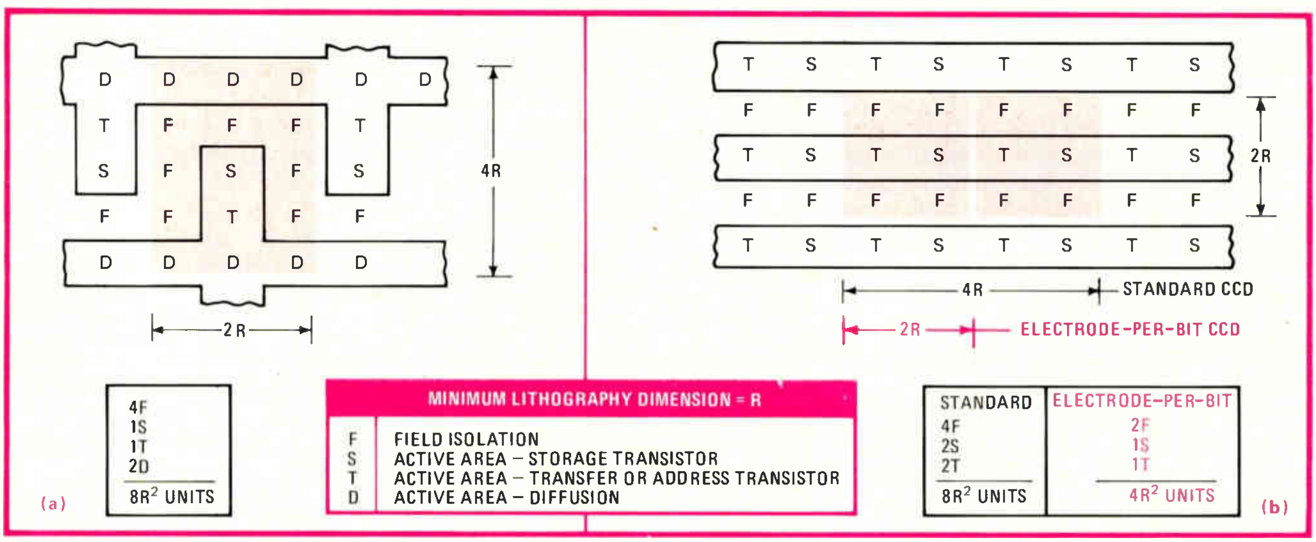
In short, it is doubtful that the CCD memory will ever attain the popularity originally projected for it because the improvements in technology that were supposed to give the CCD its price advantage have also boosted RAM density and cost-effectiveness. A more limited success is expected for CCDs in applications that can exploit the serial nature of the device. It is likely that CCDs will be best suited to analog signal applications like filters and delay lines, as well as imaging devices.

Nevertheless, at its inception in 1970, the CCD was rightfully hailed as a significant breakthrough in memory density. Boyle and Smith of Bell Telephone Laboratories[1] gave the world its first look at single-transistor-per-bit storage at a time when the state-of-the-art memory circuit was the 1,024-bit MOS RAM with three-transistor cells. Moreover, Bell promised a simple one-mask process and thus a higher yield than conventional MOS circuits. That no suitable means for detecting the charge packets as yet existed and that the one-mask process was not readily usable did not matter—single-capacitor or single-transistor bit storage—albeit in a serial embodiment—had become a possibility.

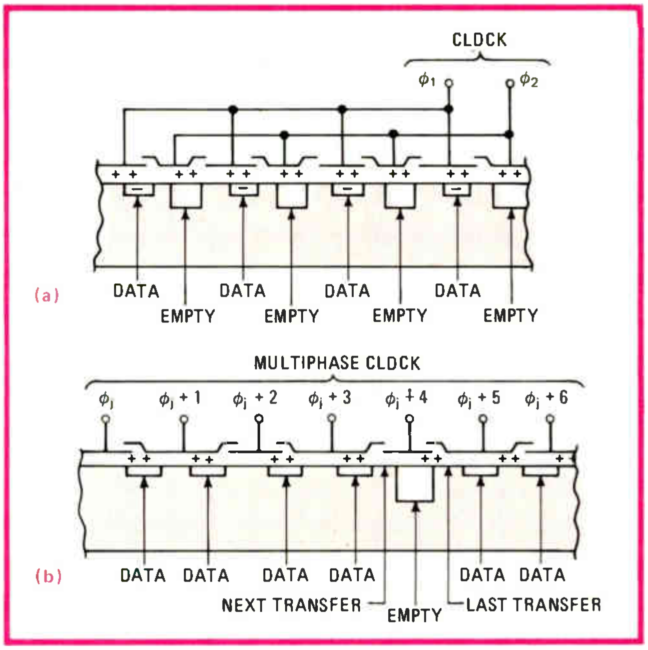
Thus the projections of CCD chip size and cost were based mainly upon the individual cell areas, which were less than a third that of three-transistor RAMs.

But by 1973, one-transistor RAM cells had become a reality with the advent of suitable sense amplifiers. Moreover, the one-transistor RAM cell was a manufacturable embodiment of the CCD storage phenomenon in a random-access configuration, which has proved to be more useful than the serial arrangement of CCDs.

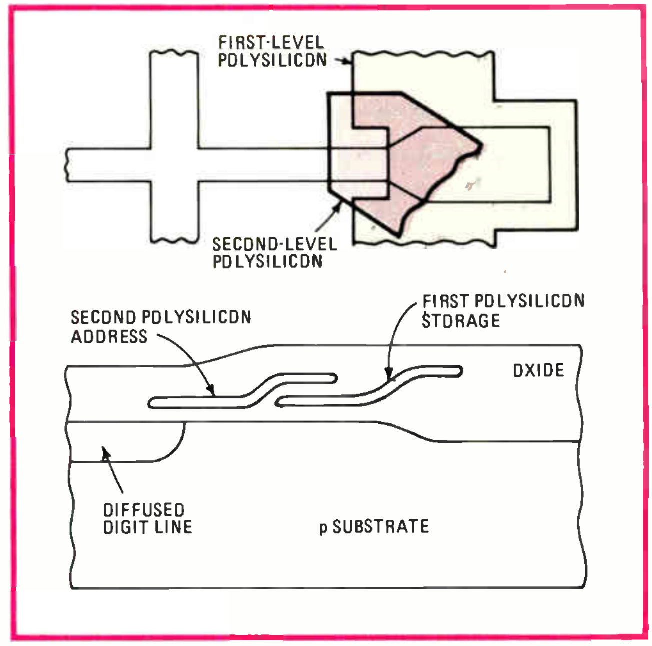
The development of the single-transistor RAM cell ushered in the 4,096-bit dynamic RAM, which remained the leading-edge memory part from 1973 to 1975. With



1. Cells. Minimum-resolution blocks compare cell sizes of RAMs and CCDs. RAM (a) is comparable in area to two-electrode-per-bit CCD (b). An electrode-per-bit CCD design could double density, but requires additional clock-decoding circuits.



2. Density doubling. Standard CCD designs use a two-electrode-per-bit structure (a), which requires two clocks but wastes space since half the array is empty. Electrode-per-bit design (b) maintains only 1 empty bit in whole array but needs a clock phase for every bit.



3. RAM process. The typical double-polysilicon process used for dynamic RAMs can be implemented in a five-mask sequence, not including double-coat masks or final mask to remove oxide from bonding pads. Cross section is typical of today's 16-K devices.

that part rapidly becoming a commercial success, the only way CCDs could still aim at a lower cost per bit was through greater-capacity devices. But though several manufacturers tried to develop such devices, few came through. Fairchild Camera and Instrument Corp., Mountain View, Calif., announced a 9-K CCD in January 1975 and slated a 16-K part for introduction some months later. Intel Corp., Santa Clara, Calif., introduced a 16-K CCD in February 1975. But those parts did not encounter much success because of delivery problems and were in essence made obsolete by the 16-K dynamic RAMs introduced in 1976.

Consequently, with 16-K RAMs enjoying rapid commercial success, CCDs were forced into redesign for the 64-K level in 1977. Today, with the 64-K RAM at the leading edge of memory technology, CCD memory must advance to 256-K bits to spark commercial interest.

The greater bit density of CCDs has been one of the prime reasons for ascribing to them a lower cost per bit than RAMs. But while a clear twofold advantage can be demonstrated theoretically using minimum-resolution unit building blocks, the real-life density advantage when CCDs and RAMs use the same design rules is likely to be less than twofold.

Comparing cells

Figure 1 shows simplified CCD and one-transistor RAM cells, both laid out with an absolute minimum geometry of dimension R. Ignoring how contacts and silicon and metal lines might later be patterned, consider only how the area of silicon should be optimally proportioned between isolation or field oxide (F) and active area (denoted D for diffusion, T for transistor-transfer region, and S for transistor or capacitor region). Each F, S, D, or T region is 1 R^2 unit of area.

While Fig. 1a shows that a standard two-phase CCD cell and a one-transistor RAM cell occupy the same eight basic resolution-space units, a more popular CCD configuration—the electrode-per-bit one—could double those densities. A standard two-phase CCD wastes half the storage area in the array, because all transfers in the serial portion of the CCD memory blocks are done simultaneously; for every storage bit, there must be an empty bit to receive the charge packet. The electrode-per-bit CCD (Fig. 2), which nearly doubles the density by propagating a single empty storage site back through the array, could, in principle, approach a density of a $4R^2$-unit area per bit.

Practical considerations

Theoretical conclusions aside, a memory-manufacturing process establishes its own criteria for minimum dimensions, which are constrained to values much larger than minimum resolution units in order to align with other circuit elements, including the metal and polysilicon lines and contact openings. Also, layouts must maximize the storage-capacitance area and minimize the transfer and field regions, to give enough design margin for usable frequency and temperature operating ranges and to provide immunity against data loss from factors such as alpha radiation.

Another practical limitation is the interfacing of the memory array to its input/output and clock-driving circuits. A standard serial-parallel-serial CCD array requires two low-frequency clocks to drive most of the parallel storage array. Adopting the denser electrode-per-bit configuration adds the expense of additional clock drivers since a ripple-through clock signal is needed to propagate the single empty transfer bit back through the CCD registers. Like the row- and column-

Dynamic charge storage in RAMs and CCDs

To retain data, both CCDs and one-transistor RAMs rely on dynamic charge storage on a semiconductor surface. Figure shows a metal-oxide-semiconductor structure (a) that could be part of a CCD shift register or the storage capacitor and address transistor of a one-transistor RAM. The storage region is the silicon surface beneath the storage gate where a field-induced junction contains a negative charge of mobile electrons.

The surface of the semiconductor behaves like a capacitive voltage divider—the upper capacitor is the fixed gate capacitance, while the lower one is the space-charge region of the field-induced junction; the connection between the capacitors is the field-induced junction itself.

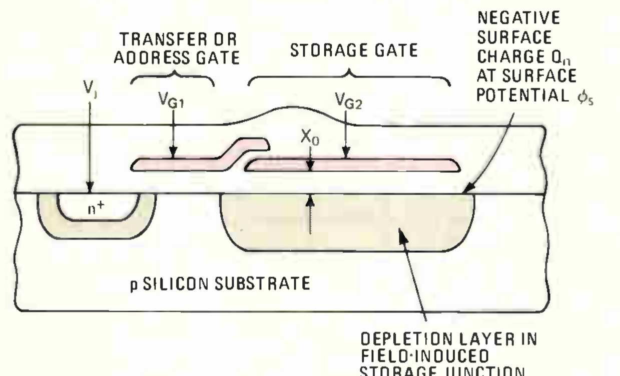
The transfer or address gate forms a temporary conductive path between the two junction regions. If the voltage applied to the storage gate (V_{G2}) exceeds the threshold voltage, then the surface-potential of the field-induced junction will equal the diffuse-junction potential when the transfer or address gate (V_{G1}) is turned on.

Graph (b) shows the dependence of surface charge in the field-induced storage region on surface potential (with respect to the substrate) for three different values of substrate doping density. (The plot has been made for values typical of three-supply 16-K dynamic RAMs.) The graph shows that the surface charge is inversely proportional to the surface potential.

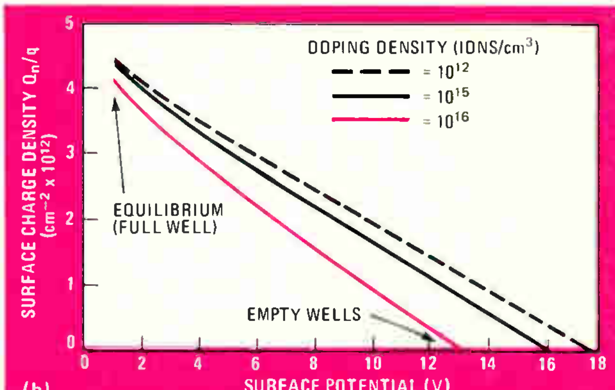
The minimum surface potential corresponds to inversion and to maximum charge in the inversion layer. If the transfer gate is turned off, minimum surface potential is in a condition of equilibrium. With the transfer gate turned off, any other surface potential is not at equilibrium, and leakage currents arising from generation of current in the space charge region, plus diffusion current from the adjacent neutral region (plus any other source of electron-hole pairs, including light and other ionizing radiation), cause a decay in surface potential toward the equilibrium value. As surface potential decays, the surface charge density increases toward its maximum value; thus the potential well tends to fill with charge as a result of leakage current.

High surface potentials are empty wells and correspond to logic level 1s. The time required for a logic level 1 to decay to logic level 0 (for an empty well to fill up due to leakage) is a measure of the dynamic storage time. In actual circuits, the dominant leakage current at high temperatures is from diffusion current in the substrate. Refresh time in RAMs (or minimum frequency in CCDs) is determined by how much decay in surface potential will be allowed before the sense amplifier detects logic errors.

Both the maximum charge density and maximum surface potential increase with more positive gate voltages and more negative threshold voltages since the size and capacity of the potential well is proportional to the difference of the gate voltage and the threshold voltage. In one-transistor RAMs, the surface potential and surface charge density is set by the appropriate digit line during a write operation and read out by the same digit line during a read operation. In CCDs, charge (or surface potential) stored in one cell is transferred to an adjacent cell by increasing its gate voltage—which in turn increases its surface potential—making it more attractive to charge. Charge then flows from the present stored well into the well with the higher driving force.



(a)



(b)

decoders in a RAM, 1-of-n decoders are required for the electrode-per-bit CCD. So though in theory the cell spacing, or pitch, of the electrode-per-bit cell is 2R in the horizontal direction (Fig. 1), in actuality it is limited by the 1-of-n clock-driver/decoder circuit pitch, just as it is limited in RAMs by the row and column clock-driver/decoder circuit pitch. RAMs and electrode-per-bit CCDs will therefore be approximately equal in horizontal pitch.

As for vertical pitch, minimum-resolution-block theory predicted it should in CCDs be half that of RAMs. But the loop-architecture considerations of laying out the CCD chip in a serial-parallel-serial array dictate that the vertical pitch cannot be less than that of the horizontal serial portion of the array, which requires a minimum of 4R resolution units—the same as in RAMs.

Thus even for the denser electrode/bit configuration, CCDs and RAMs will have similar chip dimensions for a given bit capacity. As an example, currently available 64-K RAM and CCD devices have similar line widths in the 2.5-to-5-micrometer range and share a chip size of about 35,000 square mils.

Yield factors

Although the assumption is frequently made that the CCD process is simpler than that of dynamic RAMs, both are built with the same double-polysilicon n-channel MOS process and use the same leading-edge-technology line widths. For all purposes, the CCD is at least equivalent to a RAM in processing complexity.

Figure 3 shows the layout and structure of a typical double-polysilicon RAM cell, which can be implemented in a basic five-mask sequence (active area, first and second polysilicon levels, contacts, and metalization). The CCD structure of Fig. 4 uses the same number of masks. Although it is called a surface-channel, four-phase CCD, the structure can have self-registered depletion implants under the second polysilicon gates, allowing it to operate in a two-phase manner. Also, the structure suffices to build electrode-per-bit serial-parallel-serial chips, while still requiring nearly the same processing as RAMs, save for the different implant conditions under the second level of polysilicon.

Transfer difference

One of the major operating differences between RAMs and CCD memories lies in how often the stored data is transferred. During a write cycle in a RAM, the charge is transferred into the storage cell from the digit line, which, in effect, is an infinite source of charge. Any given finite charge packet undergoes only one transfer: during readout, when the storage cell transfers its charge back to the digit line. In CCD memories, however, a given charge packet undergoes multiple transfers on its way from input to output. Each transfer involves the movement of finite charge from one storage site to the next during a specified interval. Because there is no gain in the CCD cells, loss mechanisms prevent a small fraction of charge from being transferred during each cycle. The effects of this incomplete transfer are cumulative, ultimately dispersing the data waveforms unless registers are short enough to refresh the charge before excessive dispersion occurs. For a given CCD design, this further reduces yield and moreover is a yield loss factor that has no significance for RAMs.

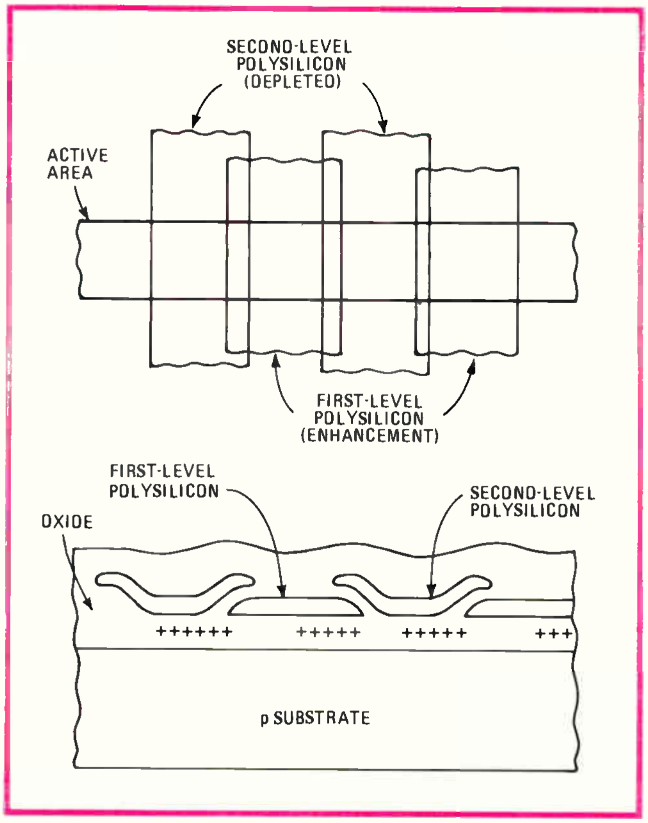
True, in RAMs the heavy signal loading on the storage cell by the bit lines, which have more than 10 times the cell's capacitance, does greatly reduce the signal amplitude at the sense amplifier. But the success of one-transistor RAMs indicates that satisfactory sense amplifiers can be built to detect the charge packet.

The CCD actually has a more favorable read-out situation. Since the output bit of the serial chain feeds directly into the sense amplifier, there is no digit line, so that capacitive loading is at a minimum. That advantage is put to use since the CCD is usually designed with smaller storage cells; however, in most cases, the size of the storage cell is limited less by minimum capacitor area requirements than by clock-driver layout considerations.

A compound problem

The problem of dynamic storage—for CCDs and for RAMs—is that the amount of time data can be retained in a cell before leakage currents cause error is limited. But the charge-transfer inefficiency compounds this problem further for CCDs.

To be sure, the charge-transfer efficiency in surface-channel CCDs approaches unity—on the order of 0.999—and things can be done to further improve the figure. One approach is the buried-channel CCD, where the channel-doping profile causes the data charge to flow in a layer below the interface of the silicon and oxide: surface scattering is reduced and fringing fields actually



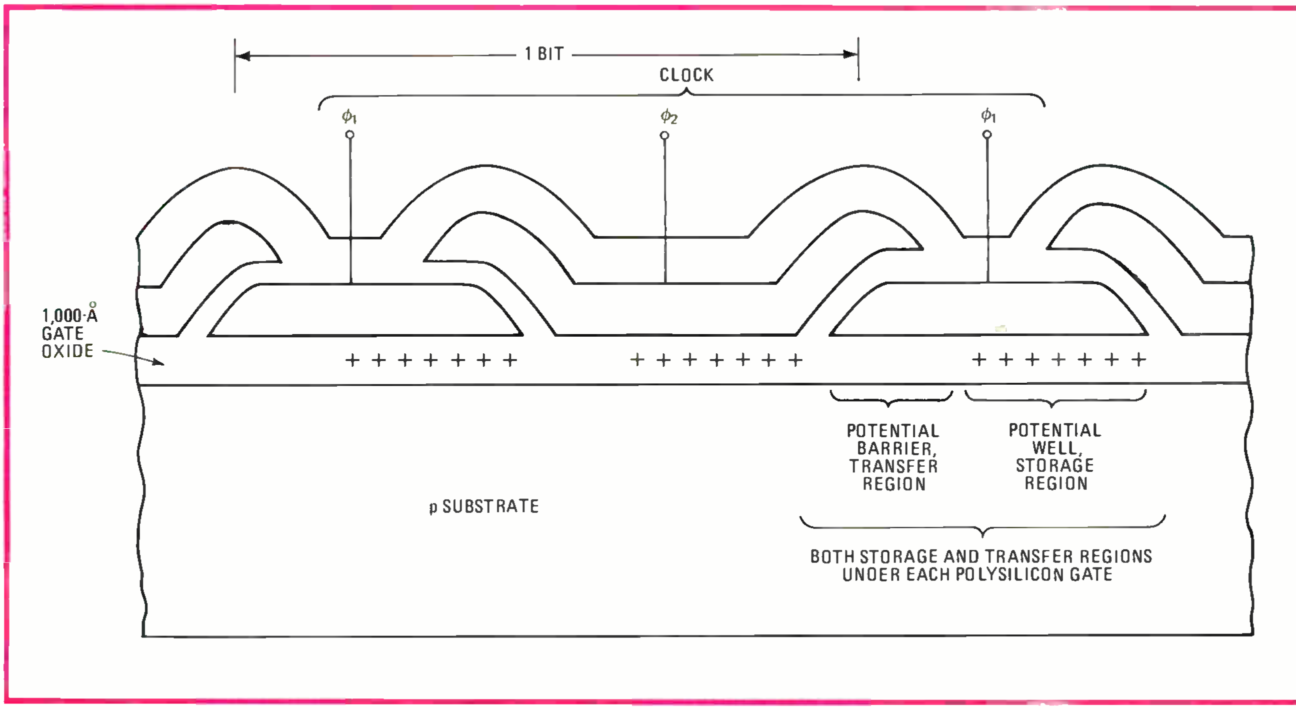
4. CCD process. The CCD structure uses essentially the same double-polysilicon process as that of dynamic RAMs. Shown is a surface-channel, four-phase CCD, but self-registered depletion implants under the second polysilicon give two-phase operation.

aid charge transfer. But while buried-channel devices improve charge transfer efficiency, they reduce the amount of charge. Worse is that additional processing steps are needed, which eat into yield. Also, the reduced signal charge increases sensitivity to soft error.

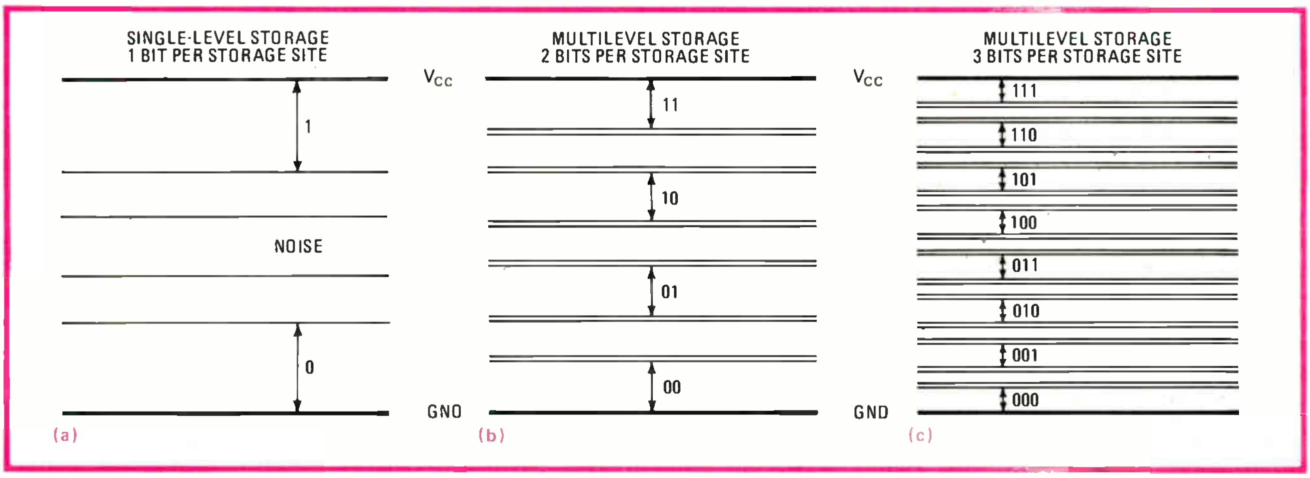
Improving density

Although it has been shown that little can be done to improve the device layout density of CCDs beyond that of RAMs, several methods of improving the number of bits per electrode have been proposed. One, called the barrier-well CCD, forms both the storage and transfer regions under a single polysilicon gate region, as shown in Fig. 5, as opposed to transfer channels under one polysilicon level and storage regions under the other. Several more processing steps are required to implement this type of CCD, since matched enhancement and depletion characteristics must be formed with each polysilicon level and concomitant yield loss is incurred. What's more, the location of the edge of the depletion implant requires critical alignment—it must be accurately placed with respect to the polysilicon gate widths. The achievement of suitable alignment tolerance results in wider polysilicon lines, so that the net length of the barrier and well regions is about the same as in the more standard process. But the increased process difficulty offsets the advantage of the relaxed linewidth requirement without giving any real density advantage.

There is one way in which CCD serial memories would



5. Denser. One way to improve density of the standard four-phase CCD is to form both the storage and transfer regions under a single polysilicon gate region. Device becomes a two-electrode-per-bit, two-phase CCD with twice the density, but process is more difficult.



6. Multilevel storage. CCDs could leapfrog RAM densities by a multilevel scheme that, instead of two discrete levels per site (a), would double (b) or triple (c) the number. But sensing would be very difficult, since signals and margins become prohibitively small.

be able to achieve significantly higher bit densities than RAMs that have equivalent line widths. The technique is called multilevel storage, the levels referring to voltages other than the simple 0 (ground) and 1 (positive) supply levels. This storage exploits the analog nature of CCD registers, which can store and transfer charge of any analog value.

As shown in Fig. 6a, conventional CCDs, like other digital circuits, represent 1s and 0s by high and low voltage levels, with appropriate guard bands and noise margins between the levels. Because CCDs can handle analog signals, appropriate guard bands and noise margins could in principle be set up in such a manner that the surface potential in a single storage area would represent 2 or even 3 logic bits (Figs. 6b and c). The data sequences would thus be encoded into four or eight analog voltage ranges, each of which would have to be generated and detected without error. But while multilevel storage offers the promise of increased density without requiring finer line widths, the practical difficulties of data readout in the presence of noise and other disturbances do not make the technique an immediate contender for significant density improvements.

To sum up, the rapidity with which CCD density is overtaken by that of commercial RAM circuits is easy to explain. Both make use of the same storage phenomenon and the same basic technology, so that any line width or other technological improvement affecting CCDs can be applied to RAMs as well. □

References
1. W. S. Boyle and G. E. Smith, "Charge-Coupled Semiconductor Devices," Bell System Technical Journal, Vol. 49, 1970, p. 587.

With the new improved bandstacking feature in our Model 2002A sweeper, you can now cover the entire 1 to 2500 MHz range in one fell swoop. You can also start and stop anywhere in between. Anywhere.

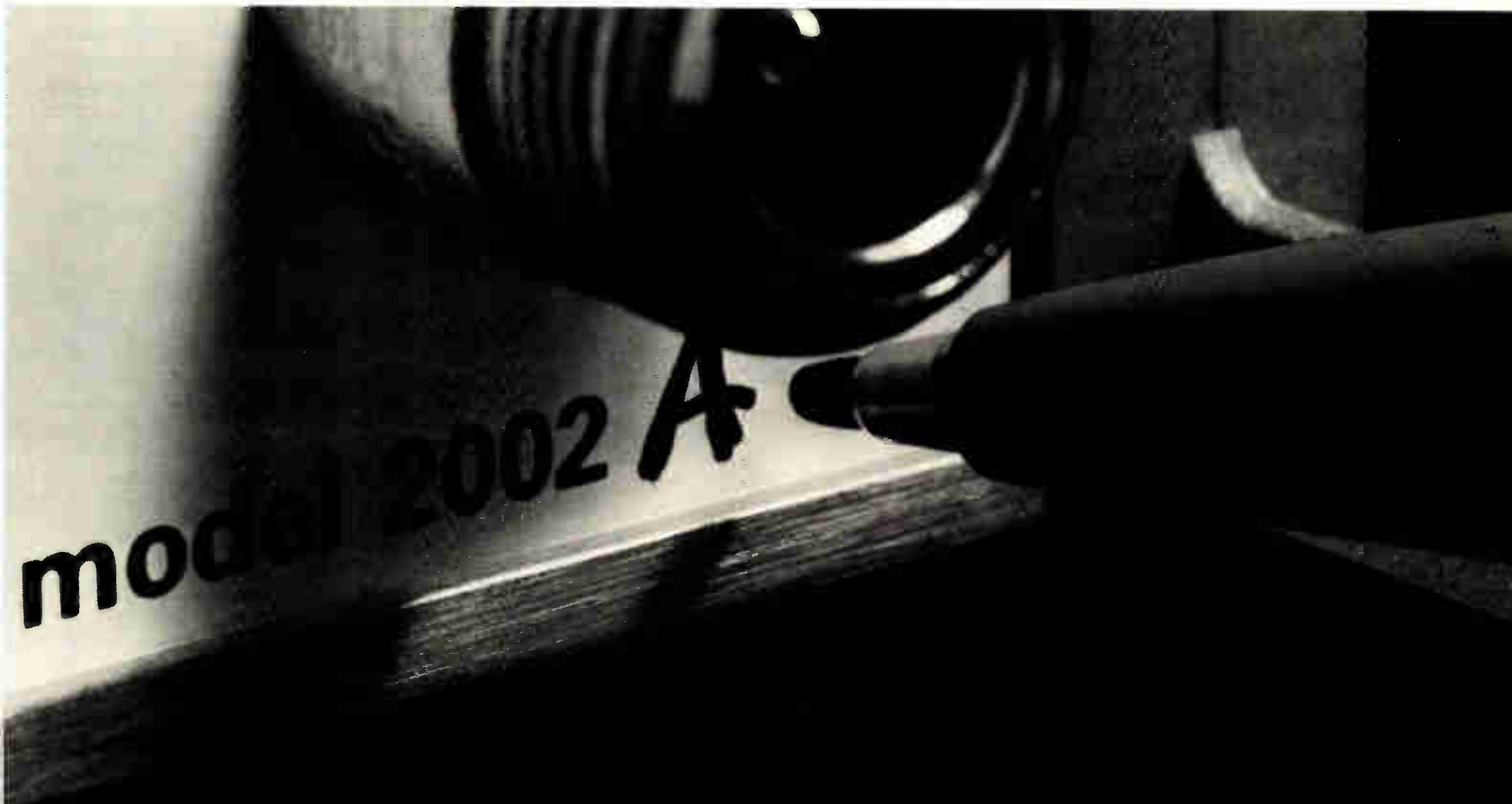
Try to find another stand-alone sweep-signal generator that has this capability. Or one with a front-panel meter on which you can easily set and read the output over its +13 to −77 dBm range.

Flatness is ±0.5 dB at the 20-milliwatt output; display linearity is ±1%. For compensation of frequency-dependent variations in test set-ups, a ±2 dB slope adjustment is right there on the front panel. There's also a provision for external leveling.

Besides all this standard equipment, the 2002A has options. Like a deluxe harmonic marker system that provides 1, 10, 50 and 100 MHz markers over the entire frequency range. Or you can order specific single-frequency markers when you buy your 2002A, or whenever a specific application comes along.

But the important thing to remember is that the Model 2002A gets you from 1 to 2500 MHz in a single sweep. And you can't get this anywhere for just $3,400. Not anywhere. Wavetek Indiana, P.O. Box 190, Beech Grove, Indiana 46107. (317) 783-3221. TWX 810-341-3226.

WAVETEK®



The A stands for anywhere.

Circle No. 126 for demonstration

Circle No. 127 for literature

Bridged-T selects filter's notch frequency and bandwidth

by P. V. Ananda Mohan
Indian Telephone Industries Ltd., Bangalore, India

If a bridged-T network is used in place of the Wien bridge in the notch filter proposed by Fellot,[1] both the bandwidth and the frequency may be independently adjusted. The bridged-T approach has been explored previously[2] as an extension of some work carried out on parallel-T notch filters, and, as illustrated here, the technique offers an excellent way of building units that are simple and versatile.

R_N and R_Q comprise the balancing arms of the bridged-T network (note A_1 is a unity-gain buffer) as seen in (a). In this configuration, the circuit's transfer function is:

$$e_o/e_i = [ns^2+\omega_o^2]/[s^2+3(1\text{-}q)s\omega_o+\omega_o^2]$$

where n and q are selected by R_N and R_Q, respectively, and $\omega_o = 1/RC$. Note that $0 \leq n$, $q \leq 1$, and that the frequency of the notch is

$$\omega_n = \omega_o/n^{1/2}$$

Therefore for this circuit ω_n will always be equal to or greater than ω_o.

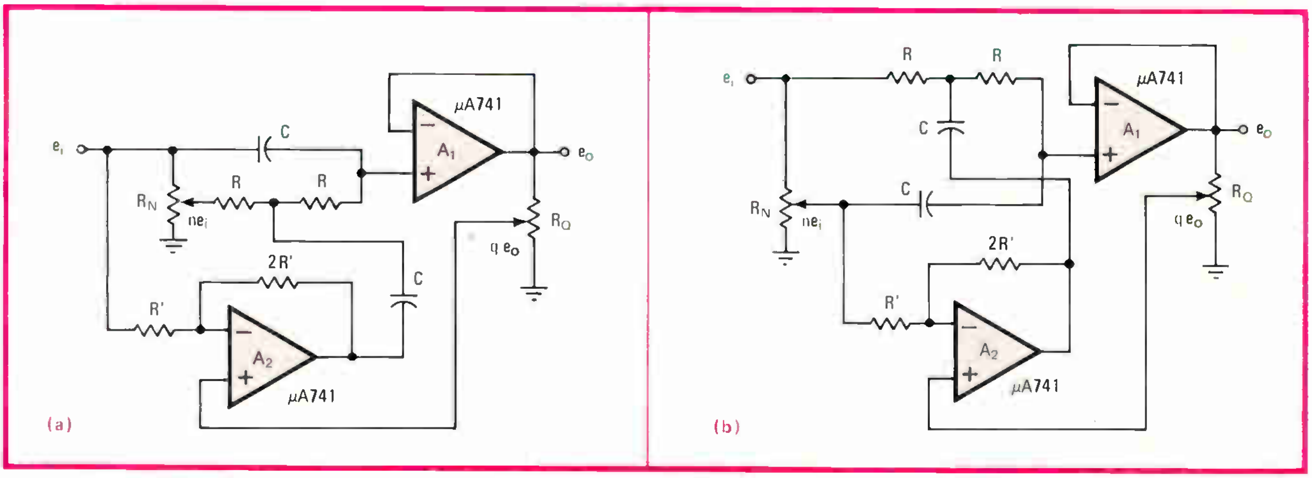
The bandwidth is adjusted with R_Q, and Qs greater than 1,000 will be realized when high-gain operational amplifiers are used. In general, Qs will be higher than can be achieved with parallel-T networks. The notch depth is at least 50 decibels throughout the operating range. R_N and R_Q must only be at least 10 times smaller than R to achieve the stated filter characteristics.

By modifying the circuit slightly, as in (b), the transfer function becomes:

$$e_o/e_i = [s^2+n\omega_o^2]/[s^2+3(1\text{-}q)s\omega_o+\omega_o^2]$$

and the notch frequency ω_n is made tunable for frequencies below ω_o, so that $\omega_n = \omega_o n^{1/2}$. □

References
1. Dominique Fellot, "Wien bridge and op amp select notch filter's bandwidth," *Electronics*, Dec. 7, 1978, p. 124.
2. "An Active RC Bridged-T Notch Filter," *Proc. IEEE*, August 1977, p. 208.



Changing tune. Using bridged-T network in place of Wien-bridge arrangement in notch filter enables independent control of filter's bandwidth and frequency. Circuit can be configured for tuning filter above (a) or below (b) its natural radian frequency $\omega_o = 1/RC$.

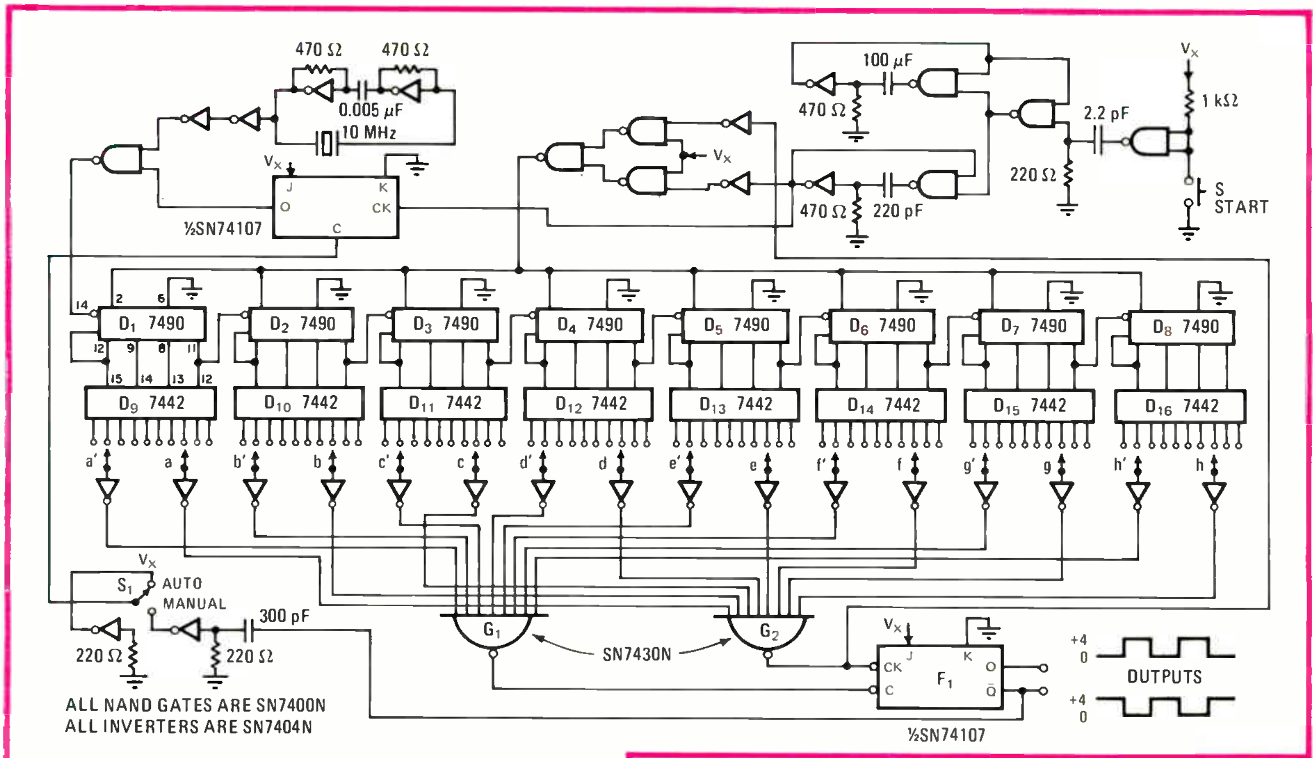
Wide-range pulse generator displays timing parameters

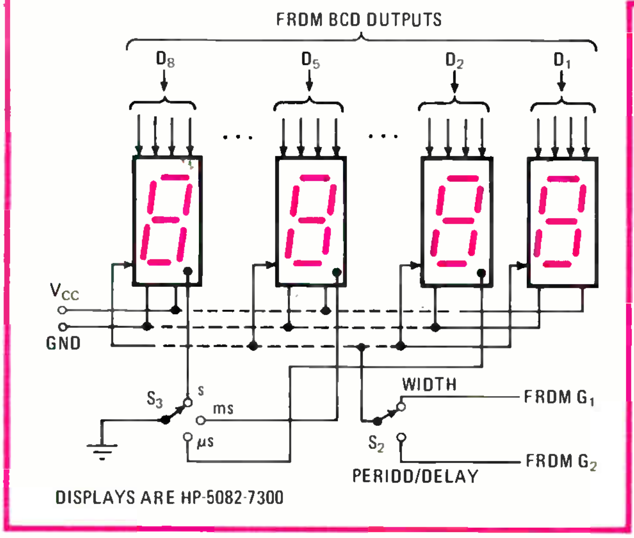
by C. L. Bhat and R. C. Yadav
Bhabha Atomic Research Center, Srinigar, India

In this circuit, cascaded decade counters provide adjustable pulse width, period, and delay from 0.1 microsecond to 10 seconds. This generator contains an LED digit display, too, for direct readout of the various pulse parameters.

The 7490 counters, D_1–D_8, serve simultaneously as a frequency divider and preset counter unit. Depressing the momentary-contact switch S resets D_1–D_8 and gates the 10-megahertz clock through to the counters, whereupon they advance upward from zero.

When operated in the automatic mode (switch S_1), the unit will generate pulses with repetition frequency and width controlled by the clock frequency and the position of two sets of taps at the output of the 7442 4-to-10-line decoders. Here taps a′–h′ bring output flip-flop F_1 low





Watching width. Pulse generator provides adjustable width and period over a 0.1-microsecond-to-10-second range. A single pulse of specified delay may also be generated. LED-digit display gives direct readout. Wiring of display-switching circuitry (inset) is simple.

through gate G_1 when D_1–D_8 reaches some preset number. The counter continues to advance, reaching a number determined by taps a–h, which are set to activate G_2 and clock F_1 high. The counters are then reset, and the process repeats.

In the manual mode, a single pulse having a specified delay is generated, with the pulse width again selected by both sets of taps. The basic difference in manual operation is that the resetting of F_1 results in the resetting of F_2 and the disabling of the clock signal to D_1–D_8. Note that taps a–h are set below taps a′–h′.

As for the display circuitry (see inset), the outputs of all counters drive their respective light-emitting diodes. The decimal points of displays two, five, and eight are wired to time-base switch S_3 as shown. The pulse's width and period/delay will be displayed by appropriately setting switch S_2. S_3 orders up the readout time in seconds, milliseconds, or microseconds. □

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.

C-MOS triac trigger cuts parts count

by Hul Tytus
Tytus & Co., Cincinnati, Ohio

Integrated circuits made to trigger triacs often consume large amounts of power and require biasing schemes substantially increasing the number of components in the circuit facing the ac load. But by using a C-MOS operational amplifier, the circuit shown can deliver a peak current of 100 milliamperes to the triac, draws an average current of only a few milliamperes and uses a minimum of parts.

Circuit operation is based on the fact that the output of a C-MOS device acts as a current source or sink. As the ac-input voltage rises up through zero, the CA3160 generates a positive-going current pulse of a preset magnitude and charges C_1, which determines the triac's

Will next year's technology catch your board test system by surprise?

Not if it's from GenRad.

All GenRad functional board test systems are designed around CAPS—our powerful, flexible diagnostic package. With CAPS, you can keep up with changes without always changing your hardware.

Instead, you just change CAPS. And that's easy. Because we're constantly updating it to make sure your system stays up to date.

Introducing CAPS IX. The most sophisticated diagnostic software package available. Plug CAPS IX into your GenRad system and you can diagnose and test the latest LSI bus-structured boards. What's more, CAPS IX lets you do it faster and more reliably than other systems because it comes with features the other systems don't even offer. Like a dynamic high-speed probe.

CAPS IX also lets you diagnose beyond the node. It even tells you the specific IC to replace, rather than a list of interconnected possibilities. As a result, it helps you increase board throughput and lower your trouble-shooting costs.

In addition, CAPS IX helps you reduce set-up costs. Because it features GenRad's Interactive Program Generation technique—a fast, systematic way to develop new test programs as they're needed. The fact is: the whole GenRad system—hardware and software—is designed to keep you current. No matter what takes place. Or when.

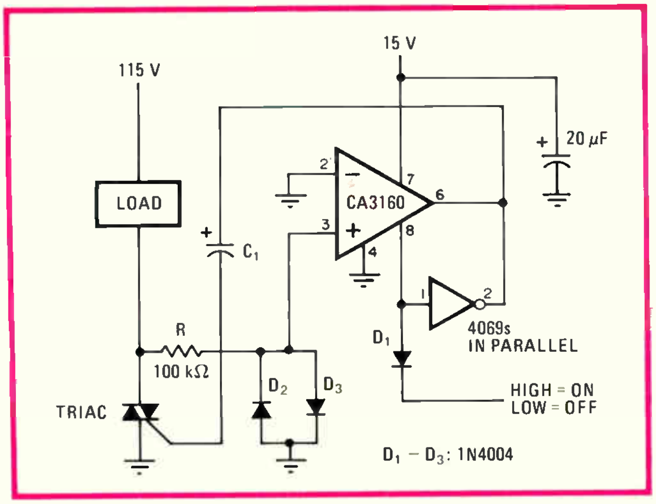
If your test system isn't able to handle tomorrow's technology, do yourself a favor and contact GenRad today. Write GenRad, Concord, MA 01742 or call the office nearest you. Atlanta (404) 394-5380; Boston (617) 646-0550; Chicago (312) 884-6900; Dallas (214) 234-3357; Dayton (513) 294-1500; Los Angeles (714) 540-9830; New York (NY) (212) 964-2722, (NJ) (201) 791-8990; San Francisco (408) 985-0662; Washington, D.C. (301) 948-7071; Toronto (416) 252-3395; Bourne End (UK) (06285) 2 66 11.

CAPS IX, the newest update of our proven diagnostic package, allows GenRad systems to handle the latest LSI bus-structured boards.

Circle 130 on reader service card

GenRad

Put our leadership to the test.



Diminutive driver. C-MOS operational amplifier, operated from a single supply, minimizes power drain and parts count in triac trigger that can source 100 milliamperes. C-MOS inverters may be placed in parallel with op amp for circuit to drive heavier loads.

pulsing time. As the ac line voltage completes a half cycle and drops through zero, C_1 discharges through the op amp, which now serves as a current sink, so that the triac is again fired.

Note that several 4069 inverters can be placed in parallel with the op amp's strobe (pin 8) and normal outputs to drive heavier loads. Pin 8 and D_1 may also serve as a control terminal, enabling operation with 4049s permanently wired into the circuit.

The maximum rated trigger current of the triac should equal the minimum current the 3160 and 4069s are capable of sourcing. The pulse time for the triac—typically measured in microseconds—should equal the time necessary for the ac supply to generate the necessary conduction voltage across the triac, plus t_T max, the maximum trigger time for the triac. The value of capacitance required for a given trigger current, I, triac pulse time, t, and maximum trigger voltage, V_T, is given by:

$$C_1 = I\,t/(0.75\,V_{dd} - V_T)$$

where V_{dd} is the op amp's supply voltage. □

One-chip gyrator simplifies active filter

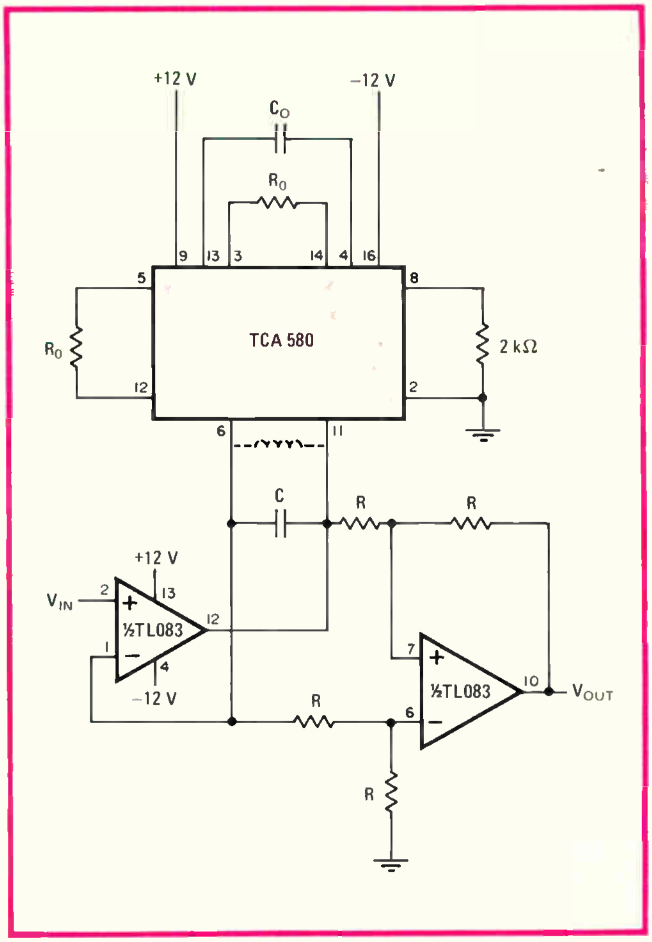
by Kamil Kraus
Rokycany, Czechoslovakia

Now that gyrators, or impedance inverters, are available on a single integrated circuit, active filters with both high input impedance and few component-sensitivity problems can be easily built in a small area with a minimum of parts. This one uses only one other active component—a dual operational amplifier—to provide low-pass, high-pass, bandpass, or band-reject response at reasonable cost over the dc range to 10 kilohertz.

The low-cost TL-083 op amp has been selected for use in the circuit because of its virtually negligible input-offset voltage and input-bias current. These characteristics are required to achieve a high input impedance over the range of interest and to realize the optimum response of the filter.

The Signetics TCA 580 gyrator simulates the relatively large inductor needed for the required LC (passive) network. The inductance across pins 6 and 11, and thus in parallel with capacitor C, is $L = C_0R_0^2$. The resonant (center) frequency of the LC combination, in turn, is $f_0 = 1/2\pi\,(LC)^{1/2}$, with its quality factor $Q = R(C/L)^{1/2}$. Thus the filter, which is shown configured on the bandpass mode, can be made to work at any frequency and Q, once its components are suitably selected.

The circuit can be transformed into a low-pass filter if its output is applied to an integrator whose time constant is RC. Similarly, it will function as a high-pass filter if its output is applied to a differentiator whose time constant is RC. For band-reject operation, C must be placed in series with the simulated inductor. □



Optimal. Gyrator and operational amplifier comprise a simple two-chip bandpass filter with high impedance and state-of-the-art stability. Filter configuration remains the same for high-pass and low-pass operation; only an external differentiator or the integrator, respectively, need be added. For the band-reject mode, C is placed in series with a simulated inductor.

Codec has on-chip signaling for phone applications

Putting coding and decoding functions on two separate chips also cuts out crosstalk and increases design flexibility

by Walt Heinzer and Steve Bolger, *Siliconix Inc., Santa Clara, Calif.*

☐ For the would-be codec user, the separation of the encoding and decoding functions onto two chips has many advantages. Such a configuration is low-cost, guarantees high isolation between the transmitting and receiving operations, and allows him considerable freedom of design.

Each chip of such a pair is smaller than a one-chip codec, so that reliability and yields are higher and cost lower. Each fits in a 14-pin package, so that board layout is compact. Being isolated from one another, coding and decoding can be carried out asynchronously, as need be, and crosstalk between the two directions of voice travel is completely eliminated.

Moreover, using minimal support circuitry, the designer can lay out his system in a variety of ways—on single-channel codec cards, for example, or on multiple-channel receive-only and transmit-only cards that minimize the amount of digital busing that will be needed on motherboards.

Another plus

All these advantages and more accrue to Siliconix' complementary-MOS encoder and decoder chips, the DF331/DF332, the first codec chip set to be introduced. For in addition, these chips include signaling functions in both their μ-law and A-law versions. This feature makes them particularly effective and easy to use in channel bank or central office applications.

One member of the pair provides the complete encoder analog-to-digital conversion function, the other the complete digital-to-analog conversion function (Fig. 1). Each of the chips has the same basic requirements for power supplies, voltage references, clock signals, and synchronization pulses. All digital data is time-division-multiplexed into a single serial bit stream.

The C-MOS technology with which the pair is built is well able to meet governing AT&T channel bank specifications. These specifications require a codec to have a precise dynamic signal response over a range of audio frequencies. This response is measured in terms of gain tracking, signal-to-noise distortion ratio, and channel noise and must also have certain quantization levels and timing and data formats. When the need for low power consumption was added to these considerations, C-MOS appeared the best integrated-circuit technology to use.

The ±7.5-volt (±10%) power supplies required for each chip keep power dissipation low, to an average of only 40 to 45 milliwatts per device. The supply voltages are easily obtained from a discrete regulator supply circuit or from standard three-terminal regulator chips.

These reasonable power dissipation levels do not impair the codec's analog system performance. Both the Bell System's D-3 specification and the CCITT recommendations are readily met. What is more, any encoder is guaranteed to function properly with any decoder since the analog performance is specified on a per-part basis. For example, the signal-to-noise distortion ratio exceeds the requirements by at least 6 decibels over all input ranges (4 dB for signaling every sixth frame, as required by the μ law). Gain tracking is typically ±0.15 dB per part for input levels from +3 to −45 dBm and +0.25 dB per part for −45- to −55-dBm inputs.

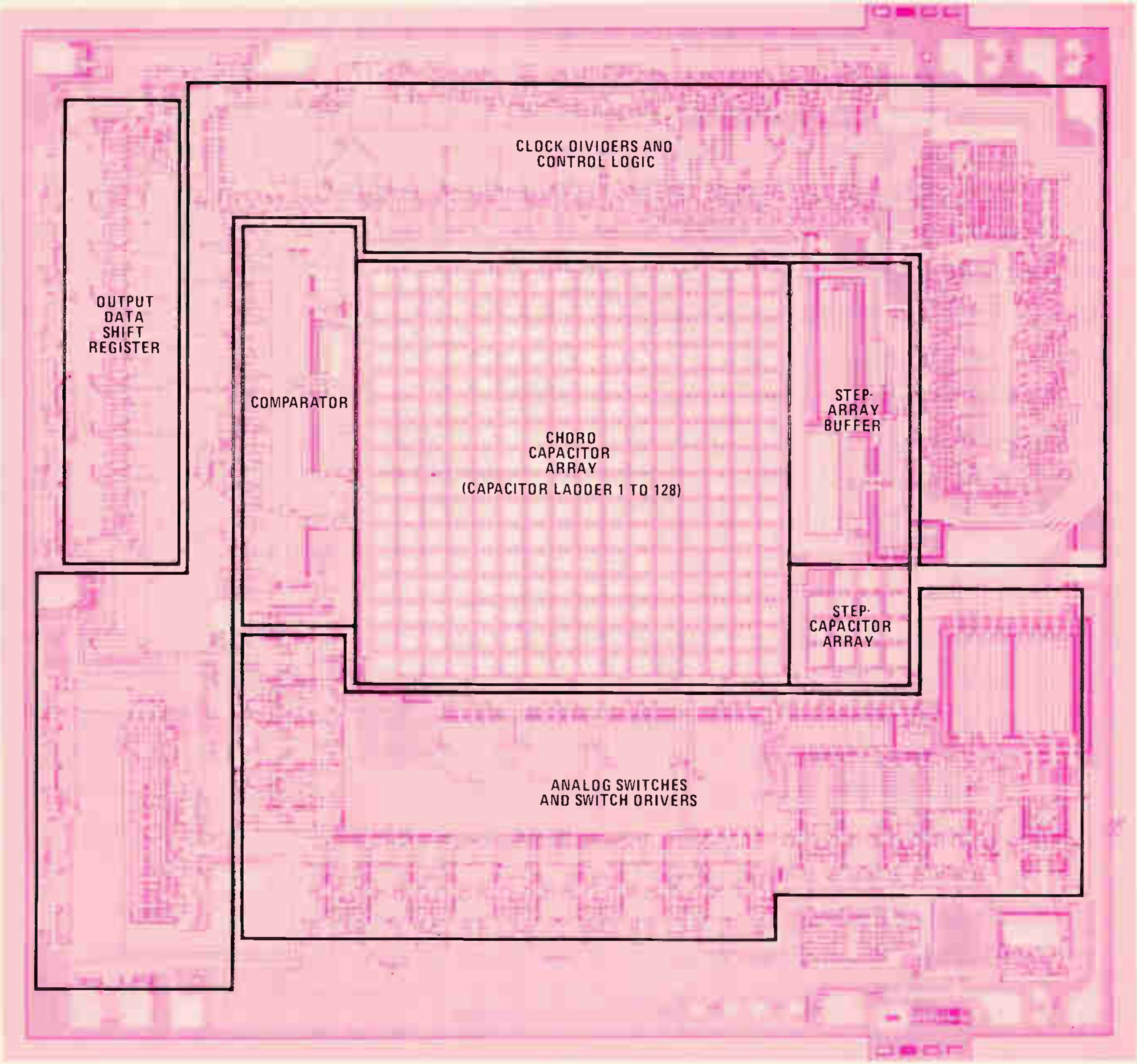
A standby condition reduces power dissipation still further, typically to 11 mW for the codec pair. The two devices are switched into the standby condition by using C-MOS-logic–compatible switches to open the analog ground line, thus turning off the current sources to the analog circuitry that uses most of the codec power. In this standby mode, synchronization pulses to the decoder should be stopped. Otherwise its output sample-and-hold circuitry will slew to either the positive or the negative codec voltage reference signal as it tries to decode.

Keeping on track

The reference voltages are important to the performance of a codec's analog system. They serve both the a-d and d-a conversions and are crucial to achieving proper gain levels throughout the system. For the Siliconix design, external voltage references were chosen for their cost-effectiveness, accuracy over the long term, and independence of the codec chips. They minimize the effect of codec manufacturing tolerances on system gain and temperature stability since the responsibility for gain and long-term drift is shifted to an external and therefore easily controlled, maintained, and designed source.

The approach yields an absolute gain accuracy of

This is the seventh in a continuing series of articles on the new integrated-circuit codecs. The other articles have appeared in the issues of Sept. 14, 1978, p. 108 and p. 111; Sept. 28, p. 141; Oct. 12, p. 130; Feb. 1, 1979, p. 126; and April 26, p. 138.



1. One of a pair. The DF331 encoder shown combines with the DF332 decoder to provide a codec complementary-MOS chip pair. Asynchronous operation is simplified with this approach and crosstalk between transmitted and received voice signals is virtually eliminated.

typically ±0.2 dB from device to device, making the codecs interchangeable without additional channel gain adjustment. The ±3.0-V external voltage reference also sets the maximum allowable input signal level. Given a system dynamic range of 72 dB, this also means the minimum signal-to-noise ratio will be relatively large.

To obtain the best system signal-to-noise ratios and to minimize gain error, the positive and negative references must track within 1% of each other. They are also used by the a-d and d-a converters to determine the voltage step sizes to be employed in the conversion—a critical process. These codecs perform the conversions with a successive-approximation technique using weighted capacitive arrays (see "Capacitors make stable converters," p.136). As the reference levels are the overrange levels of the converter, the maximum digital signals correspond to ±3.0 V.

Both encoder and decoder use a system clock synchronization pulse for logic inputs. The input logic levels are quasi-TTL-compatible (logic low of at most 0.6 V, logic high of at least 3.4 V) to allow use with TTL as well as C-MOS logic circuits. For μ-law devices, the transmission data clock rate is 1.544 MHz with a range of 1.34 to 3.0 MHz. For A-Law devices, the rate is 2.048 MHz with a range of 1.8 to 3.0 MHz.

Both μ- and A-law devices use an 8-kilohertz sample rate. Thus, the synchronization pulses have a period of 125 microseconds with a pulse width of eight clock pulses. During the sync time, the encoder shifts its digital output out of its shift register at the positive clock edges. Open-drain, n-channel MOS transistors produce this digital output by being pulled down to digital ground for logic low signals and being pulled up by a pull-up resistor for logic high, which is 5 V for TTL and 4 to 12 V

Capacitors make stable converters

The decoder uses a weighted capacitive ladder to convert analog into digital signals. Integrated-circuit capacitors, unlike their resistor counterparts, dissipate no power within themselves and the capacitance ratios can be held within closer tolerances for given layout rules. So they are ideal ratio-ing devices with which to build stable and accurate converters that must operate over the normal telecommunications temperature range.

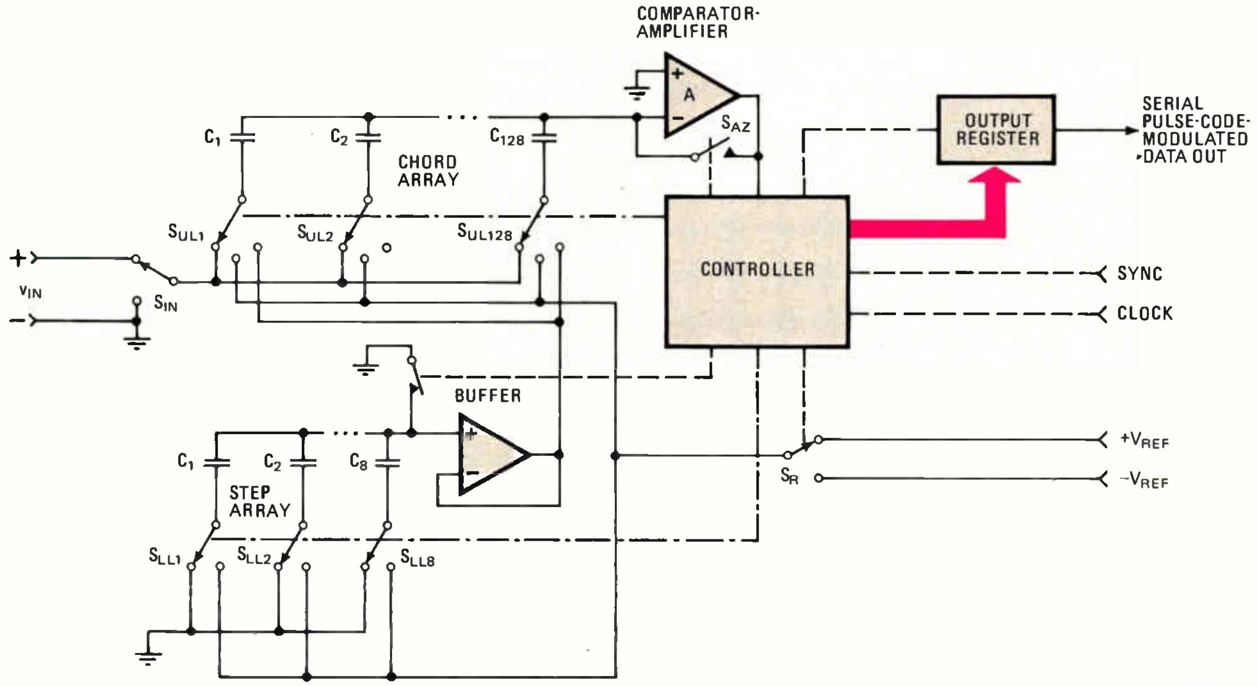
The a-d conversion process (see figure) requires a specific sequence of steps. First the analog sample is acquired. Next the sign, the chord, and the step within the chord are determined [*Electronics*, Sept. 14, 1978, p. 108]. Finally, an output shift register is loaded, the circuit is reset and returned to the sample mode, and an output is presented in the form of serial digital data.

To start the process, the receipt of the synchronization pulse initiates voltage sampling through switch S_{IN}. This voltage is stored on the bottom plate of the capacitor array. During acquisition, switch S_{AZ} is closed, placing the comparator V_{OFFSET} on the top plate of the capacitor array. Comparator A acts as a unity-gain buffer. At the end of the sampling time, the capacitor array, acting as a sample-and-hold, is charged to $-V_{IN}+V_{OFFSET}{}^{(A)}$.

After acquisition, the top plate is floated (S_{AZ} opened) and the bottom plate is shorted to ground (S_{IN}). The output of the comparator represents the polarity of the signal with the offset nulled out. Since the polarity of the signal is now known and present at the output of the comparator, the controller switches S_R to the appropriate reference.

The upper ladder switches (S_{UL}) are then connected in a successive-approximation sequence to determine the proper chord. Charge redistribution takes place on the capacitive ladder, continuously updating the voltage presented to comparator A.

Finally, the lower ladder is switched in a successive-approximation sequence to determine the appropriate step within the previously determined chord. Only at this point does the digital result of the conversion load the output register.



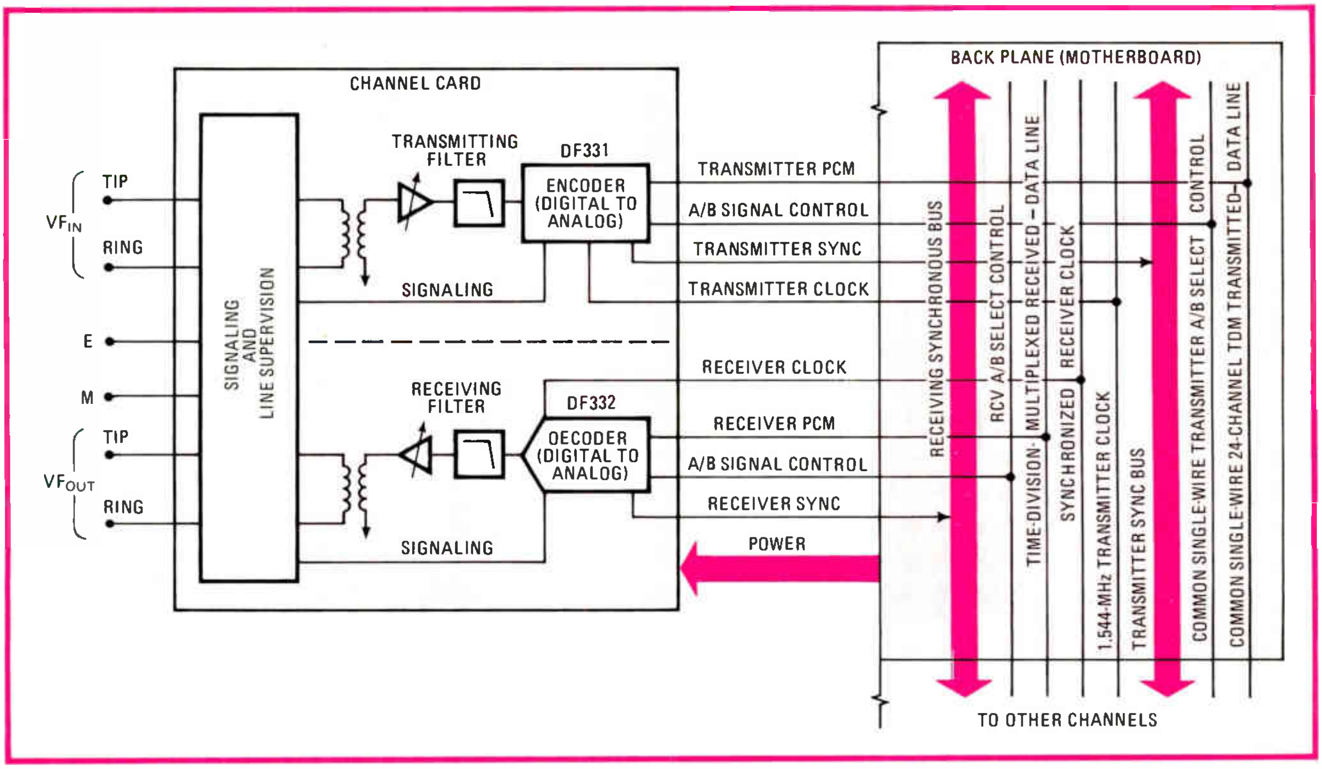
for C-MOS. If several encoders are being used, they are wire-ORed together so as to time-division-multiplex their outputs onto a single pulse-code-modulated data line.

The rates for encoding and decoding differ since the decoding d-a conversion is a faster operation. Decoding takes less than 15 μs and resetting the chip results in a total conversion time of 25 μs. Encoding requires a total of 108 μs to do the sampling, successive approximation, and resetting operations.

Channel bank signaling

The signaling functions included on the codecs ensure their simplicity and flexibility of use in channel bank applications. For the American μ-law family, the signaling occurs every sixth frame in the data stream. Each frame consists of 193 bits: 24 8-bit data words, each time-multiplexed into its own time slot, plus 1 framing (S) bit. During each signaling frame, the 8-bit conversion yields only 7 data bits, the 8th being used as a signal bit for transmitting and receiving supervision and signaling information. The encoder contains logic inputs for the A signal input, B signal input and A/B select. The A/B select input is an edge-sensitive input that tells the chip to encode a signaling input into the 8th bit position in the pulse-code(d)-modulated (PCM) data stream.

At the decoder, the A/B select logic input tells the chip to take the 8th bit and transfer the data to the A or B signal output pin. During signaling, the decoder's digital-to-analog converter still needs 8 bits, but since the data word has transferred only the most significant 7



2. Channel card. The encoder chip that converts analog into digital signals and the decoder chip that does the reverse are typically mounted on a separate channel card for an individual telephone. All control signals and power, however, come from the motherboard.

bits, an average value of a logic 0 and a logic 1—logic ½—is assigned to the 8th and least significant bit. The assignment of a ½ bit in the LSB position enhances a system's signal-to-noise distortion ratio at low signal levels by making a smooth transition through the origin of the analog-to-digital transfer characteristic.

Thus, these μ-law codecs readily produce the signaling logic required for channel bank operations. Adding to design flexibility, all channels can have the A/B select transition occur at the beginning of the signal frame, eliminating the need for separate A/B select lines for each channel.

In the A-law format, signaling is done on the 16th time slot of every frame in the data stream. The A-Law encoder incorporates the necessary gated signal logic—a NAND gate with two inputs, one the signal and the other a sync NANDed to the signal-out open-drain n-MOS transistor. This setup allows each encoder to gate any signal information with its sync pulse and tie all of the channel signal-out information to a common digital signal output line.

External capacitors for sampling and holding or automatic zeroing are unnecessary. The encoder samples the input signal, while the internal capacitor array performs the necessary sample-and-hold function. The capacitor array also stores the necessary charge for auto zeroing.

A phone system

The benefits of keeping a coder and decoder separate are also evident in a phone system (Fig. 2). In this application a typical per-channel codec has a four-wire interface located between toll centers. Voice paths are completely divided, even on the channel card.

The PCM transmitter data and clock lines require separation from the PCM receiver data and clock lines since the timing controls are several tens of miles apart. The problem here is that the phases of the two clocks and even the fundamental frequency will be different. These differences make it difficult to design a single-chip encoder/decoder such that interactions like beat frequencies will not occur between the two data paths. But a two-chip model of its nature guarantees the necessary isolation.

Easy interface

The Siliconix codec also eliminates the external logic often necessary to interface between the four-wire signaling and the μ-law signaling formats. Its common A/B select control line for all channels in the channel bank simplifies the loading and unloading of signaling data into every sixth frame. The loading and unloading of 24-channel PCM data onto the signal wire data bus is controlled by the time-slot generator. The PCM binary data signal is converted into a bipolar signal in the digital line driver interface. The bipolar signal is then transmitted over the 1.544-MHz twisted pair.

At the receiver, the serial bipolar data is reconstructed as a binary PCM data stream and a new clock rate derived from it. This clock rate serves as the basic timing device for the controller and all receiving circuitry, since delay variations in the carrier prohibit use of a totally synchronous system clock.

Receiver resynchronization to the incoming bit stream is accomplished by the framing (S) bit, which is present at the beginning of each 193-bit frame and handles both frame and signal synchronization. □

Designing V-f converters to handle bipolar signals

Careful design makes these usually unipolar units more versatile in data-acquisition and control applications

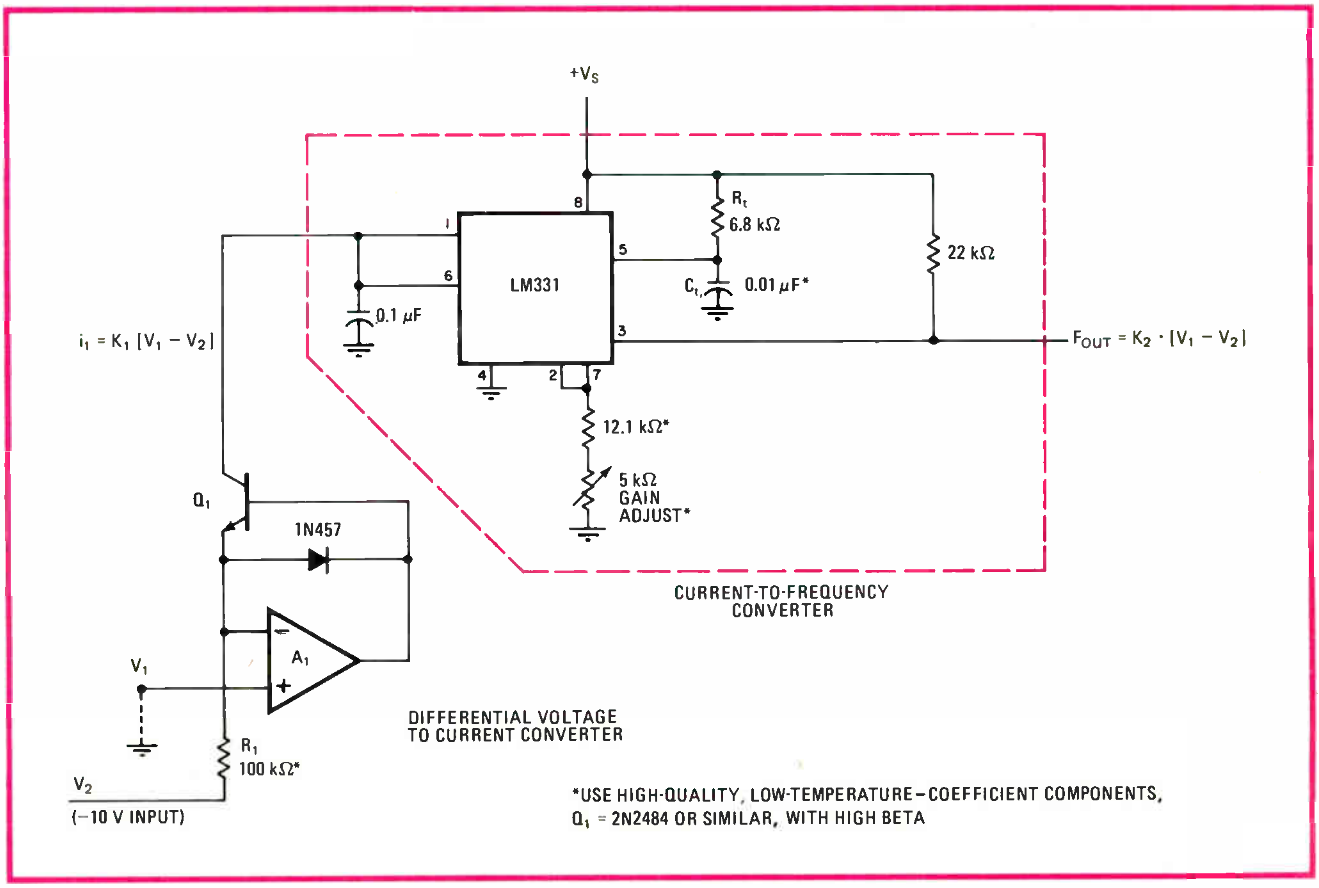
by Robert A. Pease, *National Semiconductor Corp., Santa Clara, Calif.*

☐ Voltage-to-frequency converters are popular forms of analog-to-digital converters that are most often used when the input is a voltage or a current of a single polarity. Generally the output frequency is linearly proportional to the input, neglecting a small offset that can be easily trimmed to zero. But with proper design, V-f converters can also accommodate bipolar signals and thus extend their versatility in data-acquisition and control applications.

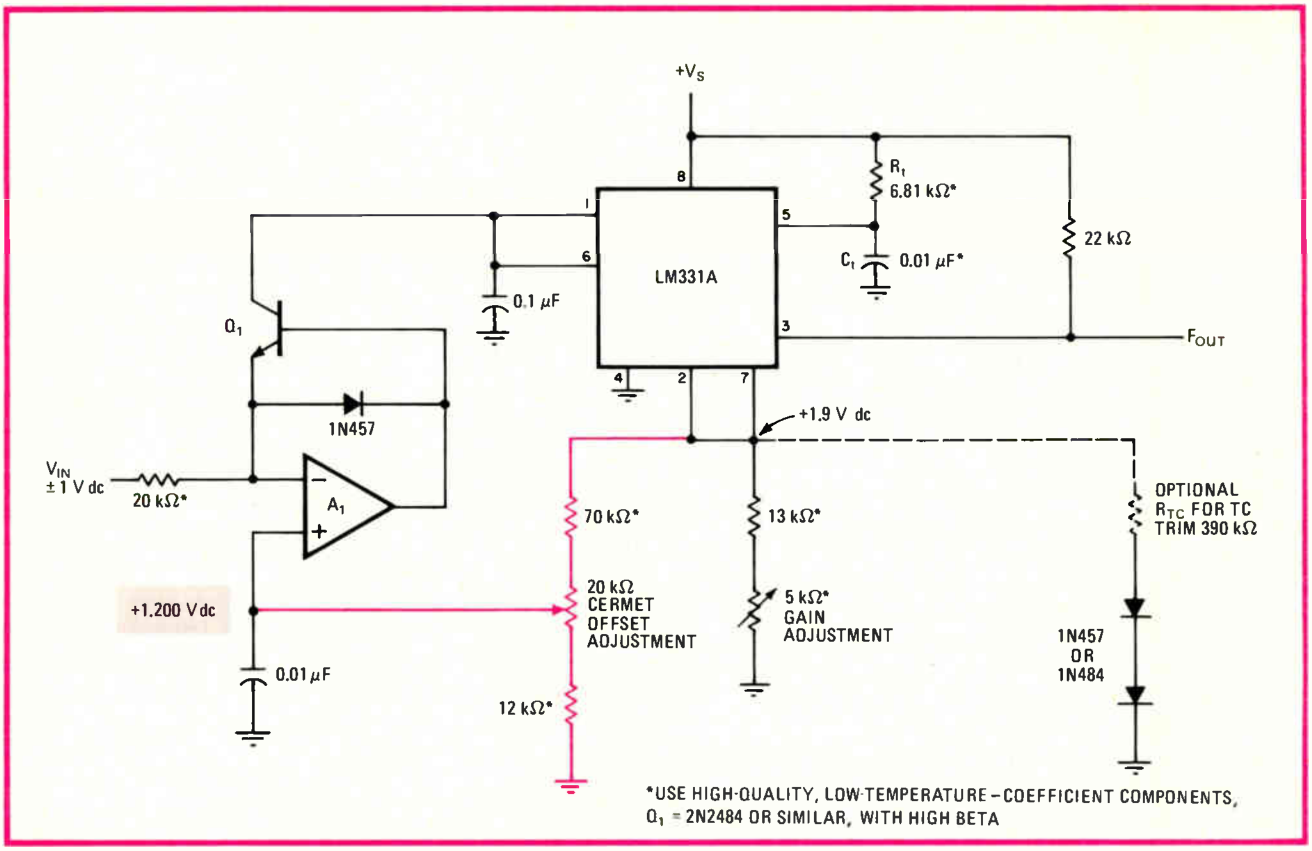
The simple differential V-f converter circuit in Fig. 1 can accept either a positive input at V_1 as large as 1 volt or a negative input up to −10 V at V_2, but not an input that varies between plus and minus. This converter is inherently differential, where the input, i, equals $(V_1 - V_2)/R_1$ and the output frequency is linearly proportional to $V_1 - V_2$.

Bipolar inputs

However, like most a-d converters, a V-f unit may be operated with an offset, so that for bipolar inputs the internal converter sees only a single polarity. Such an arrangement is shown in Fig. 2. The stable +1.9-V dc reference at pin 2 of the LM331 converter is divided down to a +1.200-V level and is fed to the operational amplifier's positive input. The current from Q_1 will be $(+1.2\text{ V} - V_{in})/R_1$ and for an input range of +1 to −1 V



1. Simplicity. This voltage-to-frequency converter can accept a positive input at V_1 or a negative input at V_2, but not an input that varies between plus and minus. This arrangement is inherently differential and the output frequency is highly linear and proportional to $V_1 - V_2$.



2. Offset. To accommodate bipolar inputs, this circuit employs a highly stable dc reference to provide an offset so that the internal converter sees only a single polarity. The circuit responds rapidly to input step changes but is subject to drift due to offset instability.

the LM331's output frequency will span a range of 1.0 to 11.0 kilohertz, with nonlinearity less than 0.01%.

The excellent response of this general-purpose converter is such that when the input voltage makes a step change, the output frequency changes immediately, and thus the output can be decoded by a separate fast frequency-to-voltage converter. Although most V-f converters change their frequency as soon as their input voltage changes, their output frequency change cannot be detected until a full cycle (two full pulses) of the new frequency has occurred. At lower frequencies, this time can be significant.

Weakness

The weakness of the scheme in Fig. 2 is the stability of the offset and its dependence on gain. Assume stable components are used, so that the gain temperature coefficient of the circuit is better than 150 parts per million/°C. Then, when V_{in} = 0 V and the output frequency is 6.0 kHz, the output frequency can shift as much as 0.9 hertz/°C, or +0.18 millivolt/°C referred to the input. This input drift is only about 1% of full scale per 60°C, or 0.1% of full scale per 6°C. In many systems, though, this amount of zero drift is not acceptable.

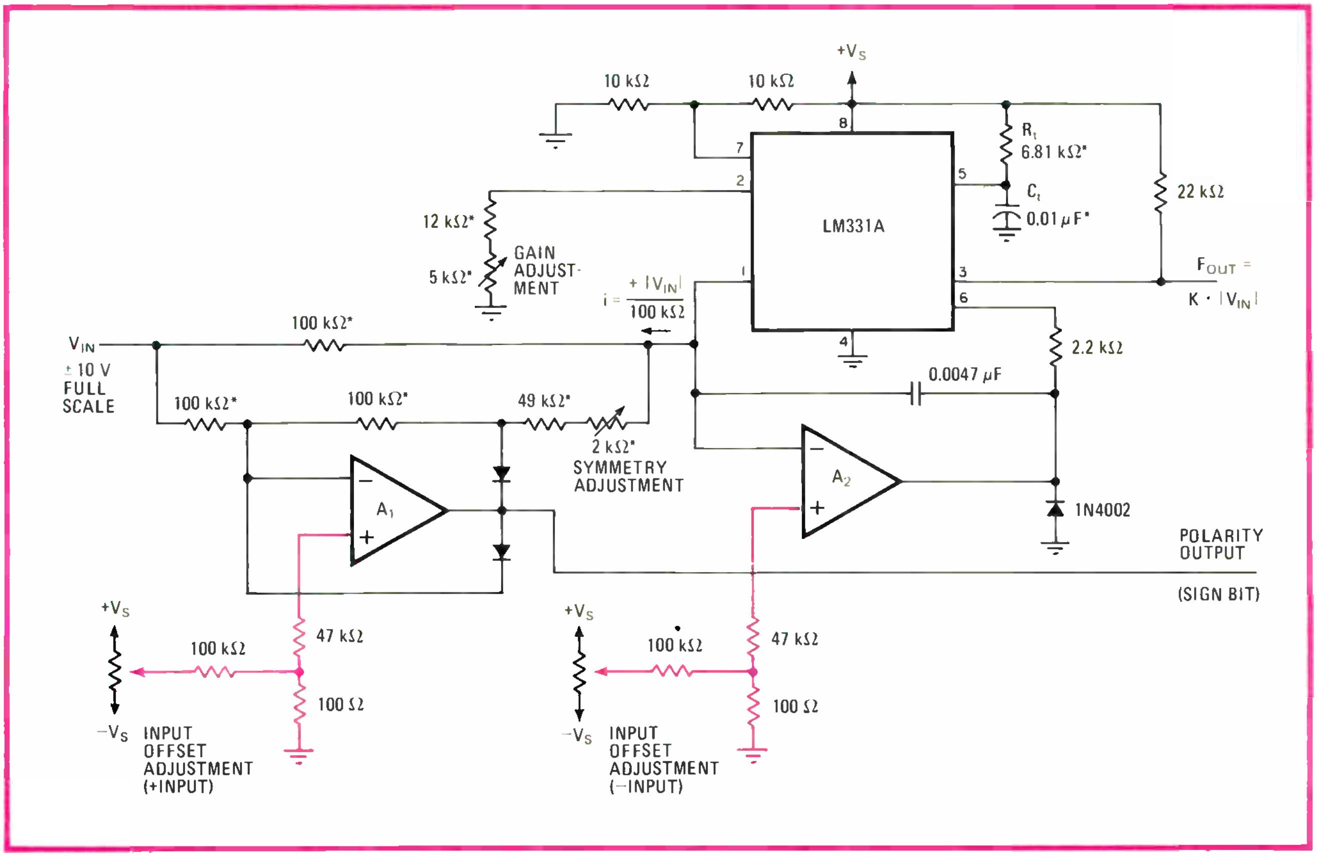
To achieve better offset and gain stability for the V-f converter of Fig. 2, a simple trimming procedure may be implemented. Using a polystyrene or Teflon capacitor for C_t will cause the gain temperature coefficient to go positive because of the −110 ppm/°C temperature coefficient of the capacitor. Connecting a 390-kilohm resistor from pin 2 to ground via two planar diodes causes the total reference current to vary by +100 ppm/°C, thus canceling the positive gain coefficient. If the temperature stability of the gain or offset is not within the desired range, the value of R_{TC} should be varied for minimum temperature coefficients. In this circuit, stability to within 20 ppm/°C of either gain or offset is achievable, but not necessarily simultaneously. Still, improving one will force the other to track closely behind. In other circuits where there is no such interaction of the gain and offset, the gain tempco can be trimmed easily to be less than 20 ppm/°C.

A classic solution of the drift problem is to establish an absolute-value circuit ahead of a unipolar V-f converter. Such a circuit is shown in Fig. 3. It can do an accurate job but is difficult to trim. A separate offset adjustment is needed for positive and negative input signals, and these tend to interact. As an alternative, the circuit of Fig. 4 is recommended.

Adding an absolute value

Here, a V-f converter is preceded by an absolute-value current circuit that provides excellent linearity and zero-offset stability. It uses substantially the same current-to-frequency converter circuit as in Fig. 1, but in this case the input signal can take the route of one of two output paths, one for negative currents and the other for positive ones.

When V_{in} is negative, the signal current flows through Q_1 to the 331A converter. When it is positive, the signal



3. Improvement One approach to solving the problem of drift is to add an absolute-value current circuit to a unipolar V-f converter. However, because individual offset adjustments are required for positive and negative inputs, interaction occurs, making trimming difficult.

current flows through Q_2 to the current inverter—a basic Wilson cell made up of Q_3, Q_4, and Q_5—and then to the converter. This circuit thus has excellent dc accuracy. But one weakness remains. When ac noise is added to the input signal, it is rectified, and although the output frequency represents the average rectified amplitude of the input, dc-level information may be lost or garbled.

Disadvantage

For example, if V_{in} has a 0.000-V dc level, but has a peak sine-wave signal of 200 mV at 120 Hz riding on it, the output frequency will be about 120 Hz. Also, the sign bit will change polarity at 120 Hz. Depending on the phase relationship between input and output, the F_{out} pulses may occur when the sign bit is low, indicating a positive input. Or, if the phase is reversed, the pulses will be counted at a time when the sign bit indicates that V_{in} is a negative voltage. On a long-term basis, this error may cancel out because the output pulses have no tendency to lock in with the noise frequency, but for real-time conversion a serious misrepresentation of V_{in} (dc) may occur.

In some systems, this aliasing problem can be circumvented by increasing the feedback capacitance, C_f, around A_1. A 1-microfarad Mylar capacitor will usually reduce 60- or 120-Hz noise effects by 30 to 50 decibels. Adding a multiple-pole low-pass filter ahead of this V-f converter is also helpful.

Depending on system requirements, both fixes together may ensure adequate noise rejection. For true integration as well as excellent noise rejection, Fig. 5 has further advantages. The operational amplifier A_1 acts as a real integrator, with excellent accuracy and resolution (better than 1 ppm of full scale). When V_{in} is negative, the op amp's output ramps up until it triggers IC_1, and IC_1's output current, i_1, balances out the input signal. When V_{in} is positive, the integrator triggers IC_2 instead, and IC_2's output current, i_3, is reflected by the precision current inverter A_2. Thus, i_2 balances out the input current. If there is only a pure ac input signal, the number of current pulses out of IC_1 will be exactly equal to the number of pulses out of IC_2, assuming that the gains have been trimmed to be equal. Notice that here a low-drift op amp is used as a current reflector, with excellent precision and simplicity.

The gain of IC_1 and all its attendant resistors and capacitors can easily be made to match the gain of IC_2 well enough to reject ac noise. Even if the temperature changes +5°C and the gain mismatch of IC_1 versus IC_2 becomes 0.005% or 0.01%, the rejection of an input noise signal as high as 5% of full scale will cause an error rate of only 2 to 5 ppm. But when this kind of circuit is used, as it often is, as the converter and integrator in an inertial guidance system, a 100-ppm gain mismatch between IC_1 and IC_2 would cause an unacceptable error. The positive path gain must match the negative path gain much more tightly than this circuit can achieve.

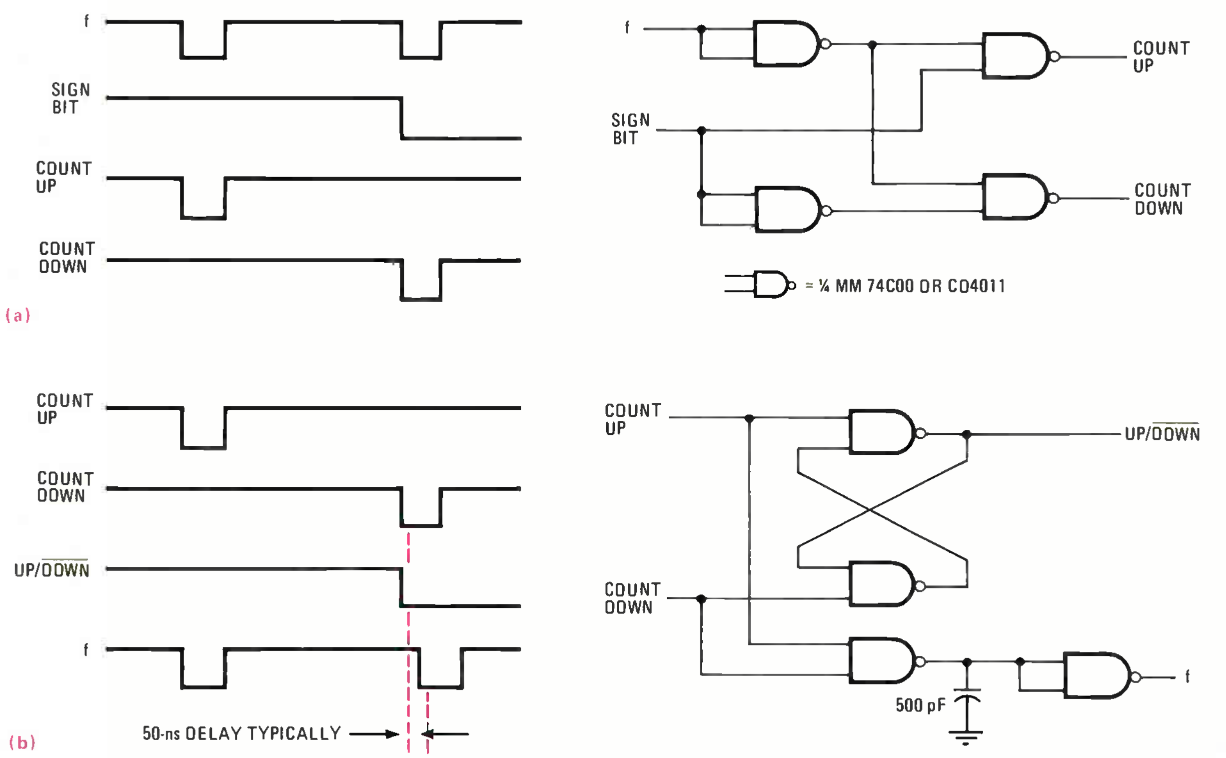
However, there is a circuit that comes close to performing ideally. Figure 6 shows a bipolar V-f converter of a highly refined design. Here, a single LM331 puts

How do you use those output pulses?

The circuit in Fig. 5 (p. 144) has two output lines and will put out a count-up or a count-down pulse (but never both at the same time). These pulses can be fed directly to the count-up and count-down inputs of a 74C193 up-down counter. When two or more of these up-down counters are cascaded, a long-term integration of 20 to 40 bits, or even more, can be accomplished, with a maximum error of less than 0.1% of the signal whether the integrated signal is large or small.

The circuits of Figs. 3 (p. 141), 4 (p. 143), and 6 (p. 145) put out a pulse whose sense is denoted by a sign bit. A comparator such as LM311 is suitable to detect this low-level bit and then drive a complementary-MOS–level counter. The CD4029 is a C-MOS up-down counter that accepts pulses on a count line, and the direction of counting is determined by the up-down input at pin 10. Thus CD4929s may be cascaded in the same way as mentioned above to perform wide-range integration of up and down signals.

A frequency output and a sign-bit signal can be converted to the count-up and count-down format using the circuit shown in (a). To convert in the opposite direction is not as easy, but a little capacitive delay will help get the job done (b). The 500-picofarad capacitor allows up/down to change, whenever it does, before the pulse appears at f.



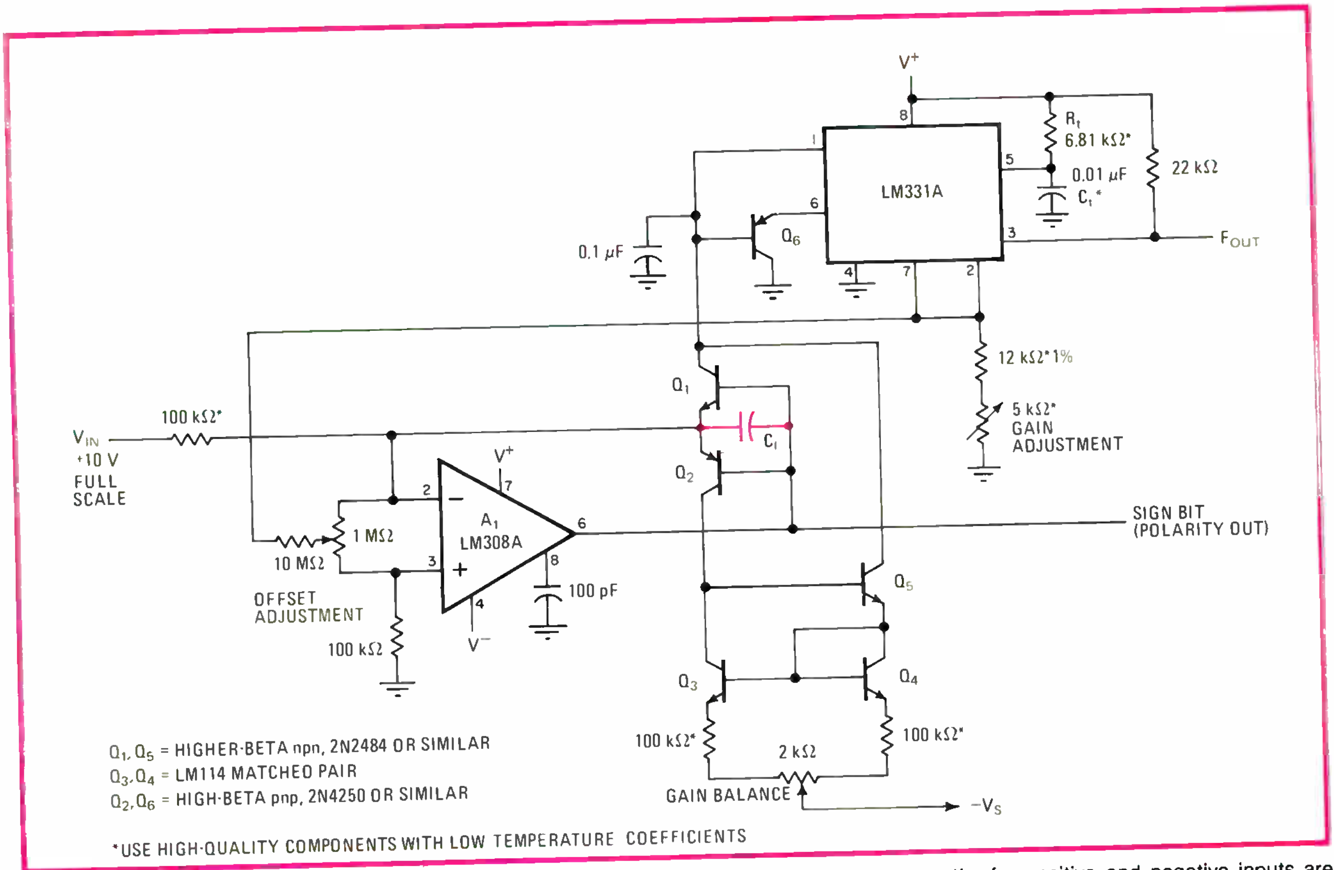
out current pulses that are steered either directly to the summing point or through a current reflector. To achieve full accuracy, the steering circuitry and the current reflector each have a gain-tracking rate of better than 1 ppm/°C, as verified in evaluation circuits.

Ultraprecision with a flair

When V_{in} is negative, the op amp's output will integrate up to +7 V dc, upon which gate G_1's output starts decreasing, resetting the G_3–G_4 flip-flop so that the countdown output is high. This will enable Q_2 to turn on. G_1's output will also pull pin 6 of the LM331 low and will initiate a standard charge pulse out of pin 1. Since the voltage of Q_2's base is higher than that at Q_1's base, the current from pin 1 will be steered directly to the summing point, forcing the op amp to ramp back down.

When V_{in} goes positive, the op amp's output will fall to +0.6 V, G_2's output will fall, and G_3–G_4 will be set to the other mode. The current from pin 1 of the LM131 will be steered through Q_1 to the current reflector consisting of Q_3, Q_5, and the well-matched 20-kΩ ± 0.01% resistors.

The output of G_3 (and G_4) may be used as a sign bit to stipulate whether each output pulse should be counted up or down. If desired, that output can steer the pulse to appear on a "count-up bus" or on a "count-down bus" in a digital bus structure. A possible configuration would include the 74C193, a standard integrated-circuit counter that accepts the count-up bus and count-down bus, or the CD4029, a presettable binary decade up-down counter that accepts a single count input, and an up-down control input.



4. Better yet. A variation of Fig. 3 results in improved linearity and stability. Here, separate paths for positive and negative inputs are provided. Although the circuit has excellent dc accuracy, it is subject to aliasing effects from ac noise riding on the dc signal.

To get equal outputs in terms of kilohertz per volt for both positive and negative signals, the alphas of Q_1 and Q_2 must be closely matched at all temperatures of interest. When betas of 2N2605 or 2N4250 pnp transistors are matched to within ±1%, the temperature coefficient of their alphas will match within ±½ ppm/°C. If still better gain accuracy is required, p-channel field-effect transistors such as the 2N5116 may give better matching of alphas (when the gate drive to the FET's gates is increased to be +8 v high, +2 v low). However, FETs often leak more than the pnp bipolar transistors mentioned, and the effect of leakage will degrade the effective input drift at elevated temperatures.

Matching betas

Similarly, the betas of Q_{3A} and Q_{3B} must match well and should track the betas of Q_{5A} and Q_{5B}. For this task, monolithic npn transistors such as LM114s are well-suited. Also R_3 and R_4 should have excellent temperature-coefficient tracking and stability. Although most good wire-wound resistor pairs taken from the same batch and wound from the same spool of wire will track to within ±1 or ±2 ppm/°C, it is expensive to purchase resistor pairs guaranteed to meet such a specification. Film resistors manufactured by Vishay Corp. are claimed to have an excellent yield of temperature-coefficient tracking to better than ±1 ppm/°C and thus may be cost-effective for this application.

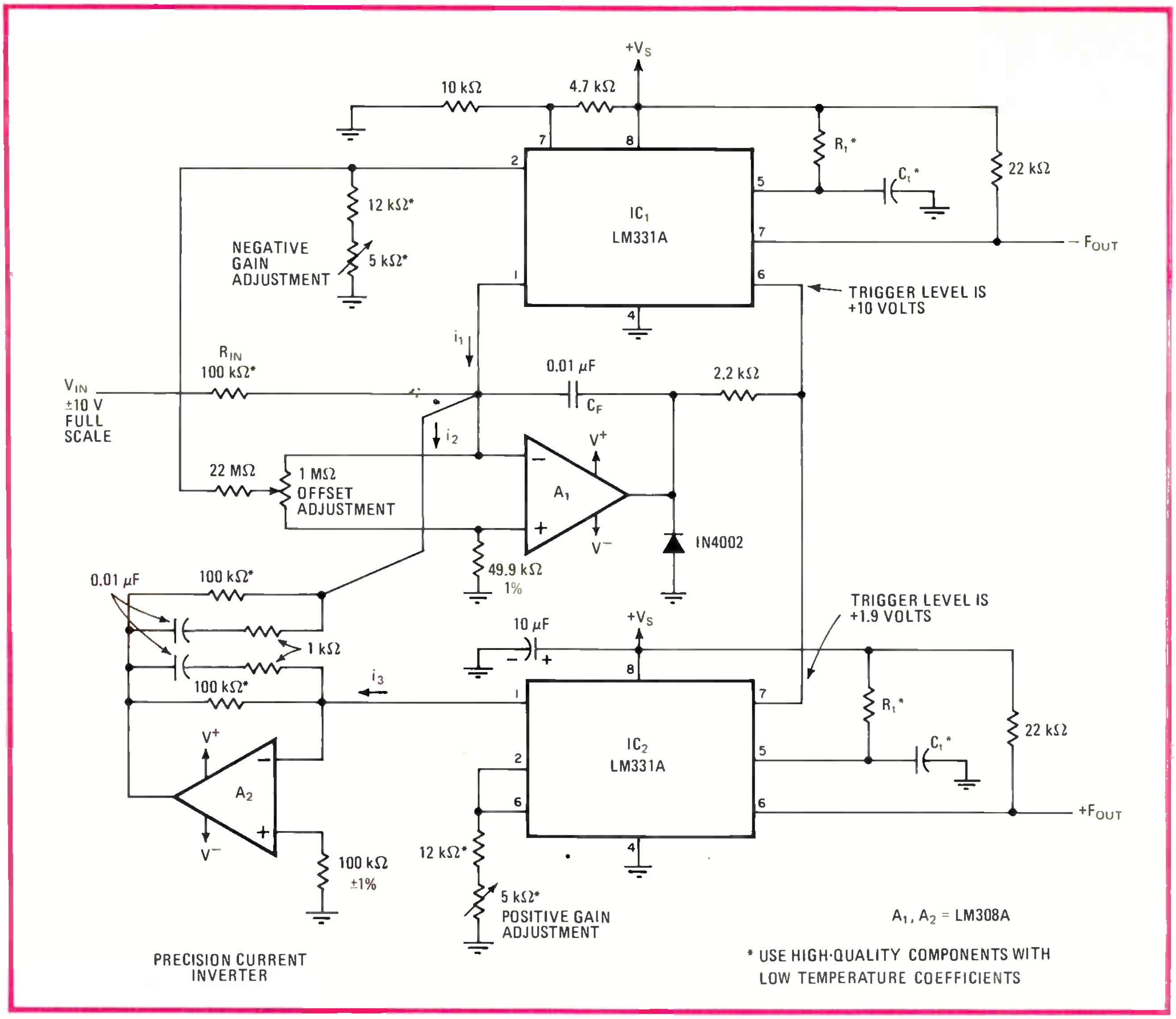
After the current reflector is built of stable, accurate parts, it is easy to trim it to ±1 ppm of functional accuracy using the high-resolution trimming potentiometer (P_2) as shown.

To obtain extremely good input offset voltage (and voltage drift) the op-amp section uses an LM194 "super-matched pair," with less than 0.1 microvolt/°C of offset voltage drift. To achieve this kind of drift, the 499-kΩ resistors R_5 and R_6 must track with temperature within 3 ppm/°C. The output amplifier also should be of a low-drift type, such as the one built using the low-cost LM308A shown. This ultralow-drift op-amp configuration provides an input offset drift of less than 0.01 ppm/°C (referred to the 10-v full-scale voltage).

Obtaining the best stability from the LM331A involves a few circuit approaches not often used in low-cost circuits, but justifiable here. For example, rather than a 5-kΩ gain-adjusting potentiometer, a set of film resistors with shorting links and stable to within 1% is used to adjust coarse gain. The selected film resistors will be considerably more stable versus time, temperature, and physical shock than a 5-kΩ potentiometer can be, and the 50-ohm cermet potentiometer in series allows the gain to be set to any necessary value.

Padding

The temperature coefficient of the complete circuit is trimmed by padding the resistance between diode D_1 and ground. For the example shown here, if the temperature coefficient of F_{out} is observed to be +20 ppm/°C (or +4 Hz per 20°C at 10 kHz full scale), it can be compensated and canceled by adding a 750-kΩ resistor in paral-



5. Integration. Combining integration and noise rejection, this circuit has excellent accuracy and resolution, provided the gains of IC_1 and IC_2 have been trimmed to match precisely. In some applications, a gain mismatch of 100 parts per million can cause an unacceptable error.

lel with the 150-kΩ one. Conversely, a −30 ppm/°C temperature coefficient may be canceled by adding a 43-kΩ resistor in series with the 150-kΩ one. In practical circuits, temperature coefficient well below 5 ppm/°C in the temperature range +10° to +40°C is usually attainable after two or three adjustment trials.

Highly linear

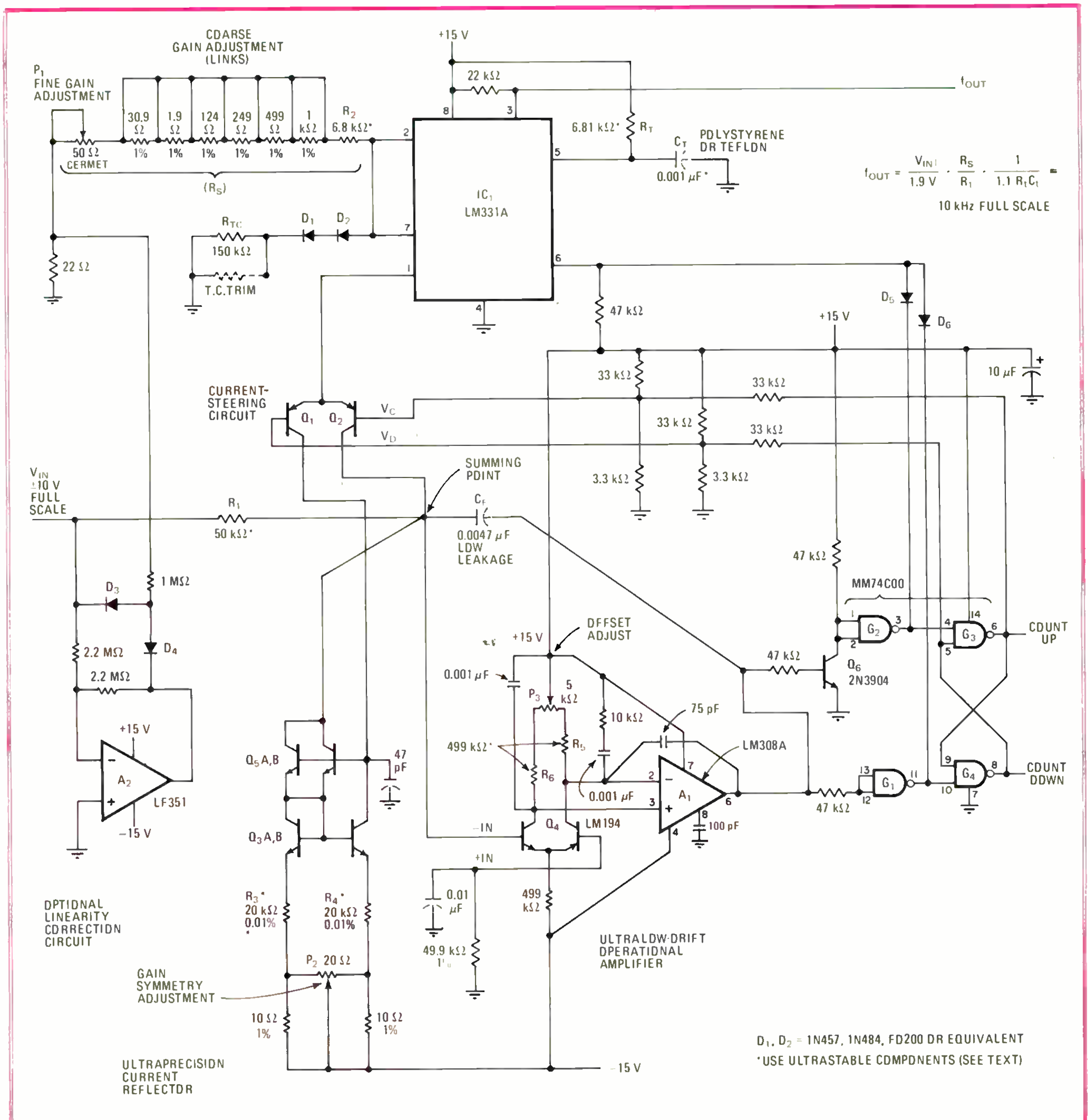
The gain transfer of this circuit is highly linear—35 or 40 ppm of full scale. If a small fraction (about 200 μV maximum) of V_{in} is applied to the low end of the R_s adjustment network, this nonlinearity can be improved to 15 or 20 ppm. The optional op amp A_2, a low-cost type such as the LF355 or LF351, provides this function for both polarities of input.

Care must be exercised in choosing the other components for the circuit in Fig 6. R_2 and R_t should be of the same type and the same value, to ensure good stability and good temperature-coefficient tracking.

Choosing C_t of a stable polystyrene type (rated to +75°C) or Teflon (to +125°C) with a −110 ppm/°C temperature coefficient will yield good stability with time and temperature cycling. Expensive hermetically sealed capacitors are usually the best, for example. R_1 should have a reasonably low tempco (±10 ppm/°C), and R_3 and R_4 should track very closely (±1 ppm/°C or as needed). R_5 and R_6 should track within ±5 ppm/°C or as desired, to ensure a stable offset temperature coefficient of V_{os}. The LM194's guaranteed 0.1 μV/°C will be doubled if the R_5/R_6 temperature-coefficient tracking is worse than 5 ppm/°C. D_1 and D_2 may be any silicon planar diodes like the 1N484, 1N457, FD200; mesa diodes, on the other hand, should be avoided, as they have a tendency to drift.

Advantage

The circuits of Figs. 5 and 6 are designed not just to accommodate a 5-μV signal with an error of less than 40% over a moderate temperature span. Rather, the advantage of voltage-to-frequency converters in general



$$f_{OUT} = \frac{V_{IN}}{1.9\ V} \cdot \frac{R_S}{R_1} \cdot \frac{1}{1.1\ R_t C_t} =$$

6. Near-ideal. This bipolar V-f converter is extremely accurate. It features a steering circuit that steers the output current pulses from the LM331 either to the summing point directly or through a current reflector, depending on whether V_{in} is positive or negative.

and these circuits in particular, as opposed to a-d units, is their ability to provide very good relative accuracy, with signals covering a wide dynamic range.

For example, note that the V-f converter in Fig. 6 has much better linearity than the nonlinearity error of 25 ppm of full scale indicates, as that implies that an error of ±0.25 mV could occur with a small input as well as a large one. Actually, the nonlinearity error decreases as the input level decreases and should be expressed as ±1 ppm of full scale ±25 ppm of the signal. The relative accuracy for small inputs is no worse than for large ones, but the actual error, in hertz or in microvolts, will be much smaller. With small inputs, the only significant error is the noise and offset of the operational amplifier, which can be held to a few microvolts by using the extra-stable components shown. Thus, a 10-mV signal may be measured and integrated or converted with almost as good accuracy as a 10-V signal. This is not true for most a-d converters. But the need for good relative accuracy with a wide range of signals is a realistic requirement for many signal conditioners and data-acquisition systems. □

Low-cost processor package programs E-PROMs

by Douglas Passey
Technology Department, Cleveland State University, Ohio

A problem for designers of the one-of-a-kind microprocessor-based system is the costly programming unit for the system's erasable-programmable read-only memories. Described here is an inexpensive E-PROM programmer built around a single-board microcomputer training kit, Intel's SDK-85. The scheme, used to achieve low-cost programming, can be readily generalized to other microcomputer systems.

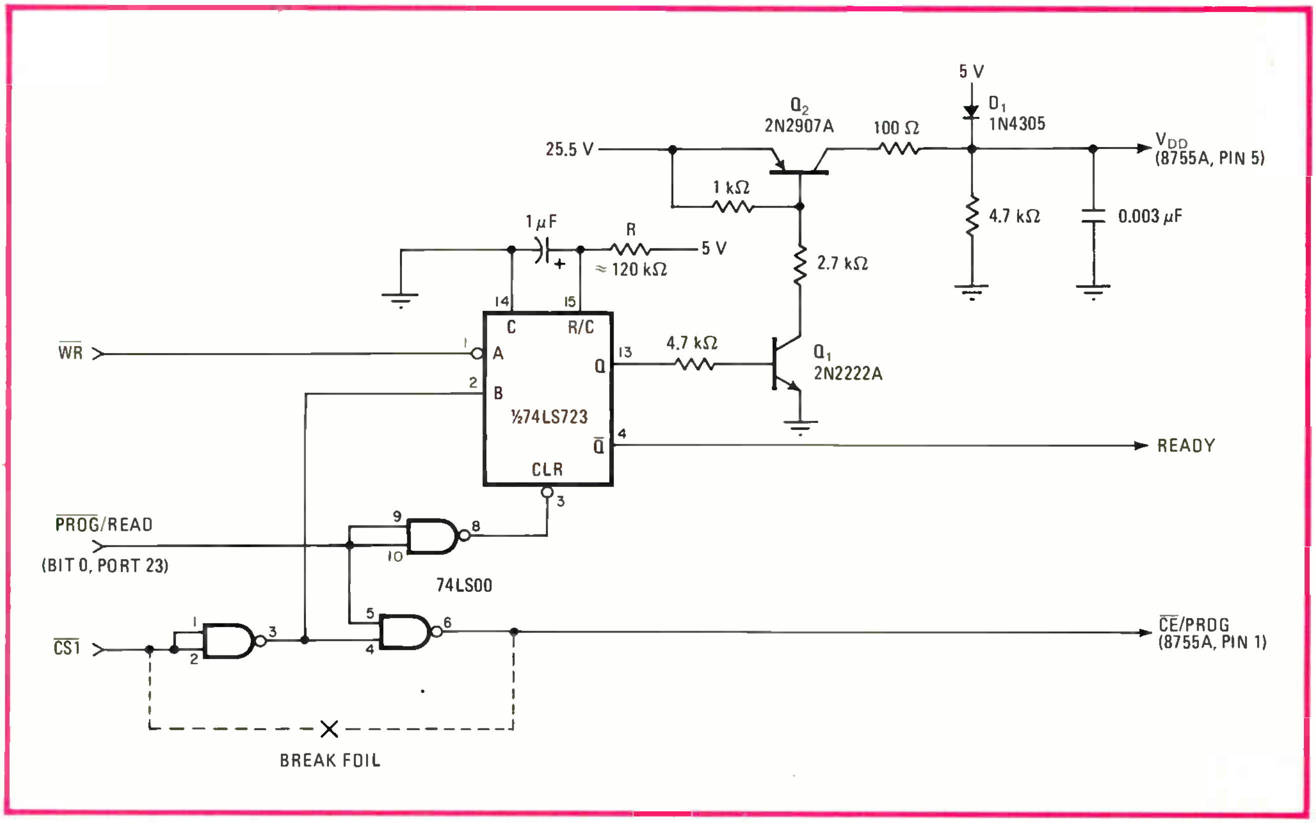
The SDK-85 uses the popular 8085 microprocessor as the central processing unit. The system has 2 kilobytes of read-only memory and 256 bytes of random-access memory. There is also a fully wired location for an additional 8355 ROM or 8755A E-PROM. With a few components and appropriate software, the added E-PROM can be programmed.

The system operation is clarified by observation of the schematic and the memory-byte transfer program. The memory-write signal ($\overline{WR}$) generated during the execution of the STAX B instruction is normally used to write data into a read/write memory. But here the signal triggers a 50-millisecond one-shot that pulses pin V_{DD} of the 8755A to 25 volts. Thus data on the system's data bus can be transferred into the addressed memory location. The address itself is automatically latched in an earlier machine cycle of the STAX B instruction.

The execution time of the STAX B instruction is extended to 50 ms by use of the CPU's READY line. Normally the READY line is used by slow memories to generate a wait state during a memory read/write cycle. In this application, the $\overline{WR}$ signal generated by the STAX B instruction triggers the 74123 one-shot, whose $\overline{Q}$ output stretches the $\overline{WR}$ signal by dropping the READY line for 50 ms.

The one-shot also turns on transistors Q_1 and Q_2, thus placing 25 volts on pin V_{DD}. When Q_1 and Q_2 are off, V_{DD} returns to a logic 1 state because of the action of pull-up diode D_1. This state satisfies the logic requirements of the V_{DD} pin during the READ mode.

The only modification of the SDK-85 circuit board required is to break the foil pattern at the $\overline{CE}$/PROG pin of the expansion ROM socket. The insertion of gating



Loading up. Minimal hardware and small byte-transfer routine simplifies programming of E-PROMs in SDK-85 one-board microcomputer design kit. Given starting and ending addresses of RAM data to be transferred, low-cost package programs 1 byte of E-PROM on each pass, then checks for parity at termination of run. If run terminates prematurely, E-PROM location causing fault will be displayed in register BC.

8085 BYTE-TRANSFER PROGRAM

```
        MVI  A, 0CH       ; define port 23 as output port
        OUT  20H
        LXI  B, PRMAD     ; load EPROM beginning address
        LXI  H, SRTAD     ; load RAM beginning address
        LXI  D, ENDAD     ; load RAM ending address
PROG:   XRA  A            ; set in PROGRAM mode
        OUT  23H
        MOV  A,M          ; get byte from RAM
        STAX B            ; program byte into EPROM
        MVI  A, 01H       ; set in READ mode
        OUT  23H
        LDAX B            ; get byte from EPROM
        CMP  M            ; check against RAM
        JNZ  END          ; if error, jump to END
        MOV  A,E          ; check if (DE) = (HL). If so, programming finished
        CMP  L
        JNZ  NEXT
        MOV  A,D
        CMP  H
        JZ   END
NEXT:   INX  H            ; not finished, program next byte
        INX  B
        JMP  PROG
END:    RST  1            ; return to monitor
```

circuits allows control over the chip-select signal $\overline{CS}$ routed to this pin. The $\overline{CS}_1$ signal should be gated to $\overline{CE}$/PROG during the read mode, while a logic 1 should be placed on this pin during the program mode.

Bit 0 of port 23 of the SDK-85 controls the mode; placed at logic 1, it puts the unit—otherwise in the program mode—in the read mode. The one-shot is then triggered by the falling edge of the $\overline{WR}$ pulse only when $\overline{CS}_1$ is active and the system is in the program mode.

The program itself is straightforward. A byte of the E-PROM is programmed and checked on each pass through the loop. The starting and ending addresses of the block of RAM to be transferred to the E-PROM are placed in the HL and DE register pairs, respectively. The BC register pair is then loaded with the starting address, and the RST 1 instruction returns control to a starting routine in the monitor. This routine saves the contents of all registers and flags.

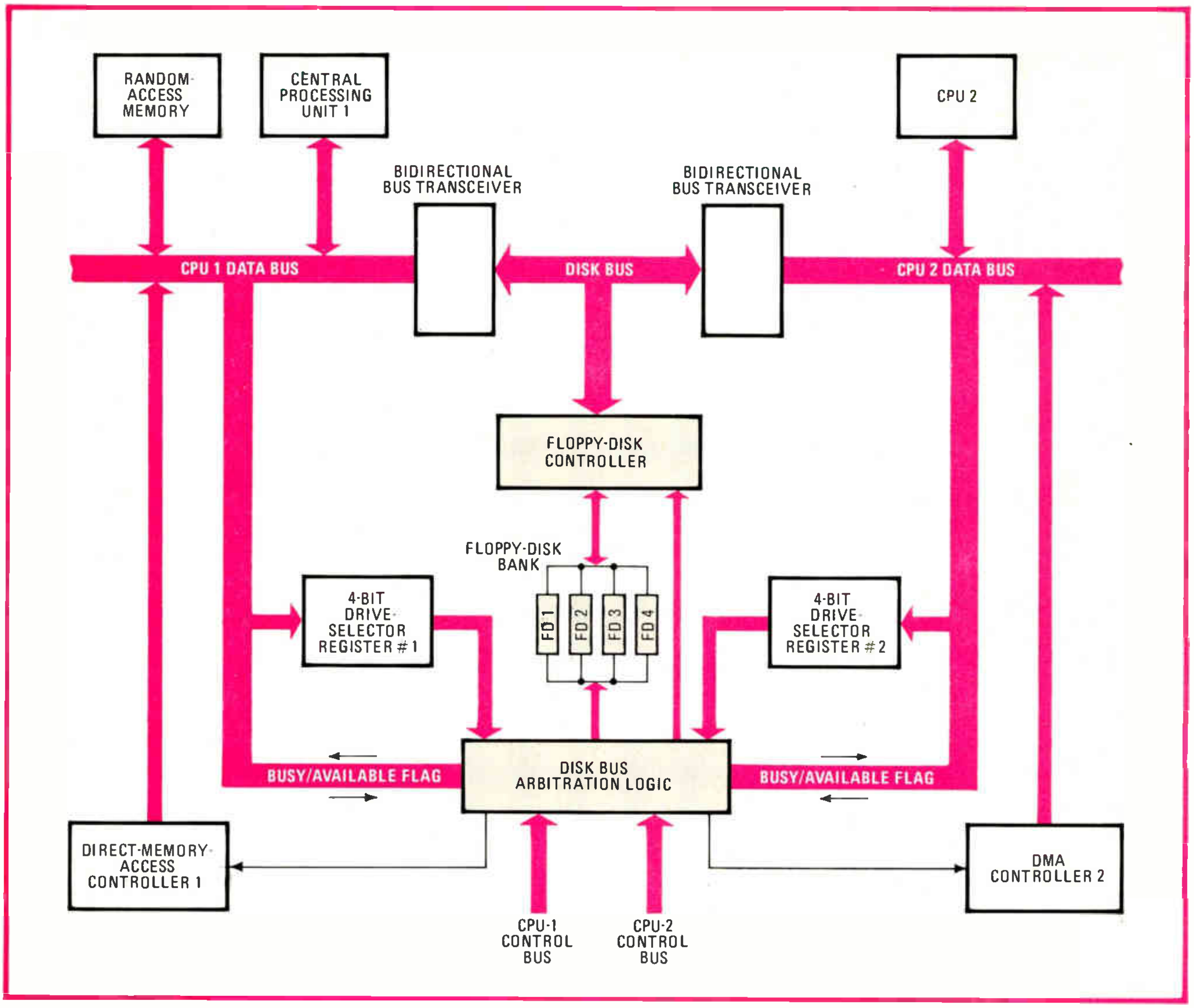
Examination of the registers after program termination must show the contents of HL and DE to be equal. If not, the BC pair will contain the address of the E-PROM location that failed to program properly. □

Sharing floppy-disk bank increases processors' efficiency

by P. W. Dandekar
The Tata Electric Companies, Bombay, India

This interface unites two asynchronously operating 8080A microprocessors and four floppy-disk memories with a single floppy-disk controller. The scheme saves the cost of duplicating floppy-disk drives in a distributed processing environment.

With small business machines and others that may use the 8080 and operate in two modes concurrently—batch and data acquisition—entering data slows the batch



1. Sharing. Multiplexed microprocessors increase operating speed of systems accessing floppy-disk memories. One CPU takes on data-acquisition chores, while the other handles data entry. Standard logic controller orchestrates bus activities.

processing considerably. But if data entry alone is entrusted to a second processor with its own data and program memories and input/output interface, the system will be more efficient if the mass storage area available on disk is shared. The proposed interface creates a bidirectional disk bus separate from the main data buses of both processors and uses arbitration logic to allocate disk access.

The block diagram of Fig. 1 clarifies the idea. Central processing units CP_1 and CP_2 are completely independent, operating asynchronously on their respective programs. A bidirectional disk bus is configured by connecting data buses 1 and 2 through isolating three-state transceivers. The disk bus is then connected to a one-chip floppy-disk controller. To transfer the data to and from the disk bank, two separate direct-memory-access controllers are used. The disk-bus arbitrator coordinates all activities of the various sections of the system.

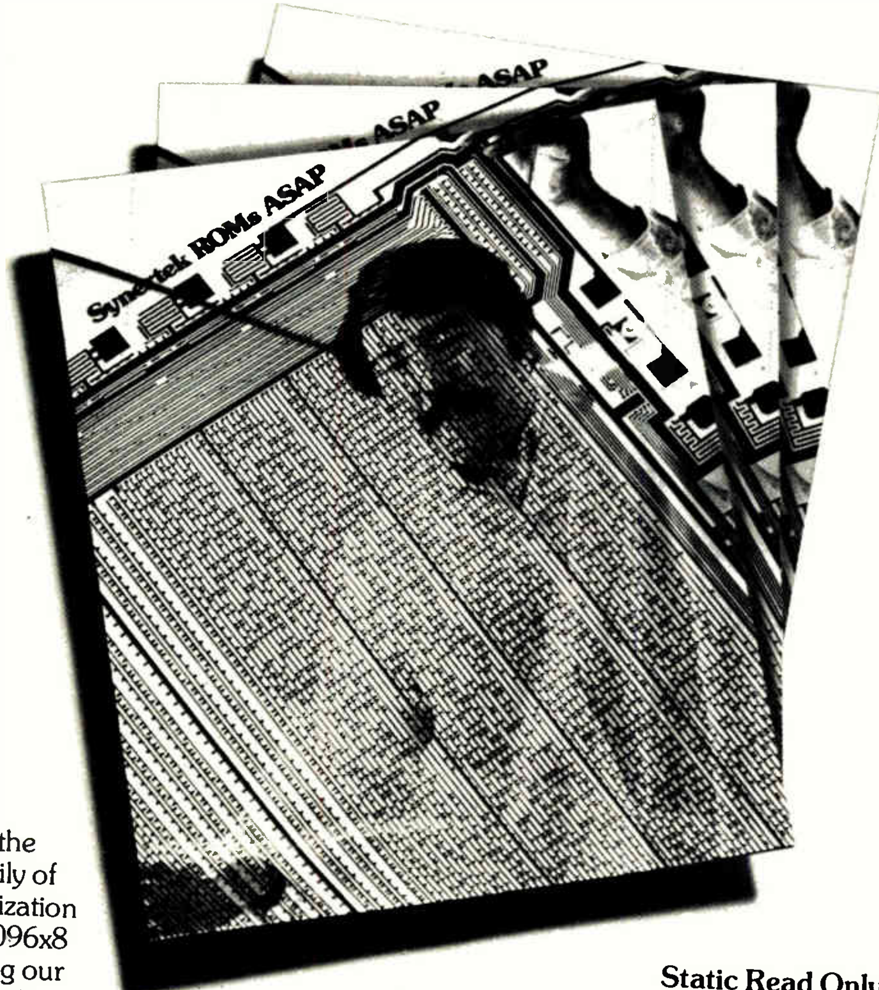
In the basic read or write operation, one CPU requests a bus line, which in turn sets a demand-pending (DP) flag. A status flag, busy/available, is then scanned. If the disk bus is free, the corresponding bus transceiver is enabled and the CPU will see the floppy-disk controller as a peripheral device hooked to its own bus. The busy/available flag to the other (inactive) CPU is then reset.

The active CPU then proceeds with its disk I/O routine. After initializing the read/write command for a given number of tracks on disk, the CPU activates its corresponding DMA controller, specifying the starting memory address and block length. It then returns to its other duties. The floppy-disk controller next reads or writes the data on a given disk. The termination of the job is indicated by an interrupt signal from the controller, which isolates itself and the disk-bus from the CPU.

The scanning of request flags (DP) is done cyclically and provides both processors equal priority. If so desired, scanning the DP flag of one CPU a greater percentage of the time gives it priority. This requires only minor changes in the existing system hardware.

The details of the hardware are shown in Fig. 2. An N-bit register operating as a ring counter scans the

The ROMs you need. When you need them.



On-time delivery puts the punch in our total family of ROMs. With the organization you need—8192x8, 4096x8 and 2048x8—including our new *300nsec 2316B-3*. At Synertek, we know there is no product area where service and responsiveness to your needs is more important than in mask programmable ROMs.

That's why two years ago we pioneered a unique dual capability—first mask programming for lowest cost and smallest real estate, last mask for fastest delivery to meet critical production schedules and get you results now. We can even combine first mask and last mask to get you into production today—and still save you money tomorrow.

Pin compatibility on our 16K, 32K and 64K ROMs gives you built-in future memory expansion capability. All it takes to upgrade your system's ROM capacity for new applications is to replace our 16K ROMs with our 32K ROMs or replace our 32K ROMs with 64K ROMs. And you can usually do it with no hardware changes.

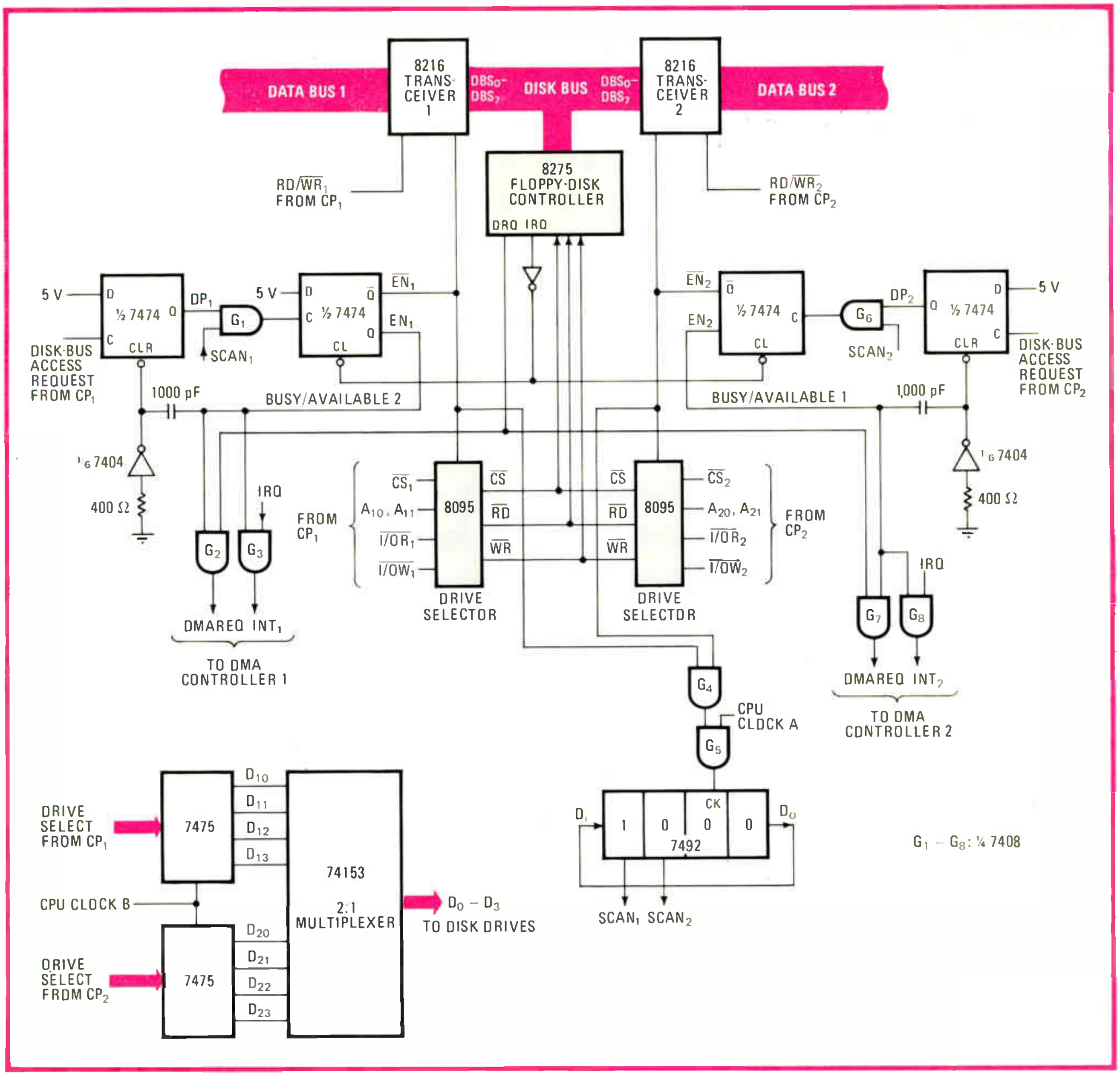
When you buy ROMs from Synertek, you know you're buying total service. Contact us now for samples, data sheets and our comprehensive folder, "Synertek ROMs ASAP." Synertek, Inc., 3001 Stender Way, Santa Clara, California 95051. (408) 988-5611. TWX: 910-338-0135.

Static Read Only Memories.

SY4600	2048x8 or 4096x4, 550nsec
SY2316A	2048x8, 550nsec
SY2316B	2048x8, 450nsec (2716 compatible)
SY2316B-3	2048x8, 300nsec (2716 compatible)
SY2332	4096x8, 450nsec (2716 compatible)
SY2364	8192x8, 450nsec, 24 pin

Synertek, Inc.

Circle 149 on reader service card



2. Moving data. Disk-bus access request from CP halts system scanning, captures corresponding bus transceiver, and activates DMA controller. Direction of data transfer is determined by read/write signal, RD/WR. Drive register selects disk drive, and floppy-disk controller transfers data from/to floppy-disk. DMA controllers release bus at termination of block transfer and enable scanning.

processors. The shift register is advanced by the clock that drives each processor. Scanning is halted when a system interrupt request is granted.

DP_1 and DP_2 are set by the respective CPU that requests the disk-bus access. In the course of the scanning, one phase of the SCAN signal and DP_i is utilized to set the busy/available flag, EN_i. Thereafter, the 8216 bus transceivers are enabled.

The EN signals also enable the 4-bit select registers, and gate the data-request (DRQ) line from the floppy-disk controller through to its DMA controller. EN_i's low-to-high transition then resets the DP_i flag to handle any future request.

The direction of the data transfer is determined by the CPUs' RD/$\overline{WR}$ signals. Each has a drive-select register and the two are multiplexed to generate D_0–D_3 for the four disk drives.

The 2:1 multiplexer is steered by EN_1. The logic is configured to enable most of the time the drive-select register corresponding to the CPU that has been given the highest priority.

The DMA controllers release their appropriate bus at the termination of the block transfer. The termination is signaled by the IRQ signal, which resets the busy/available flag of the active CPU. The scanning register is then enabled and the process repeats with the system on the alert for an interrupt. □

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.

New TI Programmable 58C with Constant Memory™ feature. Still only $125.*

If you enter a 480-step program today, the new TI Programmable 58C will remember it tomorrow...even if you turn it off overnight!

We haven't changed the price, but we've made the TI-58 even more versatile by adding a Constant Memory feature that retains data or program information even when the calculator is turned off. You can turn off your TI Programmable 58C right in the middle of the most complex problems, for hours or even days, and pick up right where you left off when you turn it back on.

The TI Programmable 58C, with plug-in application libraries and more than 170 functions and operations in scientific, engineering, and statistical fields ... now an even greater value with Constant Memory feature.

More easy-to-use software.

Take advantage of the versatility of the new TI Programmable 58C and new software. Twelve optional *Solid State Software*™ libraries are now available. Each plug-in library module contains dozens of prewritten programs. Solid-state libraries are available in a variety of fields including engineering, science, statistics, and business. From $35.*

The *Professional Program Exchange* lets you exchange programs with members. Over 1,500 programs are already available.

Specialty Pakettes are conveniently formatted program listings available in 16 subject areas. Just follow the program listings and tackle a wide variety of problems without the need to do any conventional programming. With the TI Programmable 58C's Constant Memory feature, you won't lose your program if you have to turn the calculator off. $10* per subject.

In addition, *Custom Software Modules* can be developed for specialized applications and a unique *Professional Productivity Program* is available for corporate use.

Printing and plotting capability.

Add the PC-100C printer/plotter to your TI Programmable 58C and you can plot, prompt, and print inputs and outputs automatically. $200*

Official Computer and Calculator Supplier of the 1980 Olympic Winter Games

Free literature.

We want to tell you more about our products and services. For additional information write: Texas Instruments, Programmable Calculators, P.O. Box 53, Lubbock, Texas 79408.

*U.S. suggested retail price.

Texas Instruments technology – bringing affordable electronics to your fingertips.

TEXAS INSTRUMENTS
INCORPORATED

Circle 151 on reader service card

45645A

Engineer's newsletter

Package for flatpack ICs foils statics

P-channel, n-channel, and complementary-MOS chips for military, space, and computer use are often housed in metal flatpacks. But in transit or handling, any of these MOS semiconductors can be damaged, destroyed, or degraded by an unwanted electrostatic discharge. Conductive-plastic carrying containers have been available, but only for integrated circuits in dual in-line packages. Now L. Gordon and Son Inc. has developed a novel and simple carrier to provide electrostatic protection for devices in either single or multiple flatpacks. It consists of **a folded cardboard cover lined with a sulphur-free metallic foil and closed with a plastic spline.** The company's address is 1050 S. Paca St., Baltimore, Md. 21230.

How to cross the technical language barrier

As the United States' electronics know-how starts to penetrate Eastern Europe and the Third World, the need for translation of technical terms becomes a priority. **"Poor or erroneous translations can lose millions of dollars of contracts,"** says Yuri Radzievsky, president of Euramerica Translation. This firm specializes in technical translations and in addition can produce video tapes, movies, and training programs in 10 languages. For further information, contact Euramerica Translations Inc., 50 East 42nd St., New York, N. Y., 10017

Tapes teach microwave technology

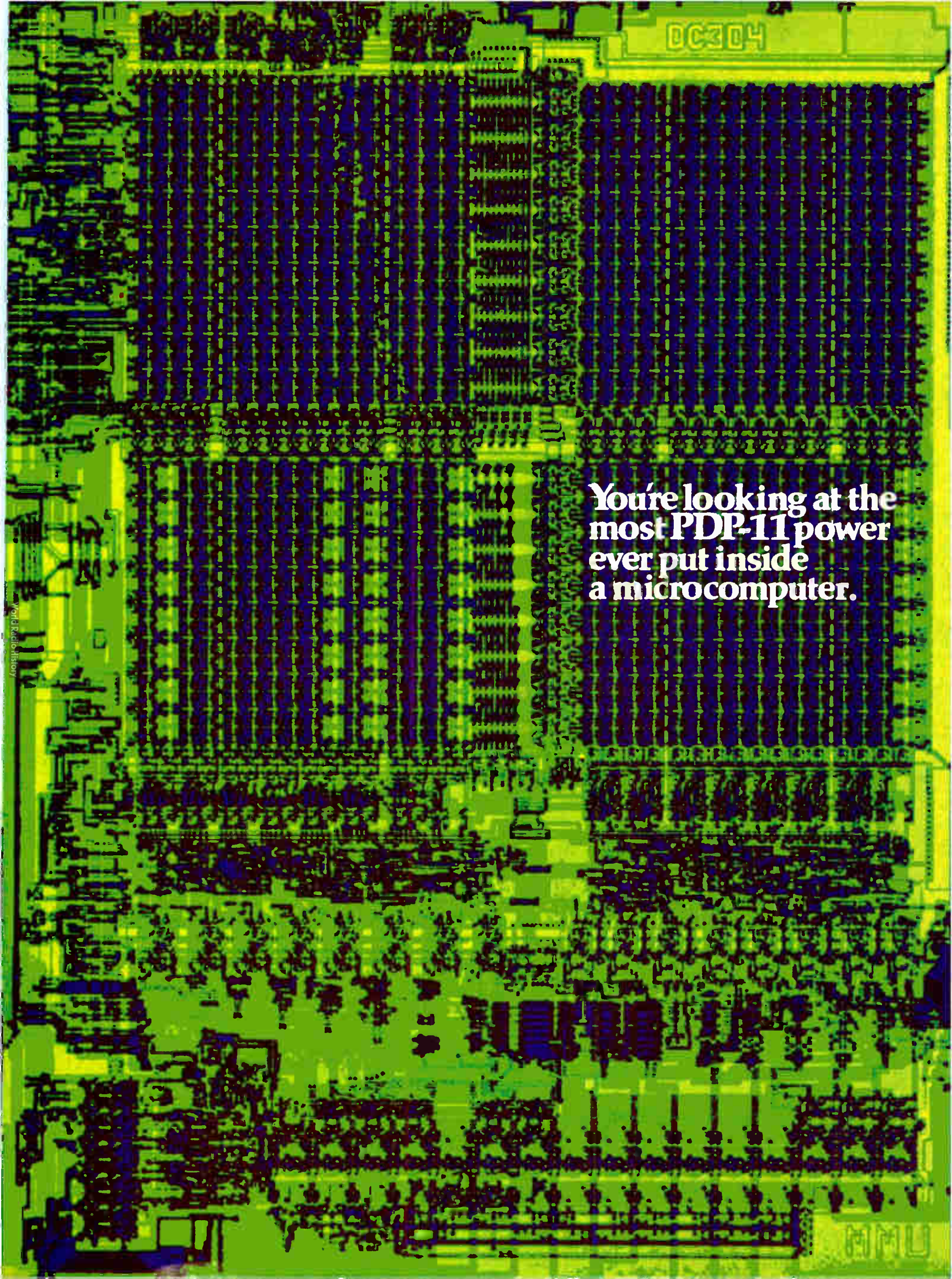
Microwaves are still a confusing and mysterious subject to a significant segment of the electronic engineering population. But with the great expansion of telecommunications, more EEs will be becoming involved in this discipline. Fortunately, a good introduction is available free on audiotape. "Survey of Microwave Systems and Devices," from Enrichment Cassettes, consists of a 60-minute cassette and an 18-page booklet of tables, graphs, and drawings. It is actually **the first unit in a longer course** consisting of six taped seminars that cover all of the technical aspects of microwave technology. To obtain the free tape and instructional material, send $3.00 for postage and handling to Enrichment Cassettes, P. O. Box 11534, Palo Alto, Calif., 94306.

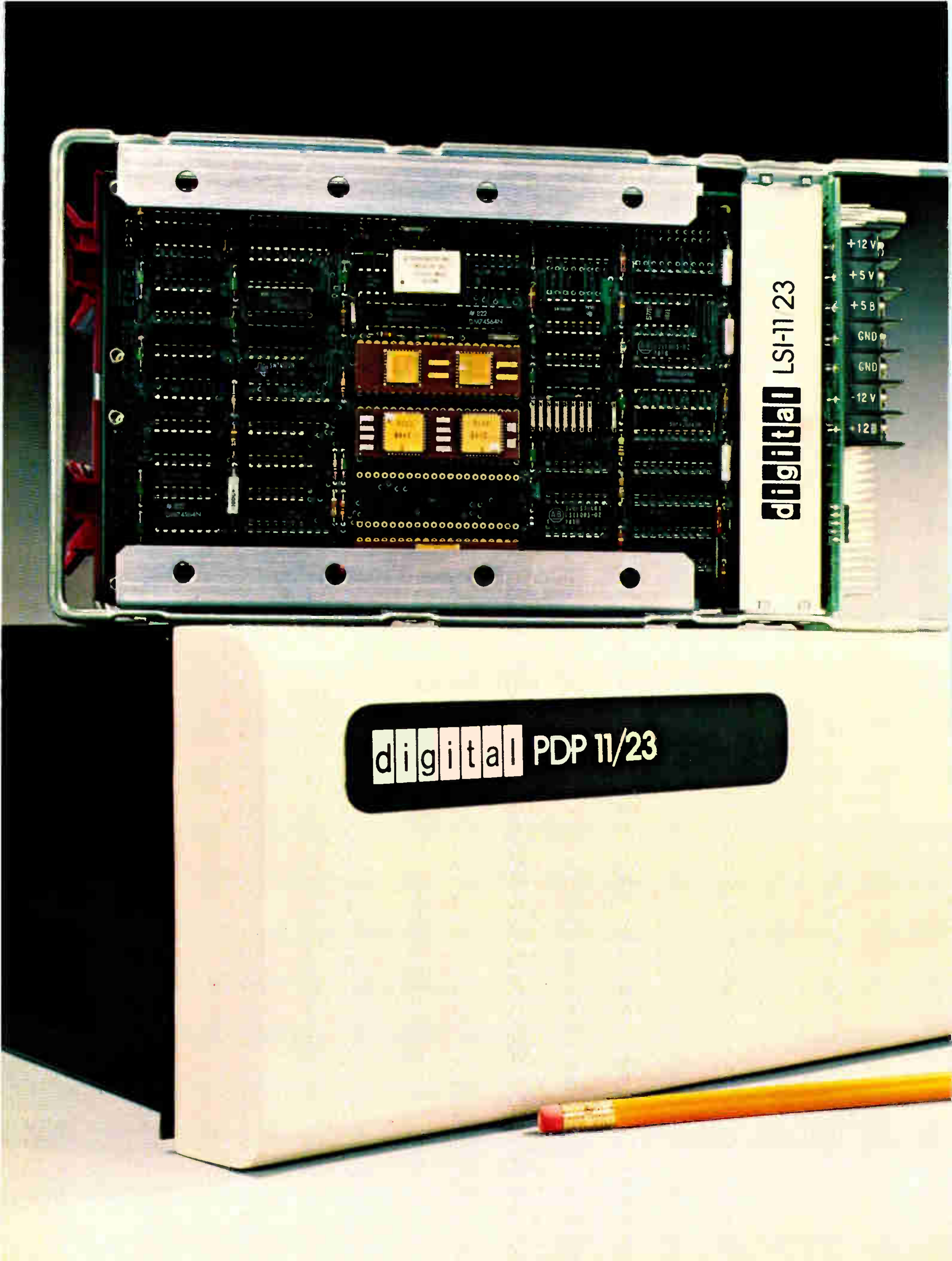
EIA sets a standard for solid-state relays

Although solid-state relays have been with us for some time, there has been no standard for these components. Now the engineering department of the Electronic Industries Association has announced the availability of RS-433, "EIA/NARM Standard for Solid State Relays." This is a standard reference for defining **the parameters of ac and hybrid solid-state relays having a single isolated input and designed to switch ac lines with maximums of 500 Hz, 300 V ac, and 50 A.** Copies of RS-433 are available at $18.75 each from the Standard Sales Office, Electronic Industries Association, 2001 Eye St. N. W., Washington, D. C. 20006.

Z80 family gets new users' group

"We are more general in scope than the Zilog Users' Group" says Jon D. Roland when asked why he formed the Z Users Group. Geared to afficionados of the Z80, Z8000, and other chips in the same family, the international organization has an irregular newsletter and other services for just $5 a year. **Their latest project is a money-saving group purchase of Z8000s.** Write to Jon at Micro Mart, 1015 Navarro, San Antonio, Texas 78205, or call him at (512) 222-1427. **-Jerry Lyman**


DC304
You're looking at the most PDP-11 power ever put inside a microcomputer.
MMU



+12 V
+5 V
+5 B
GND
GND
-12 V
digital LSI-11 23
digital PDP 11/23

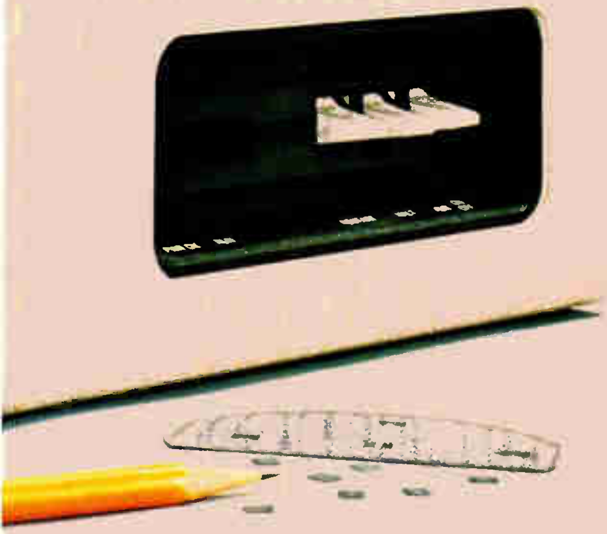
LSI-11/23. PDP-11/23.

Two new, more powerful choices from our growing family of 16-bit microcomputers.

Digital pioneered in 16-bit microcomputers with the top-selling LSI-11 and LSI-11/2. The first computers to deliver true systems performance at a micro size and price.

And now Digital offers you even more. With the LSI-11/23 boards. And the PDP-11/23 box.

More systems power. Execution speed approaching that of many mid-range minis with sophisticated instructions for single-precision (32-bit) and double-precision (64-bit) floating point, including arithmetic and data conversion capabilities; plus an optional single-chip floating point accelerator.



More systems capacity. Up to 256Kb of memory. Software supported memory management and protection. The flexibility of microcodable machine architecture. The ability to configure with a full range of over fifty LSI-11 bus terminals and options.

More systems software. The lowest cost entry into Digital's high performing RSX-11M/RSX-11S operating system family — the multi-tasking, multi-programming real-time package with over 300 man-years of PDP-11 development behind it. Plus RT-11 — the operating system that's the standard of the microcomputer industry. And a complete complement of languages and utilities including FORTRAN IV-PLUS, DATATRIEVE-11, Interactive Query Language, and Communications and Networking packages. This is the most powerful multi-user development system available today.

The secret behind this dramatic advance in microcomputer capability is Digital's leadership in the application of semiconductor technology. A brand-new microprocessor operating within the proven LSI-11 architecture that gives you the most compact form factor and simplest bus structure in the industry.

The LSI-11/23 and PDP-11/23 microcomputers.

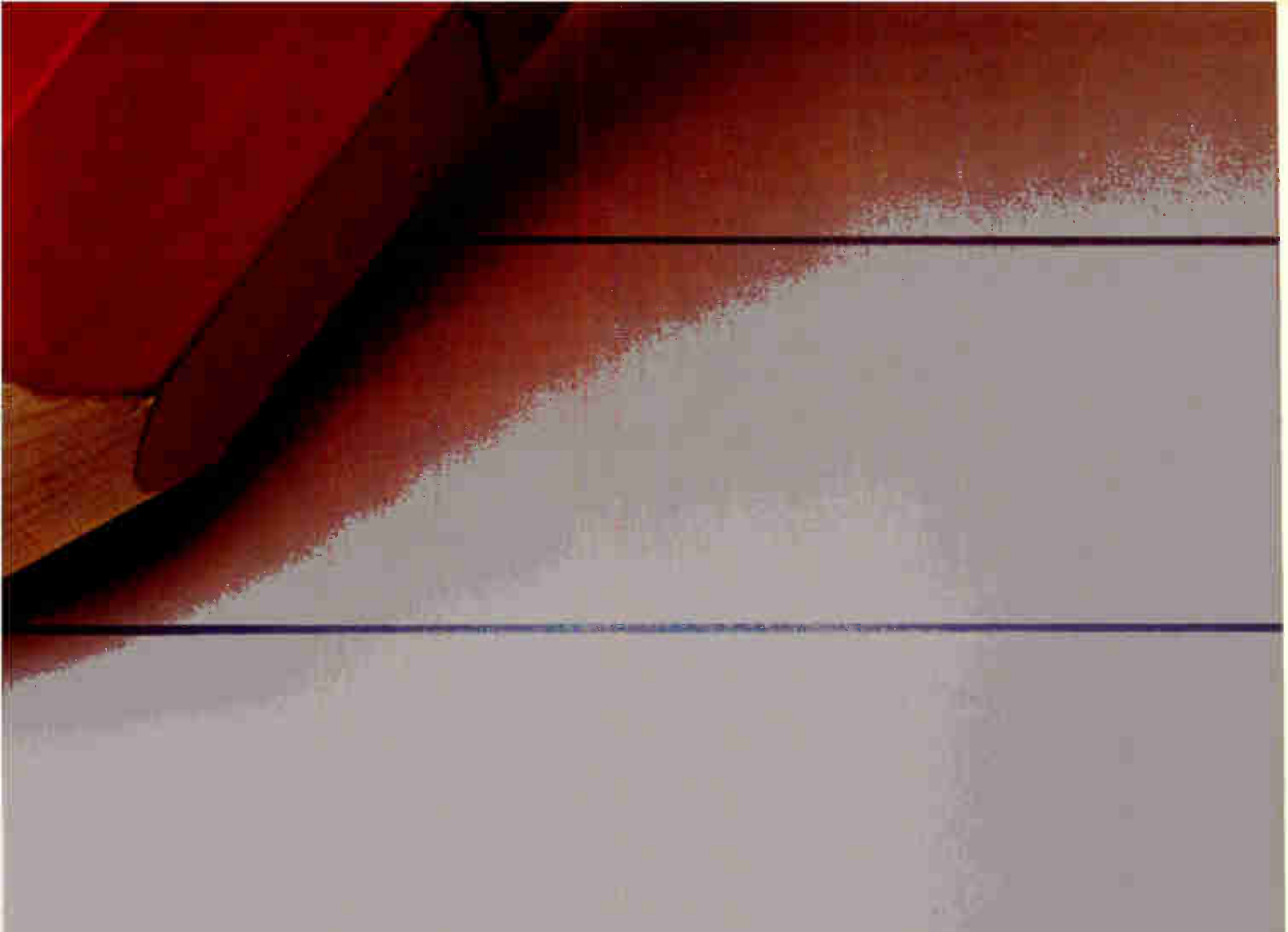
More power to you.

For more information, contact Digital Equipment Corporation, MR 2-2/M70, One Iron Way, Marlborough, MA 01752. Or call toll-free 800-225-9220. (In MA, HI, AK, and Canada, call 617-481-7400, ext. 5144). Or contact your local Hamilton/Avnet distributor (boards only). In Europe: 12 av. des Morgines, 1213 Petit-Lancy/Geneva. Tel. 93 33 11. In Canada: Digital Equipment of Canada, Ltd.

digital

Circle 155 on reader service card


28%



The highest return on investment in the Common Market.

REPUBLIC OF IRELAND

The most profitable industrial location in Europe.

US Department of Commerce statistics for the period '74-77 show a 28% average annual return on investment for US manufacturers located in the Republic of Ireland-more than twice the European average.

IDA Ireland
INDUSTRIAL DEVELOPMENT AUTHORITY

The Irish government's industrial development agency has offices in New York, Tel (212) 972-1000; Chicago, Tel (312) 644-7474; Houston, Tel (713) 658-0055; Los Angeles, Tel (213) 624-1024. Overseas offices also in Toronto, Amsterdam, London, Paris, Cologne, Stuttgart, Copenhagen, Milan, Madrid, Tokyo and Sydney.

NEC gets serious about CMOS RAMs.

Introducing the μPD444/6514

Our new 1K x 4 CMOS RAM, the μPD 444/6514, offers pin for pin compatibility with our industry-standard NMOS μPD2114L. So whether your memory requirements call for low standby power down to 0.065 μW, or high speed applications down to 150 ns, or a combination of both, NEC has exactly the part you need.

With our unique short channel length CMOS technology, we've designed the μPD444/6514 to provide access and cycle times as low as 200 ns in the industry standard 300 mil wide 18-pin package. Like the μPD2114L, it's manufactured on four-inch wafers—for low cost and high volume production. And the μPD444/6514 will operate in a fully static or asynchronous mode.

The μPD444/6514 is the latest

64-bit array processor opens new door

Unit doubles precision of previous models and, with a mini, provides power of mainframes at a fraction of the cost

by James B. Brinton, Boston bureau manager

Peripheral array processors have been part of the computer picture for only a few years, but now their time has come. With research budgets tight and engineering computations growing more complex, such a processor is often the only answer for engineers and scientists seeking to meet high-speed, high-volume, number-crunching needs with a minicomputer budget. And now the market has taken a leap forward with the introduction of the MAP-6400, the first 64-bit peripheral array processor, from CSP Inc., Burlington, Mass. [*Electronics*, May 24, p. 33]. Heretofore, the largest data word available in these types of array coprocessor units was 38 bits. Sixty-four-bit precision has until now been the domain of large mainframes from such firms as IBM, Control Data and Cray.

Now, with a MAP-6400 and a minicomputer, CSPI says that the dollar-conscious user can get much of the number-crunching power of the large machines at a fraction of the cost—even including the small host computer. The new processor is compatible with almost all popular minicomputers and can operate independently and thus concurrently with the host processor.

Speed. Array processors as a group are highly parallel and contain multiple arithmetic units to maximize throughput. In the MAP-6400, these units also operate asynchronously for increased speed. Such parallelism and asynchronous operation, in addition to its medium-scale integrated TTL implementation, make the MAP-6400 up to 1,500 times faster than minicomputers for doing arithmetic. For example, a 100-by-100 real matrix-matrix multiplication takes 1 second, and a 1,024-point fast Fourier transform requires only 22 milliseconds.

This may not be as fast as the largest mainframes; in fact, depending on how the machine is programmed—whether in Fortran or in machine language—it could be only half as fast. But CSPI says that when its price is taken into account—a system of array processor and minicomputer costs only about $200,000, and a mainframe number-cruncher goes for upwards of $4 million to $11 million—the price-speed tradeoff is extremely attractive.

Moreover, an array processor usually is operated as a dedicated unit and so is almost always at the user's command. A mainframe would most often be run in a time-sharing mode and occasionally in a batch-processing mode. Thus, although the array processor may be somewhat slower than a mainframe, its dedicated application can result in greater throughput.

Why 64 bits? Some 15 to 20 companies manufacture array processors. The fact that until now their highest precision machines were 32- and 38-bit units limited the precision of their real-time processing and restricted the size of the mathematical problems they could attack. Some 32- or 38-bit machines offered double-precision operation to get higher resolution, but this often doubles the computing time.

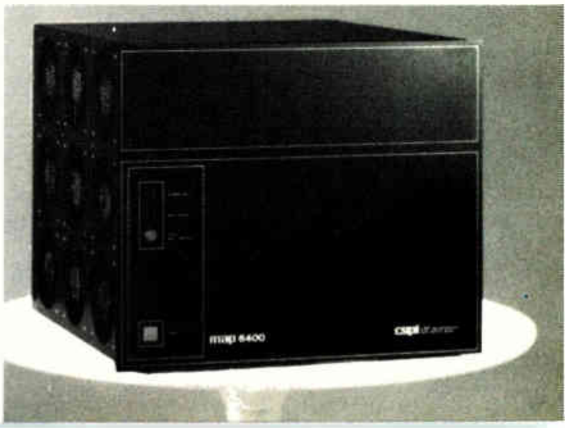
With the MAP-6400, double precision comes with the territory, so to speak. Its internal data storage and arithmetic operation are in the common IBM 64-bit format—a convenience for buyers used to running programs on large mainframes. The 64-bit format's 56-bit mantissa yields a full 16 decimal digits of precision throughout a computation—an equivalent resolution of one in several thousand trillion. And the final seven digits of the 64-bit word act as an exponent, yielding a value range of 10^{-77} to 10^{76}. Also, the fast arithmetic units perform proper unbiased rounding after each operation without a speed penalty.

The MAP-6400's instruction set is an enhanced, compatible version of that used in the firm's earlier MAP-200 and MAP-300 machines. Thus, users of these older 32-bit systems can shift directly to the MAP-6400 at the assembly code or the subroutine library level.

The MAP-6400's software and speed permit image-processing operations like translation, rotation, zoom, perspective, and hidden-line resolution at near mainframe speeds. Contributing to that speed is the unit's direct-memory-output feature, which permits output-data flow rates as high as 36 megabytes per second.

The price of the MAP-6400 with operating software and mathematics library is $89,000. Prototype units are now in the field, and deliveries are to start in January 1980.

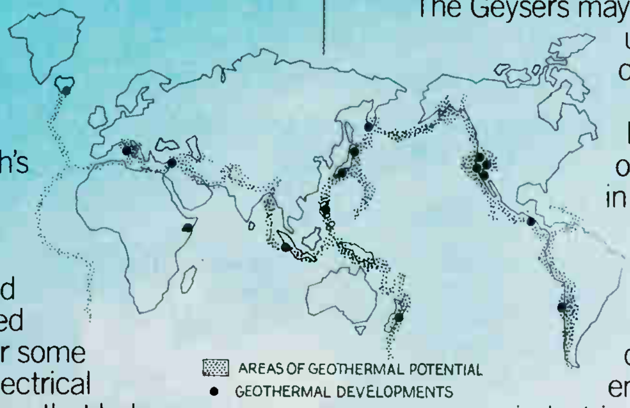
CSP Inc., 209 Middlesex Tpk., Burlington, Mass. 01803. Phone (617) 272-6020 [338]



MOTOROLA HELPS GET ENERGY FROM

In northern California, the natural heat of the earth is being harnessed to serve the energy needs of man. Natural steam, heated by the molten rock below the earth's crust, is being tapped, extracted and piped to power some of the electrical generators that help light up San Francisco, 90 miles to the south.

The place is called The Geysers, and it's part of a pioneering effort by Union Oil Company of California to make geothermal energy a practical alternative to expensive imported oil.



The Geysers may be an unorthodox power source, but it has one thing in common with every other branch of the energy industries: the need to maintain good, reliable communications, no matter how remote or primitive the site.

At The Geysers, as in many places around the world, the solution to that problem is Motorola communications.

ELECTRONIC PROBLEM-SOLVING.

One problem at The Geysers, for instance, was the rolling terrain and steep, narrow canyons, among which conventional high-frequency radio signals could get diffused and lost. Motorola solved that one with ingenious simplicity: a low-band two-way radio system that, as one engineer put it, "gets into the nooks and crannies."

ELECTRONICS EVERYWHERE.

But this is merely the tip of the iceberg of Motorola's experience in energy-industry communications.

One of America's largest oil refineries has 35 Motorola

THE EARTH, THE SEA AND THE SUN.

systems and subsystems, among which are pagers that tell a man he's wanted on the phone; closed-circuit video monitoring systems; and alarm and control systems that not only tell when something is going wrong, but also when everything is working right.

In the North Sea, a Motorola microwave system will provide a data and voice-communication link that will help one person control six unmanned oil-production platforms. He'll be able to check pressures and flow rates, regulate meters, pumps and motors, all by touching a few buttons.

Some of the Motorola equipment on the Alaska Pipeline is so sophisticated that a hard-hat worker in the field can talk directly to an executive in an office a thousand miles away.

In Canada, specially designed Motorola equipment is in use at an oil mine, an extraordinary strip-mining process for extracting petroleum from tar sands.

Motorola has made the apparently impossible happen by taking radio communication underground into deep-shaft coal mines.

And in solar energy, Motorola has gone beyond communications to actual energy development. Our engineers are producing photovoltaic systems that convert sunlight into electricity.

ELECTRONICS AND PEOPLE.

Motorola's preeminence in energy-industry communications is as much a matter of people as of technology. We made an early and total commitment to solving energy-industry communications problems, not merely as suppliers but as participants.

Microelectronics is at the heart of the matter, as it is in many of the things we do today. But if there are similarities among communications devices, there are none at all among the communications systems that the energy industries need in all their activities.

A microcomputer, drawn larger than life.

In designing these systems, Motorola brings to bear a combination of expertise and enthusiasm that helps us keep expanding the limits of what's possible in electronics.

MOTOROLA

Making electronics history since 1928.

Circle 163 on reader service card

For further information, write Public Affairs Office, Corporate Offices, Motorola, Inc., 1303 E. Algonquin Road, Schaumburg, Illinois 60196

Bubble testers divide the work

Magnetic memory tester comes in production-line and laboratory versions, breaks software chores into two parts

by William F. Arnold, San Francisco regional bureau manager

Divergent approaches appear quickly in new technologies. So it is no surprise that this is the case with the new class of testers designed to check out magnetic-bubble memories. Whereas some companies make a universal tester that can handle development, production, and incoming inspection, Watkins-Johnson believes that two models are better than one for the tricky new business of testing bubble devices. Consequently, it is introducing two models in July: the Adate 1450 for development labs, and the Adate 1475 for production testing.

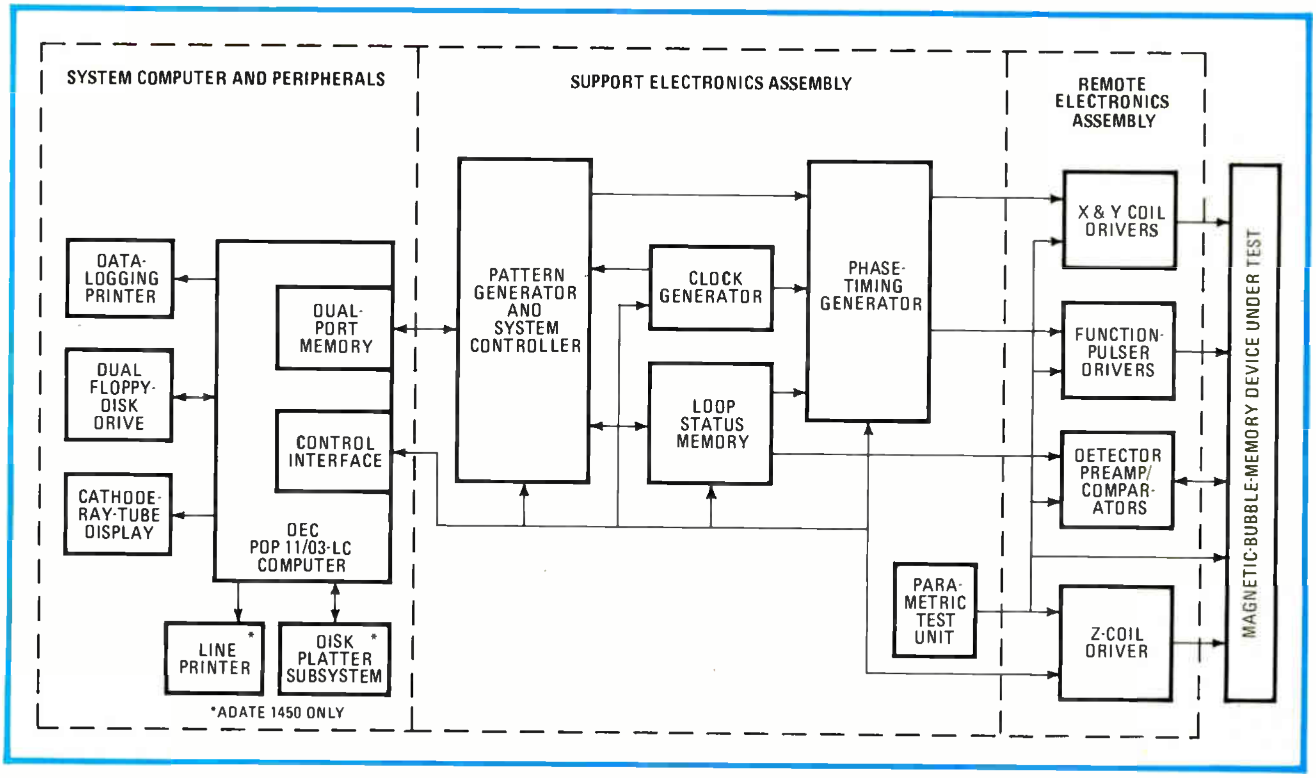
Says Mike Glenn, applications engineer, "In the development lab designers would be developing many different types of tests for the production people to use." Therefore, "the developers would need different, more sophisticated peripherals," he says. These include a line printer for documentation and a 5-megabyte hard-disk system for expanded test-storage capability. Basically, the 1450 is "a little more tailored for someone with a computer background," Glenn says.

Both Adate systems can test the variations of serial or block-replicated bubble-memory architectures from the 64-kilobit serial device (in development by Plessey Co. in England) up to 64 megabytes maximum size (4,000 loops with 16,000 sites per loop). "We've built in a lot of room for growth," Glenn jokes.

The 1450 and 1475 are built around a PDP-11/03 that governs all central control and data-collection functions. They come with a cathode-ray-tube terminal for operator control and a dual-drive floppy-disk unit to load programs and collect data. Additional options include test-system networking for larger installations, interfaces to wafer probers, extra pulsers, and increased computing power.

Watkins-Johnson is especially pleased with its software approach, called Device Independent Software. Essentially, it separates the test procedure, embodied in the Pascal test program using the Pascal control-subroutine library, from the implementation of the test data base, contained in one or more test-program patterns using a macro-library. This allows users to specify algorithms and test patterns independently. Moreover, because the procedure and pattern programs "work out of a data base, you can change the data base to test other device architectures," Glenn says.

The Pascal library consists of



Your sure way out of the impedance jungle.

Untangle R-C-L component measurement
with a cost effective ESI digital bridge.

μP SPEED ON THE PRODUCTION LINE
This dual frequency bridge is RCL production King of the Beasts. Fast. Versatile. Automatic. Measures R,C,L to 0.1%, at up to 16 tests/sec., plus G,D,Q. Multiband sorting, parts handling interfacing. Under $5000 USA.

LOW COST INCOMING RCL INSPECTION
Fend off wild components with this low cost meter. Measure R,C,L to 0.25%, plus get G & D. Autoranging, low frequency optional. Under $800 USA.

AUTOMATIC 1 MHz CAPACITANCE
Renegade components at RF levels are quickly and surely snared with this 1 MHz RCL bridge. Measure R,C,L to 0.1%, plus get G,D,Q,X,B—all with μP muscle and speed.

SUPER ACCURACY FOR ABSOLUTE OHMS
Cage any species resistance with this precision ohmmeter's 3 modes: switched DC, continuous DC or single pulse. 0.02% accuracy to 20 MΩ. 1 μΩ resolution available.

See us at Electro,
Booth 2232.

The sure way to innovation.

esi® ELECTRO SCIENTIFIC

Electro Scientific Industries, Inc.
13900 N.W. Science Park Drive
Portland, Oregon USA 97229
503/641-4141; telex 36-0273

Circle 165 on reader service card

subroutines to control loading and execution of patterns for testing a particular magnetic-bubble-memory parameter. The test-pattern programs, on the other hand, are composed of macro-instructions from the macrolibrary that cause the test-pattern generator to write and read data from the device.

The macros are in a hierarchical, three-tier organization. At the base of the structure, level one specifies test-pattern segments. Level two employs the architectural information from the data tables along with the level-one macros to read and write a data stream into a single page or fault-map loop. Level three uses the level-two macros to read and write multiple pages.

Controlled cycle. In operation, a pattern generator and a controller subsystem control the bubble memory under test cycle by cycle. The pattern generator, a bipolar-based system with 2-μs instruction times, fetches and executes the 32-bit microprogram command words on a cycle-by-cycle basis, in synchronization with the X-Y drive field.

The X-Y coil drivers are programmable from 0 to ±30 V maximum in 160-mV steps to an accuracy of within 0.5%. Current waveform maximum deviation is less than 5% and the drive frequency range is 10 to 500 kHz in 0.5-kHz steps.

The Z coil drivers, featuring a constant-current power supply capable of sourcing or sinking 10 A maximum, are programmable in two ranges: 0 to 1 A in 0.5-mA steps, or 0 to 10 A in 5-mA steps. They are accurate to within 0.1% and repeatably settable to within 0.05% FS.

Two types of 16-function pulsers are provided in various optional current ranges and steps. Glenn points out that the two types can be OR-ed together to create composite waveforms. The pulsers are accurate and repeatably settable to within 2% and 1% of full scale, respectively.

The price is expected to be about $100,000 for the 1475 model and somewhat less for the 1450.

Watkins-Johnson Co., Test Service Department, 333 Hillview Ave., Palo Alto, Calif. 94304 [339]

Check incoming DACs the ESI way:

Interchangeable test fixtures for quick switch to different DACs

Test virtually any DAC with up to 12 input bits (see below).

PASS/FAIL indicators for easy sorting (even non-technical operators).

Tiltstand handle to go with compact size, light weight.

Absolute and differential linearity shown as fractions of one least significant bit (to ⅛ LSB).

Warning indicator of nonmonotonic behavior.

Only one button to push.

Microprocessor-based, calibration-free.

Subtract $27,000 to start.

Until recently, testing D/A Converters required $30,000-$200,000, and a roomful of equipment—out of the question for most incoming applications. Now for less than $3,000 and the push of one button, the microprocessor-based Model 1262 quickly tests the key parameters you need to know for most any DAC.

Front panel LEDs show linearity, both absolute and differential, plus warn of nonmonotonic behavior. Test fixture LEDs indicate PASS/FAIL, or superposition error (bit addition error) for those few instances when further testing is necessary. Accuracy is keen at 30 ppm and test techniques are industry approved.

Want to test a variety of DACs? Just swap test fixtures. We offer prewired fixtures for many popular DACs, or it's simple to wire your own. Test DACs with different:

- Input codes. All binary and BCD codes.
- Number of bits. 6, 8, 10, 12.
- Analog outputs. Voltage or current in either polarity.
- Design types. DACs requiring full-time data and microprocessor-compatible DACs (strobe latched data).

Test time is as fast as ½ sec. plus your selected DAC warmup period. High volume testing is also possible using the 1262's parts handler interface.

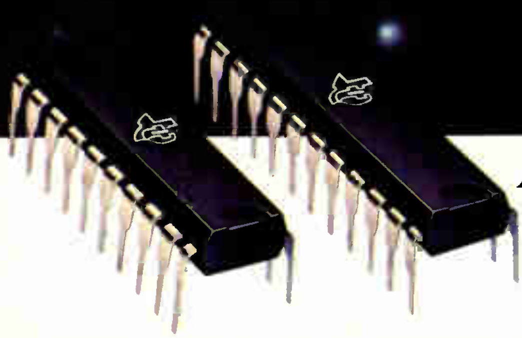
Send for a complete brochure on our low cost way to separate the DACs from the duds.

The sure way to innovation.

esi® ELECTRO SCIENTIFIC

Electro Scientific Industries, Inc.
13900 N.W. Science Park Drive
Portland, Oregon USA 97229
503/641-4141; telex 36-0273

Circle 167 on reader service card



An advance look at third generation TTL.
Highest speed. Lowest power. Ever.

Two new Schottky TTL families. An alternative to ECL. New dimensions in low-power logic. From Texas Instruments.

Until now, when you increased processing throughput rate, you paid a power penalty.

And, if you reduced power, you had to sacrifice speed. Not any more.

Now Texas Instruments offers you the most sought-after features on both ends of the bipolar speed/power spectrum...a whole new generation of advanced families of Schottky TTL.

A generation that will spawn new and significant improvements in efficiency, density and power-budgeting options.

So, if you need exceptional speed, you now have a way to increase both the complexity and performance of your MSI and SSI functions.

And you also have an advanced low-power Schottky TTL family that's 2.5 times faster than today's popular 74LS family, at half the power.

Just examine the features, functions and benefits of our two new advanced Schottky TTL families and we're sure you'll agree.

It's the best thing that's happened to bipolar logic since TI made TTL the industry standard more than 14 years ago.

New 24-pin package

New 300-mil wide, 24-pin ceramic and plastic DIPs, in which many MSI functions will be offered, will allow the designer to virtually double the functional densities while reducing board space by 30% or more. This increased density, coupled with an increasing breadth of product selection, will provide significant improvements in efficiency and reliability—reliability in keeping with TI's proven track record of high quality standards for semiconductors.

Advanced Schottky

Featuring a typical 1.5-ns gate delay and a 20-mW gate power dissipation, the new Advanced Schottky (AS) Series is twice as fast as any Schottky device available before.

PROJECTED SAMPLE AVAILABILITY

Advanced Schottky

Part Number	Description	Available
SN54/74AS804, 05, 08, 32	Hex 2-Input Gates	2Q79
SN54/74AS857	Universal MUX	4Q79
SN54/74AS881	4-Bit ALU	4Q79
SN54/74AS882	ALU Look-Ahead	4Q79
SN54/74AS873	Octal Latch	4Q79
SN54/74AS874	Octal D Flip-Flop	4Q79
SN54/74AS894	Shifter/Scaler	1Q80
SN54/74AS870	Dual 4Bx16W File	1Q80

Advanced Low-Power Schottky

Part Number	Description	Available
SN54/74ALS74	Dual D Flip-Flops	2Q79
SN54/74ALS109, 112, 113, 114	Dual J-K Flip-Flops	3Q79
SN54/74ALS00, 01, 02, 03, 04, 05, 08, 09, 10, 11, 12, 15, 20, 21, 22, 27, 30, 32, 133, 260	Gates	4Q79
SN54/74ALS28, 33, 37, 38, 40	Buffer Gates	4Q79
SN54/74ALS373, 573, 873	Octal Latches	1Q80
SN54/74ALS374, 574, 874	Octal D Flip-Flops	1Q80

Internal gate delay for MSI functions is typically 1 ns, while power consumption is only 12 mW.

The AS Series, a combination of new high-performance 20 and 24-pin functions designed specifically for high-speed applications, will encompass the MSI arithmetic operators and supporting gate and flip-flop functions required to implement high-speed CPUs, controllers, processors, and more.

Advanced Low-Power Schottky

Featuring a typical 4-ns gate delay and 1-mW gate power dissipation, the new Advanced Low-Power Schottky (ALS) Series will consist initially of 75 popular device types currently in the LS Series, including gates, dual D and J-K flip-flops, and MSI functions.

In addition, the new ALS Series, with the same drive as today's popular LS Series, allows immediate plug-in to existing logic systems.

The ALS Series, offered initially in familar socket-compatible packages, will ultimately encompass more complex MSI products in the new 300-mil wide 24-pin DIPs.

Fully compatible

Both the new AS and ALS Series will be fully compatible with the 54/74, 54/74LS and 54/74S TTL Series, in both military and commercial temperature ranges.

The logical choice

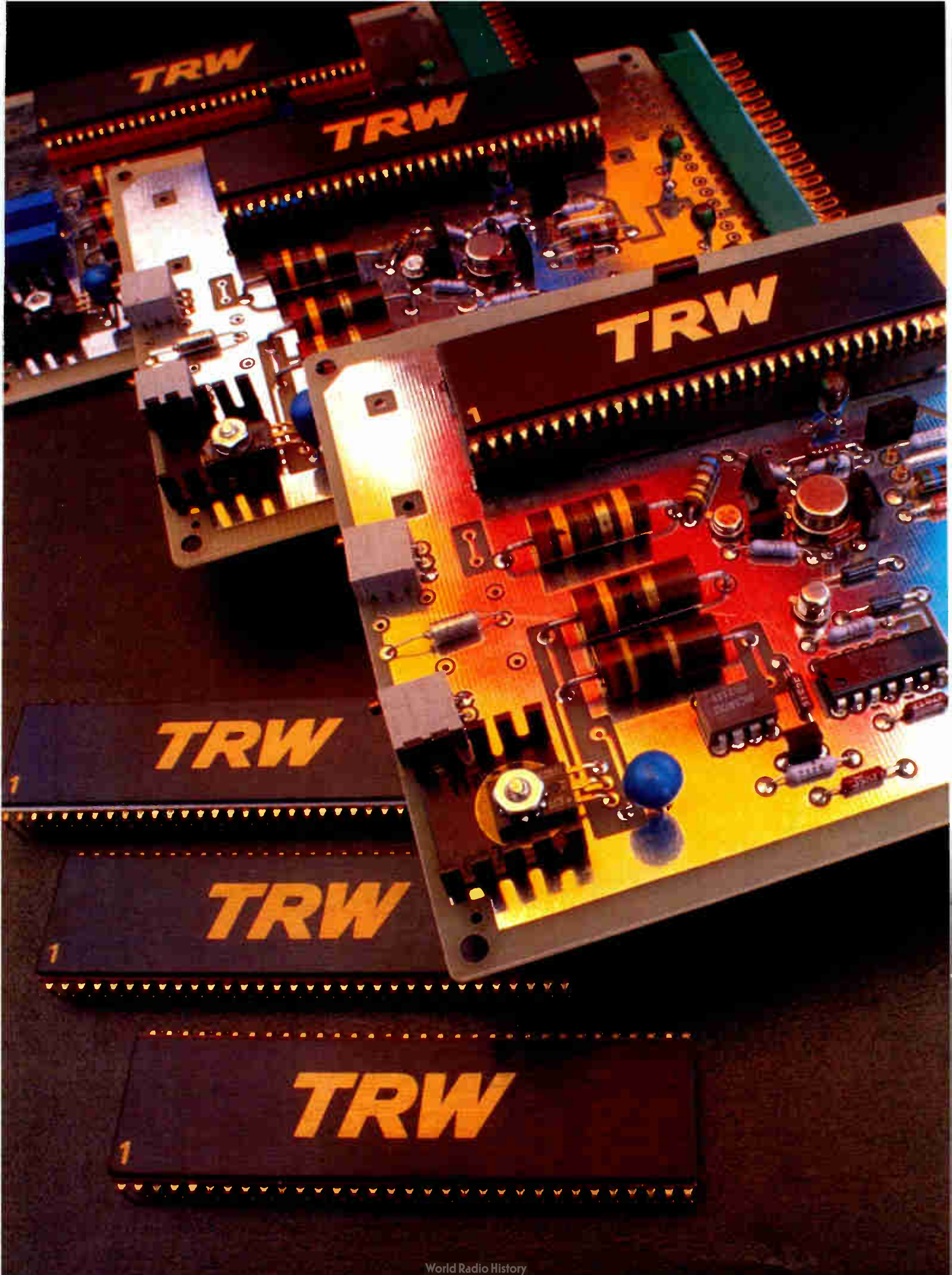
Never before have designers had such a wide range of choices. Choices of compatible catalog functions that offer effective TTL solutions to state-of-the-art systems design.

Imagine...two new advanced Schottky TTL families...both offering twice the performance...one, half the power.

For more information, call your nearest field sales office, or write: Texas Instruments Incorporated, P.O. Box 225012, M/S 308, Dallas, Texas 75265.

TEXAS INSTRUMENTS
INCORPORATED

83906


TRW
TRW
TRW
TRW
TRW
TRW

This monolithic 8-bit, 33 nsec A/D converter has everything

(And a test board to prove it.)

We've been told that the spectacular specs of our newsmaking TDC-1007J A/D converter are almost unbelievable. So we're making a "show me" offer that will make a believer out of every digital-thinking designer.

Order our monolithic 8-bit 33 nsec A/D converter on its own standard 3½"x4½" evaluation board (TDC-1007PCB). Fully assembled and tested, equipped with a 44-pin edge connector. Using +5V and ±15V power supplies, the board accepts and digitizes a 1-volt peak-to-peak signal from a 75-ohm source—at up to 30 megasamples per second.

Use it for performance evaluation of the converter. For system prototyping. As a test fixture. Price for 8-bit converter and board: $845. (Only $585 in 100s.)

Or if you prefer, deduct a hundred bucks and order our beauty by itself. Order just the converter (TDC-1007J), in an industry standard 64-pin DIP. (Only $485 in 100s.) We'll send along our data sheet/application notes to help you do your own thing.

Either way you go, you've got the TRW advantages: Up to 10-1 power reduction over other video-speed A/D converters and more than two-thirds size reduction. Conversion with unmatched accuracy at up to 30 megasamples per second. Highest reliability and stability over an indefinite time span. Wide temperature range performance.

Using the TDC-1007J is simplicity itself. A convert signal strobes 255 comparators, encodes all their binary outputs into an 8-bit word, and stores the word in an output latch. Unlike other types, our converter needs no sample-and-hold circuit. It works as a *flash converter*—doesn't depend on tedious successive-approximation techniques.

Either on the board or by itself, these products are now in stock at Hamilton/Avnet.

For immediate information, call 213/535-1831 or send in coupon.

TRW LSI Products
An Electronic Components Division of TRW Inc.
P.O. Box 1125
Redondo Beach, CA 90278

Please send data sheets on the **TDC-1007PCB** and **TDC-1007J** 8-bit A/D converter.

Name ______________________

Company ______________________

Div/Dept ______________ Mail Code ______

Address ______________________

City ______________________

State ______________ Zip ______

E-6

TRW keeps you ahead in digital signal processing

TRW LSI PRODUCTS

ANOTHER PRODUCT OF A COMPANY CALLED TRW

Circle 171 on reader service card

IN MEASUREMENT MACSYM 2 STANDS

YOU DON'T HAVE TO BE A COMPUTER EXPERT TO UNDERSTAND MACSYM 2.

MACSYM 2 is a basic, stand alone interactive real-time measurement and control system. It's human-engineered so it's easy-to-understand and easy-to-use whether you're more comfortable with a calculator or a computer. MACSYM 2 stands alone among competitive measurement and control systems. It combines integral signal conditioning, multi-tasking, ease of programming, and ease of use in a single low cost, self-contained system.

MACSYM 2 gives you a powerful minicomputer with a fast 16-bit processor and up to 128 K bytes of memory specifically designed for a variety of applications involving signal conditioning, data collection and concentration, measurement and control, storage, manipulation, computation and display. It puts real-world computer power at your fingertips without prior computer experience or separate development systems. For less than $10,000*, you can get a complete MACSYM 2, ready for operation, packaged as a single compact, desktop unit (also rack-mountable) for all of your real-time measurement and control applications.

MULTITASKING BASIC MAKES IT SIMPLE.

Like the MACSYM 2 hardware, its software has been designed specifically for measurement and control. MACBASIC is an enhancement of easy-to-use, problem-oriented standard Dartmouth BASIC. It features real-world I/O statements, real-time interactive multitasking (you can run as many as 18 independent programs simultaneously), real-time reference, data reduction, storage and presentation.

MACBASIC is a friendly programming language that lets you write programs the way you want. And lets you communicate with your process or experiment in plain English and simple algebraic expressions. For instance, real-world signals can be treated like any other variable. You can also monitor and change variables while your programs are running. And you can develop your programs on the same equipment you run them on. It's easy and hassle-free for the non-computer expert and has all of the power and flexibility the experienced programmer has been waiting for.

* Attractive quantity discounts are also available.

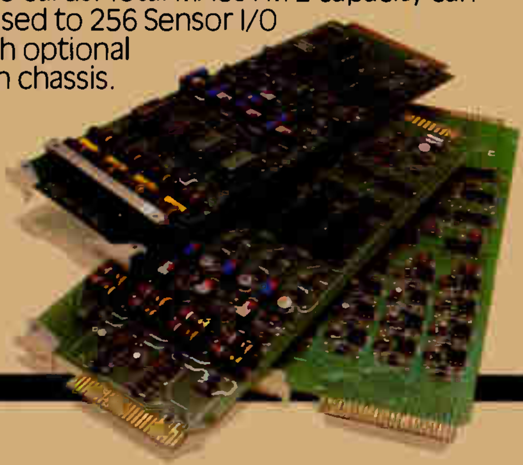
This program assigns values to variables K and L. Instructs MACSYM 2 to input analog data from channel 0; to output data on channel 1; to compare X to L. If greater, to sound alarm on channel 1; if less, to turn off alarm. Wait ½ second, read again. It's that basic.

```
40 K=0.5
50 L=5
60 X=AIN(8,0)
70 AOT(0,1)=K*SIN(X)
80 IF X>L DOT(1,1)=1
90 IF X<L DOT(1,1)=0
100 WAIT .5 GO TO 60
```

AND CONTROL, ALONE.

SENSORS CONNECT DIRECTLY TO MACSYM 2 FOR STAND ALONE REAL WORLD CONTROL.

The key to configuring a low-cost, easy-to-use, sensor-based, real-time multitasking measurement and control system is Analog Devices' unique Sensor I/O cards. They contain all necessary signal conditioning and interface directly with sensors. You can select and match as many as 16 dedicated low-cost Sensor I/O cards in a single, stand alone MACSYM 2. They plug directly into the MACSYM 2 chassis and allow direct sensor hookup by simply bringing your field wiring right into the MACSYM 2 screw terminals. Changing needs merely means changing Sensor I/O cards. Total MACSYM 2 capacity can be increased to 256 Sensor I/O cards with optional extension chassis.



Multi-channel Sensor I/O cards are available for low level and high level analog inputs; voltage or current analog outputs; digital I/O; direct sensor interface with thermocouples, strain gages, RTD's, limit switches and solenoids; pressure, frequency, temperature, flow and motion measurements; IEEE, isolation and other special functions. The unique architecture also makes hookup of optional peripherals such as disk drives, X-Y plotters, line printers or terminals just as easy.

MACSYM 2, the Basic System for Measurement and Control that stands alone. For all the basics, call (617) 329-4700. Analog Devices, Inc., Systems Division, 385 University Avenue, Westwood, MA 02090.

ANALOG DEVICES

WAY OUT IN FRONT.

Analog Devices, Inc., Box 280, Norwood, MA 02062; East Coast: (617) 329-5804; Midwest: (312) 894-3300; West Coast: (213) 595-1783; Belgium: 031/37 48 03; Denmark: (02) 845800; England: 01/94 10 46 6; France: 686-7760; Germany: 089/53 03 19; Japan: 03/26 36 82 6; Switzerland: 022/319704, and representatives around the world

Circle 173 on reader service card

When you're searching for component solutions...

Centralab ceramic capacitors give you unparalleled selection and service...

- **Extensive product line of discs and monolithics**
- **Large-scale volume capability**
- **Over 200 U.S. distributors**
- **Multinational manufacturing sites**
- **Worldwide availability**

At Centralab you'll find a range of types, values, voltages, lead configurations, encapsulation and packaging that offers solutions to your ceramic capacitor needs. Our ceramic discs; monolithic chip, axial and radial leaded capacitors; CK/CKR and other hi-rel capacitors give you a wide selection, all from a single source.

And at Centralab, service is special too. We back our broad line with high volume manufacturing plants in five countries and a distribution system that's second to none. There are 75 worldwide Sales Representative offices and over 200 Industrial Distributors waiting to serve you. Our catalog will show you the unparalleled selection of ceramic capacitors and service available from Centralab. For a copy, call your Centralab Sales Representative or write us.

Products you need from people who care.

CENTRALAB
ELECTRONICS DIVISION
GLOBE-UNION INC.
4561 Colorado Boulevard
Los Angeles, California 90039

CERAMIC CAPACITORS • EMI/RFI FILTERS • POTENTIOMETERS • SWITCHES • THICK FILM CIRCUITS • TRIMMER RESISTORS

Semiconductors

Single chip makes six echoes

3,328-stage bucket brigade tapped at uneven intervals for natural-sounding effect

In building audio-delay circuits to achieve reverberation effects, designers have had to cascade several bucket-brigade circuits to obtain multiple delays in their output signal mix. Furthermore, they have had to build the dual clock circuitry needed to drive the bucket-brigade devices (BBDs). Now Matsushita (Panasonic) has eliminated that effort and reduced the number of parts needed by putting both types of circuits into dual in-line packages.

For multiple-delay signals, the company has put together the MN3011, a BBD with 3,328 stages and six output taps. Instead of putting the taps at even intervals, which produces an orderly delay that may seem too mechanical in many applications, the designers spaced them at differing intervals to produce a more uneven, natural effect.

For example, when the device is run at the minimum clock frequency of 10 kHz, the first output is retarded by 19.8 ms and the second occurs 13.3 ms later. The third arrives 26.6 ms after the second and the fourth succeeds the third once the same unit of time has passed. After an additional wait twice as long (53.2 ms), the fifth output appears. The sixth output follows the fifth by 26.9 ms, giving a total delay from initial input to final output of 166.4 ms.

In addition to its interesting delay scheme, the p-channel MOS device offers low total harmonic distortion (THD); with a clock frequency of 40 kHz, a 1-kHz, 0.78-V rms input signal emerges with a THD of only 0.4%. For the same clock and input frequencies, insertion loss is 0 dB. At the fastest possible clock frequency, 100 kHz (which gives a total delay time of 16.64 ms), the noise level at the output is 400 μV at the worst. The typical signal-to-noise ratio for the maximum output is 76 dB.

Like other members of the MN3000 series, the MN3011 needs a set of clock frequencies 180° out of phase. These can be provided by the MN3101, which will also deliver the gate supply voltage to the BBD. The device's 8-pin package houses an oscillator, a divider, a waveform shaper, and a clock driver, as well as the gate supply circuitry.

With these two parts, two AN6551 dual operational amplifiers, a potentiometer, and a few standard resistors and capacitors, designers can put together a low-noise reverberation-effect circuit that will work with input signals up to 11 kHz. And it will fit on a printed circuit board measuring less than 3¼ by 2¼ in.

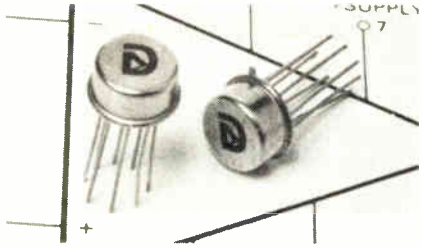
In quantities of 1,000, the MN3011 sells for under $30 and will be available from stock in about four weeks. In the same quantities, the MN3111 and the AN6551 sell for 95¢ and 60¢, respectively, and are available from stock now.

Panasonic, One Panasonic Way, Secaucus, N.J. 07094. Phone Bill Bottari at (201) 348-7276 [411]

Op amps keep the noise down

In sensitive data-acquisition systems, any but the smallest amounts of noise can easily disguise the low-level signals themselves. Designed for use in such systems, the AM-453-2 operational amplifier has an input voltage noise at 25°C of just 7 nV-Hz$^{-1/2}$ at 30 Hz, a value that drops to a mere 4 nV-Hz$^{-1/2}$ at frequencies in the 200-Hz-to-100-kHz range. At the same frequencies, the input noise current is only 2.5 pA-Hz$^{-1/2}$ and 0.6 pA-Hz$^{-1/2}$, respectively.

The wideband op amp has a gain-bandwidth product of 10 MHz and a slew rate of 13 V/μs. Open-loop dc gain is 100,000 and output capability is ±12 V at ±20 mA. Power



supply voltages can be varied from ±3 to ±20 V and, when using ±18-V supply power, the AM-453-2 is capable of driving a 600-Ω load at 10 V rms.

The unit also features a 0.5-mV input offset voltage, a ±12-V common-mode input voltage range, a 100-dB common-mode rejection ratio, and 30 μV/°C of input offset voltage drift. Packaged in a TO-99 case, a commercial unit is priced at $6.75 in single quantities. Military versions are also available for a single-unit price of $21. Delivery time is four weeks.

Datel Systems Inc., 11 Cabot Blvd., Mansfield, Mass. 02048. Phone Eugene Zuch at (617) 828-8000 [415]

Chip reads moisture inside hybrid package

Internal moisture is death to a hybrid. Since there has been no way to determine the actual moisture content inside a package, manufacturers have gone to great lengths in their packaging technology to insure hermeticity. Designers, on the other hand, have had to trust that those techniques worked for the device they are using, not finding out otherwise until a system failed and the hybrid was opened. But now there is a way to actually measure moisture content of a sealed hybrid.

Called the Mini-Mod-A, the 60-by-60-mil sensor can be mounted directly on an integrated-circuit substrate and sealed in the package with it. The two-terminal device is functionally similar to a parallel plate capacitor. Its top layer is a water-permeable gold film that lets vapor into a moisture-responsive dielectric made of a porous oxide. Any change in impedance of the sensor is proportional to the equilibrium water vapor pressure in the surrounding ambient.

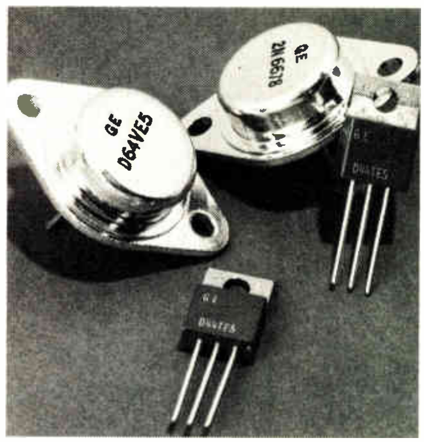
The device can measure up to 15,000 ppm by volume at 1 atmosphere pressure and can be calibrated to an accuracy of within ±25 ppm or ±25%, whichever is greater, for a user's predefined packaging process. In quantities of 1,000, the 17-mil-high chips cost $7.50. A hygrometer for measuring the chip output costs $1,695 and calibration services for the chip are free of charge with orders of 50 or more.

Panametrics, 221 Crescent St., Waltham, Mass. 02154. Phone Loyd Searle at (617) 899-2719 [413]

Power transistors handle high voltages quickly

Designers of, say, switching power supplies or pulse-width-modulated regulators whose applications demand fast-switching, high-voltage transistors can now turn to the Switchpower line. This family consists of devices rated for sustained open-base collector-emitter voltages of 300, 350, or 400 V. Typical inductive fall times for the units are less than 300 ns.

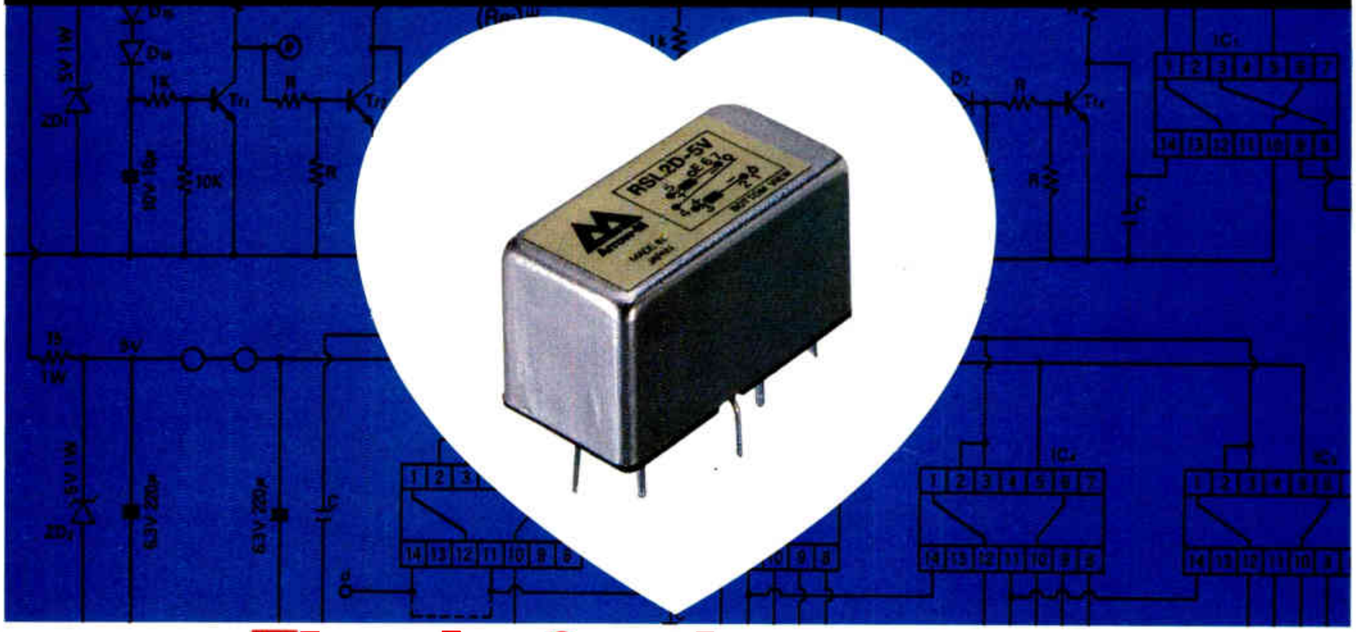
Members of the line are packaged



in metal TO-3 cans or plastic TO-220AB packages. In metal housings, the transistors have continuous collector-current ratings of 15, 7.5, or 5 A; in plastic, they are available with ratings of 4 or 2 A.

In quantities of 1,000, a 15-A,

Half-size Amber R Relays



Thanks for the memory.

Latching function acts as a memory to protect the integrity of your program.

Half-size Amber R Relays latching types operate on alternate application of reversed polarity voltage. The stability of the memory is dependable at all times, retaining program integrity even during power failures.

- Power types will switch 1 Ampere 20 watts for over 1 million operations, and they will not weld even when carrying high inrush currents.
- The unique construction permits true Form C contacts in a reed type relay.
- High sensitivity: Minimum operating power. Latching type 40mW/Standard type 80mW
- Totally encapsulated for automatic wave soldering and cleaning.

More than 26 million R Relays in service around the world.

Relays for Advanced Technology

Aromat

Member of Matsushita Group

Contact Your Aromat Representative or Distributor Today.

Aromat Corporation:
250 Sheffield Street
Mountainside, NJ 07092
(201) 232-4260

Mid-Western Office:
311 Lively Blvd.
Suite 1
Elk Grove Village, IL 60007
(312) 593-8535

Western Office:
10400 North Tantau Avenue
Cupertino, CA 95014
(408) 446-5000

43

New products

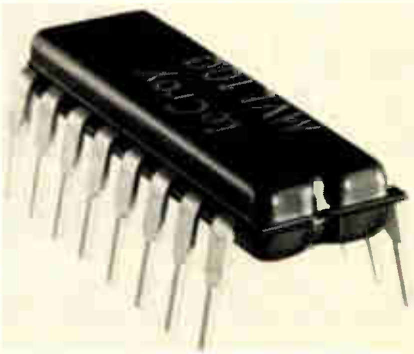
400-V Switchline transistor is priced at $7.90.

General Electric Co., West Genesee St., Box 44, Auburn, N.Y. 13021 [417]

Fast detector senses 200-μV pulses

Designed for detection of low-level pulses, the MVL100 consists of a fast input preamplifier which can be ac-coupled to a biased voltage comparator. It will sense thresholds of ±200 μV and slews typically from twice to twenty times the threshold value in just 1.5 ns.

The unit's sensing threshold is adjustable up to ±3.2 mV and it is stable to within 0.2% of the set value per °C. Furthermore, it is voltage programmable to 2.4 mV. Power



dissipation is only 0.5 W.

Differential input connectors reject common-mode noise and offsets up to ±1V. The input is provided by a non-retriggerable multivibrator whose time constant can be adjusted from 20 to 1,000 ns with external resistors and capacitors. Outputs are compatable with emitter-coupled logic and can drive 50-Ω loads.

Output jitter with respect to input is less than 0.1%. The unit also has a separate, non-inverting analog output with a gain of 10 that will drive 50-Ω loads for, say, signal monitoring in data acquisition systems.

In single quantities, the MVL100 is priced at $15.60 and delivery time is one week.

LeCroy Research Systems Corp., Microcircuits Division, 700 S. Main St., Spring Valley, N.Y. 10977. Phone (914) 425-2000 [414]

Circuit data to first board in just six weeks.

This Multiwire board, with 285 IC's and dozens of discrete components, went from circuit data to first board in just six weeks. Reason: our customer had only to supply art work for the power and ground planes, a net list and a fabrication blueprint. No need for artwork for each of the circuit layers.

These simplified input requirements for Multiwire boards get you into production faster than conventional wirewrap or multilayer techniques. You'll get the finished product as much as *10 weeks* sooner than other methods.

Multiwire boards also offer fast and easy circuit changes, controlled impedance, reduced inspection costs and higher production yields.

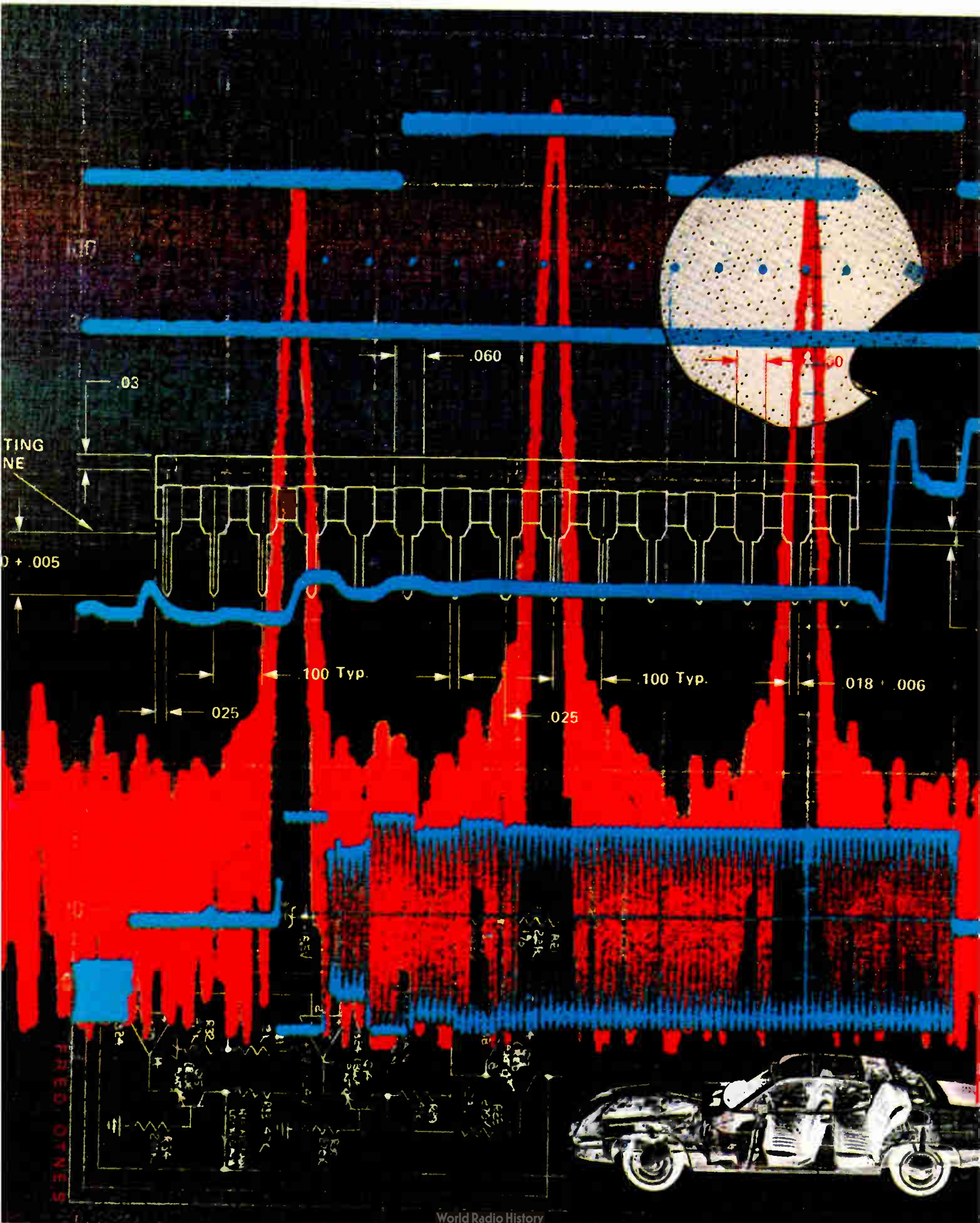
Call or write today for more details on the Multiwire system. The more you know about us, the more convinced you'll be that Multiwire is the way to go.

Multiwire, 31 Seacliff Avenue, Glen Cove, NY 15542. Phone (516) 448-1307

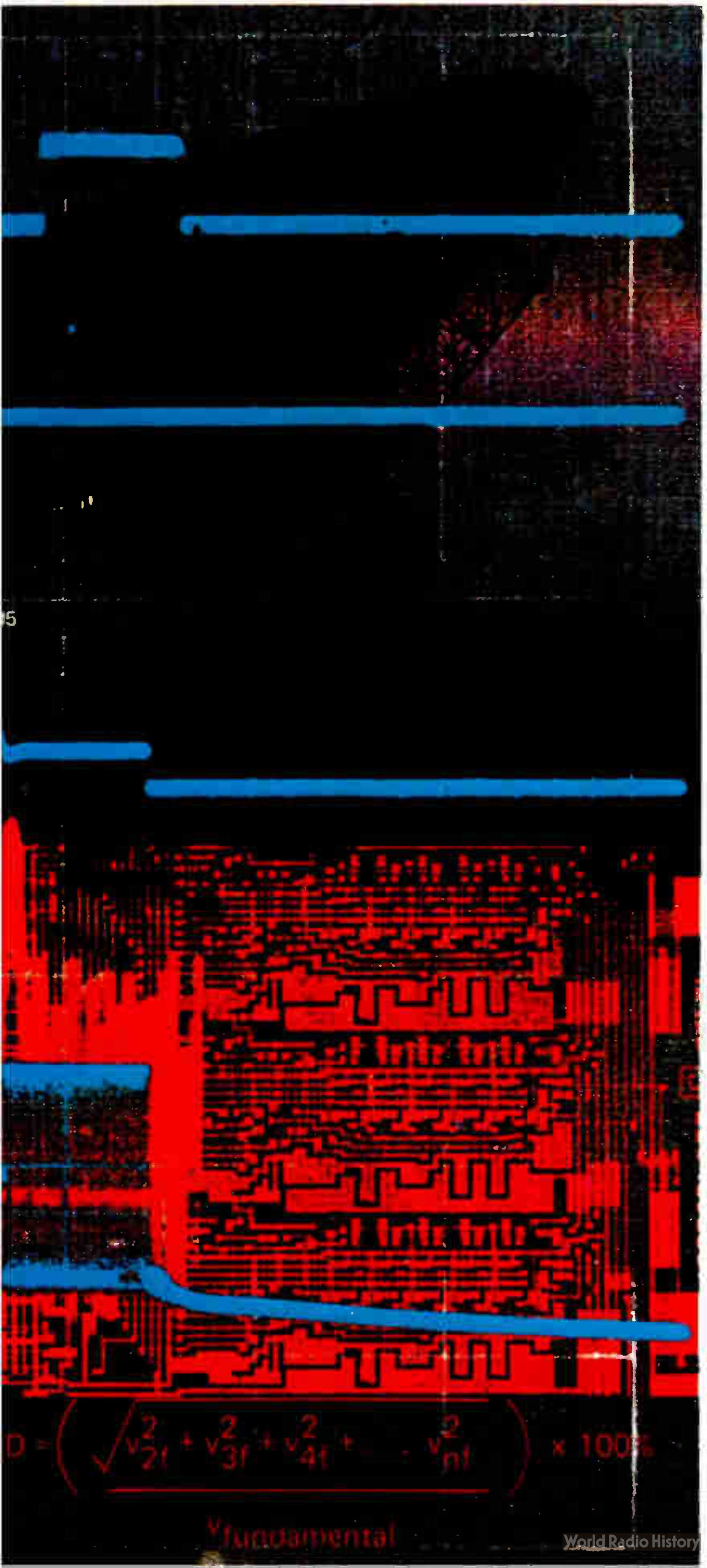
MULTIWIRE

Multiwire is a registered tradename for Kollmorgen Corporation's discrete wired circuit boards.

THE AGE OF ANALOG LSI HAS ARRIVED.



INTRODUCING THE FIRST TEST SYSTEMS OF THE NEW AGE. TERADYNE'S A300 SERIES.



It's an entirely new approach.

The first systems specifically designed to test and trim analog LSI devices. To cope with the realities these new components present.

High complexity, tight resolution specs, mixed technologies, digital-analog combinations, wafer adjustments. Problems that confound traditional test approaches are the problems Teradyne's A300 Series is designed to solve.

These systems bring the myriad opportunities of a new era within reach. Their capabilities and flexibility surpass anything else available anywhere.

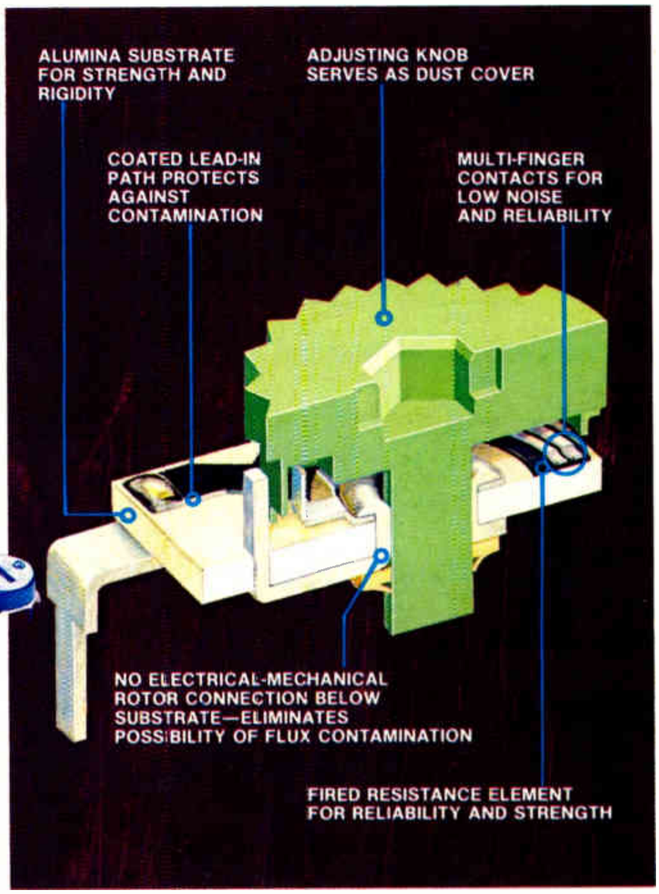
So if your future is tied to analog LSI in any way, now is the time to learn more about Teradyne's remarkable new A300 Analog LSI Test/Trim Systems.

Write: Teradyne, 183 Essex Street, Boston, MA 02111. Or call (617) 482-2700.

TERADYNE

Circle 181 on reader service card

It's no coincidence that Murata-Georgia's new subminiature trimming potentiometers created a standard for the industry



Murata-Georgia's new subminiature trimming potentiometers are loaded with electrical and mechanical performance that's unavailable in any competitively priced unit. And, they're built with a technology that's based on over 30 years of experience in the field. Check some of these outstanding features and the construction cutaway. We think you'll want to know more: ☐ 1/5 watt carbon and 1/2 watt cermet measure less than 3/8″ diameter ☐ 1/3 watt carbon and 3/4 watt cermet measure less than 1/2″ diameter ☐ alumina base ☐ up to 500 VDC in cermet units ☐ top, side and thru-board adjustment ☐ horizontal and vertical mounting ☐ excellent liniarity ☐ high resistance to solder flux solvents ☐ low noise.

Coincidence? No way. Murata-Georgia simply took a look at the competition and designed a subminiature trimming potentiometer that performs better and costs less.

muRata-Georgia

MURATA CORPORATION OF AMERICA

1148 Franklin Road, S.E.
Marietta, Georgia 30067
Phone: 404-952-9777

ceramic capacitors, subminiature potentiometers, piezoelectric ceramic filters, resonators and transducers, resistor networks, Posistor® PTC thermistors

Microcomputers & systems

Genius controller does work of five

Board with 8085A processor has room for addition of up to three more processors

If there is any Multibus module with a high IQ, it is the iSBC 569 Intelligent Digital Controller; with space for up to four 40-pin processor chips, it can really be packed with smarts. And, fully packed, it provides the computational and control power of as many as five Multibus boards.

The iSBC 569 will operate as a stand-alone digital controller using its own on-board 8085A microprocessor. It will also serve as an intelligent slave, accepting into its dual-port random-access memory those programs offloaded by 8- or 16-bit Multibus masters.

Besides the 8085A, the iSBC 569 will accommodate up to three interface-controller chips. These can be any combination of 8041A Universal Peripheral Interfaces (UPIs), the erasable programmable read-only memory (E-PROM) version called the 8741A, or any of Intel's pre-programmed UPIs such as the new iSBC 941 Digital Signal Processor.

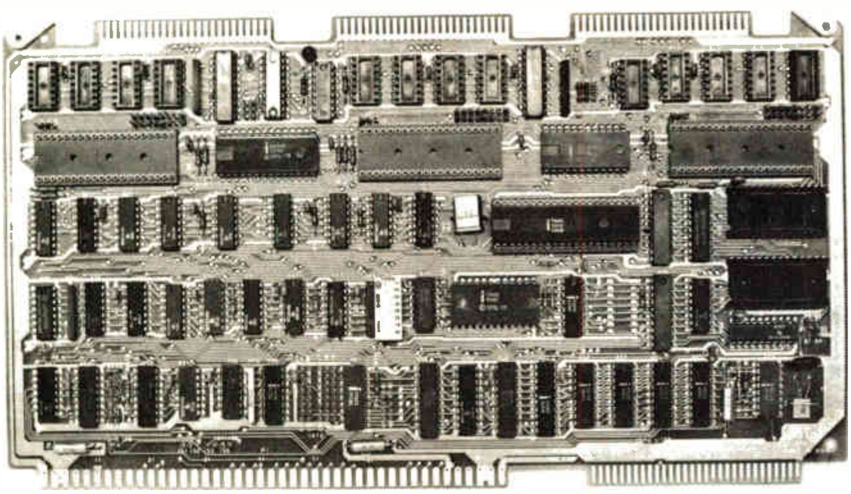
Each of these interface-integrated circuits has its own RAM, ROM, and timing circuitry. They can therefore help out the 8085A with such time-critical and time-consuming tasks as scanning alarm-switch closure, counting pulses or periods, event sensing, and printer and keyboard chores. In process-control loops, they will monitor events, log data, and perform many other functions requiring faster input/output response and more complex, multiprocessing control than most single-microprocessor controllers can keep up with.

Because the 8085A microprocessor is a general-purpose device, the iSBC 569, too, can operate as a bus master to control the memory-expansion and input/output boards of other iSBC 569s, for example, in a Multibus system. The 8085A also allows the iSBC 569 to operate from a single 5-V power supply and make use of 8080 software. But this is not meant to imply that the controller is restricted to acting as an 8-bit slave; it will also operate in 16-bit environments, with the iSBC 86/12 single-board computer, for instance.

The iSBC 569 provides space for up to 16 kilobytes of E-PROM or ROM, a 12-level interrupt control system for the 8085A, and 2 kilobytes of RAM with the dual-port control. This allows access to the memory through the on-board 8085's bus or through the Multibus connector to other system boards. In addition, the digital controller contains an 8253 Programmable Interval Timer chip having three independent timers. Each timer can act independently to provide additional functions like interval counting, interrupt-on-count, and read "on-the-fly" for time-stamping (appending a time value to an event).

The iSBC 569 is available at a single-board price of $750.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif., 95051. Phone (503) 987-8080 [371]



Microcomputer stores on 8-in. hard disk

Onyx Systems Inc. made sure it was at the top of the delivery list when International Memories Inc. started shipping its first 8-in. hard-disk drives last January [*Electronics*, April 27, 1978, p. 40 and May 10,

1979, p. 40]. And why Onyx wanted the product so badly is evident now in its C8000.

The C8000 microcomputer system uses the drive to give users access to 10 megabytes of data with an average access time of 50 ms. Backing up the drive is a Data Electronics Inc. tape drive that takes 3M DC300 cartridges.

Processing is performed by a 4-MHz Z80 with a 64-kilobyte main memory composed of 16-K dynamic random-access read/write chips. A general-purpose direct-memory-access controller speeds disk transfers and can also be used to transfer blocks of data to and from an 8-bit parallel port. The unit has three RS-232 ports as well.

Deliverable within 30 days, the C8000 sells for $12,500. In the works is a package that will upgrade the unit with a Z8000 to an intelligent file system that can support up to 10 user terminals. The package control. It requires about 2,300 bytes of RAM, loads at either 3700, 2700, or 1700, and costs $20 or $25.95.

The relocator, which can even relocate itself, requires 952 bytes and loads at 1000. It costs $20 or $25.95, too. Finally, there is the monitor, which requires an ACIA as the control port and 128 bytes of RAM at A000. In a 2716 PROM, it costs $70.

Percom Data Co., 211 N. Kirby, Garland, Texas 75042. Phone (214) 272-3421 [376]

Multiterminal computer talks to small business

Using an interactive version of Cobol, the CS/30 series of microprocessor-based systems provides multiterminal operating capability. The series' first two models, which can store up to 20 megabytes of business data, can be used as stand-alone systems by a company with up to 50 employees or as part of a larger firm's distributed processing network.

The low-end CS/30 Mod C1's center is an MP/100 microNova with a 64-kilobyte MOS main memory; mass storage is provided by a 10-megabyte cartridge disk. Data can be entered at the desk-top Dasher terminal and displayed on its cathode-ray tube or a printer.

A choice of printers ranging from 60 characters per second to 300 lines per minute is offered, as are such options as an additional 10-megabyte disk drive, a 315-kilobyte diskette drive, a synchronous communications interface compatible with IBM 2780/3780 formats, and upgrading capability. A license for the interactive Cobol is included in the basic package.

In addition to the standard features and options of the Mod 1, the Mod 3 has the ability to operate with an additional 32-kilobytes of main memory, for a total of 96 kilobytes. This lets the system support up to three terminals.

Prices for the Mod 1 start at $21,090; the Mod 3, with 96 kilobytes of main memory, is priced

starting at $49,820.

Data General Corp., Route 9, Westboro, Mass., 01581. Phone John Herbert at (617) 366-8911 [377]

Board gives networking ability to Micromodule systems

Systems built around Motorola's Micromodules can now become part of a network: the addition of the M68MM07 enables them to communicate with multiple systems using serial links. The board has four ports that can be strapped individually for RS-232, RS-422, RS-423, or 20-mA-current-loop formats and for any of 21 baud rates ranging to 11,000 bits/s.

The M68MM07 itself operates at 1 MHz and comes with an asynchronous communications interface adapter on each port that the user can change for synchronous operation in mixed operations. The board is available now and sells for $595.

Motorola Semiconductor Products Inc., P. O. Box 20912, Phoenix, Ariz. 85036. Phone Bill Crawford at (602) 962-2156 [375]

Paper-tape controller mates with LSI-11 computers

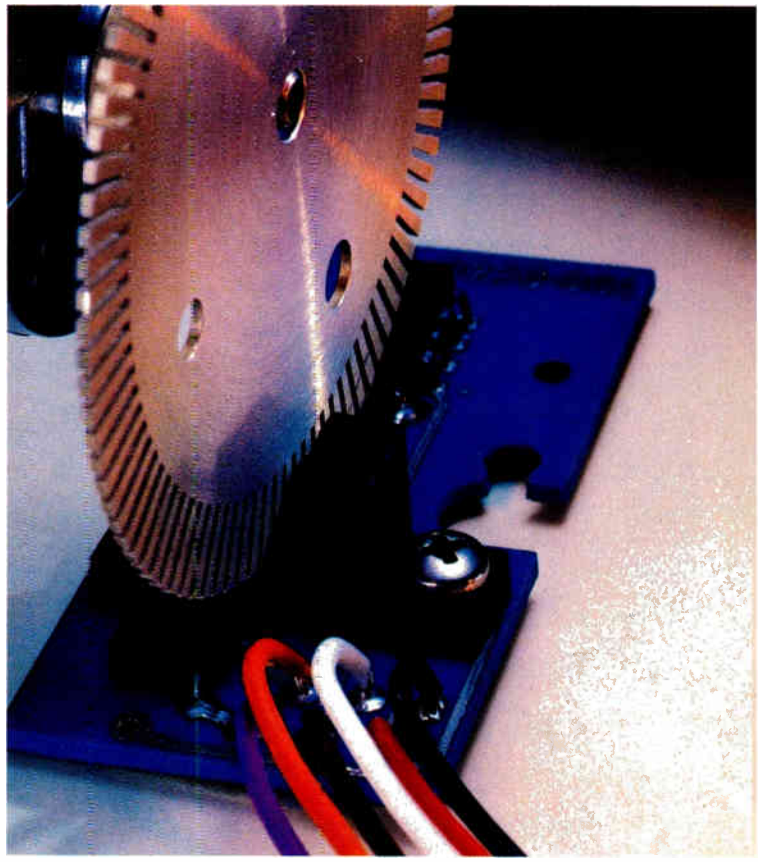
The PTC L11 paper-tape controller is completely hardware- and software-compatible with the LSI-11, LSI-11/2, and PDP-11/03. Switches allow easy address and interrupt-vector selection. The controller fills one option slot and consumes only 600 mA from a 5-V supply.

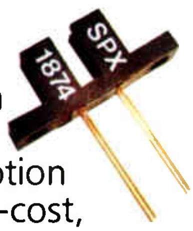
Standard interrupt vectoring allows the paper-tape system to operate at maximum efficiency. The hexadecimal sector address can be set from 000 to 370. Data is transferred in an 8-bit parallel format. An on-board jumper allows selection of 150- to 300-character-per-second reading speeds.

The single-piece price of the PTC L11 module is $600.

Computer Extension Systems Inc., 17511 El Camino Real, Houston, Texas 77058. Phone (713) 488-8830 [378].

THE INTERRUPTION YOU'VE BEEN WAITING FOR.





Most design engineers don't mind an interruption that offers a low-cost, high-volume design alternative. Like Spectronics' line of optical interrupter switches.

In fact, our SPX 1870 series has been so successful as a replacement for mechanical switch headaches like corrosion, contact bounce, and fatigue, that it's become the industry standard optical sensor.

And we're one of the largest volume producers, offering a variety of types and package designs. All microprocessor compatible with -55°C to 100°C operation and switching speeds as fast as 10 microseconds.

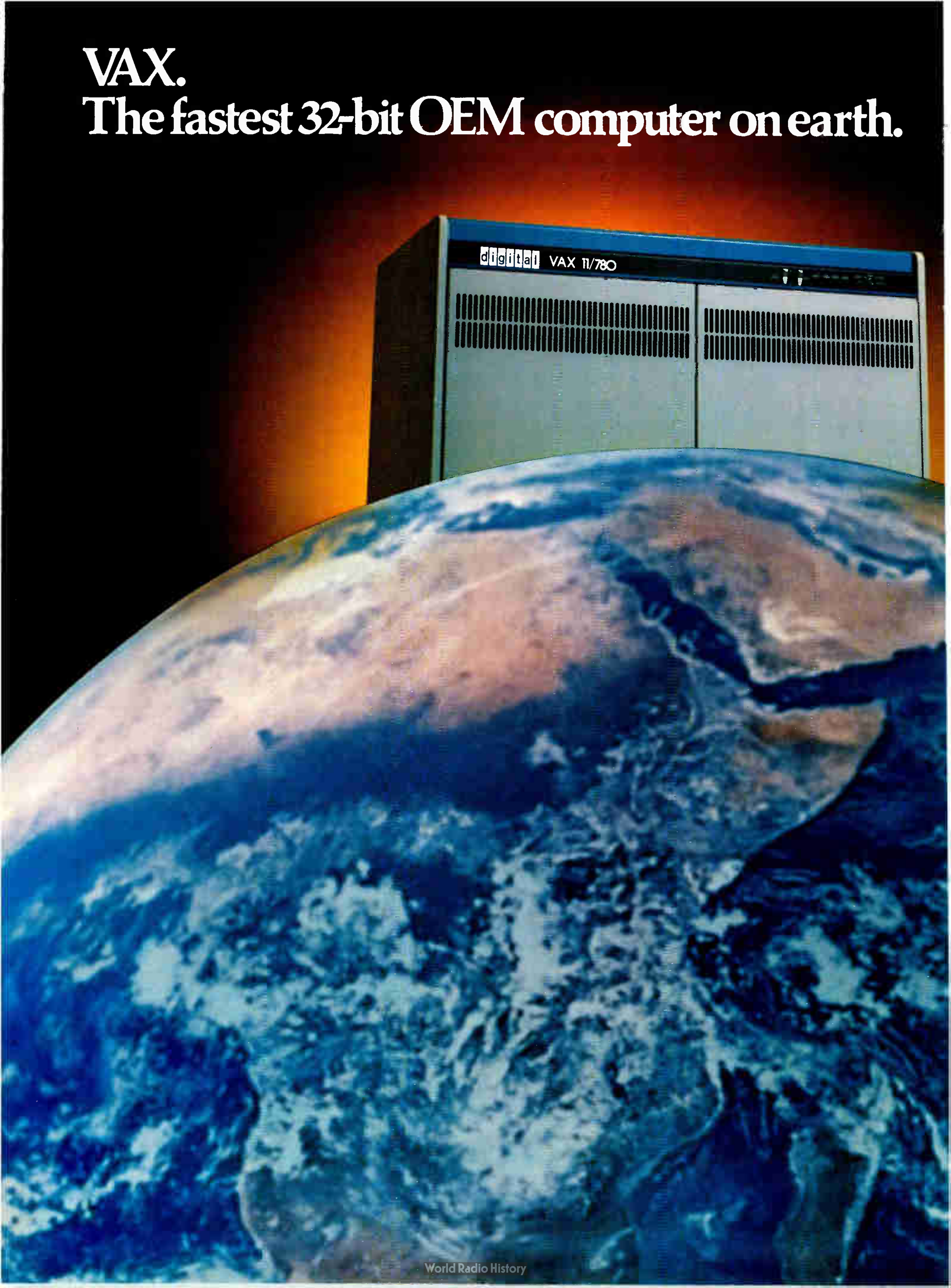
Already our sensors and encoders have turned up in applications ranging from cameras, servo systems, computer peripherals, and disc drives to automobile cruise controls, copy machines, printers and stepping motors.

We also provide the industry's leading opto isolators, infra-red components, and fiber optic products.

So if you're into optoelectronics, give us a call. That's one interruption that could save you time and money.

Give us a call at 214/234-4271. Or write us at 830 East Arapaho Road, Richardson, Texas 75081.

Spectronics
A division of Honeywell


VAX.
The fastest 32-bit OEM computer on earth.
digital VAX 11/780

Your benchmark will prove it.

When speed is an important measure of an OEM computer, nothing measures up to VAX.

In benchmark after benchmark, Digital's VAX-11/780 has beaten the competition cold. In a full range of demanding real-time, interactive, and multi-user batch applications.

Along with the fastest speed you can buy, VAX offers a long list of other unique performance advantages—features that are even more amazing when you consider that VAX is priced like a super-mini.

For example:

True 32-bit addressing, for a virtual address capacity of 4 billion bytes.

Our powerful easy-to-use VAX/VMS operating system, with a complete set of comprehensive software tools to speed your development time.

A rich, efficient instruction set to maximize FORTRAN performance.

Five I/O adaptors, providing an aggregate data rate of 9.5 megabytes.

A tunable real-time scheduler that locks critical programs and service routines in memory. Plus a variety of real-time interfaces.

What's more, VAX is available with all the peripherals you're likely to need.

Of course, the only way you'll truly appreciate VAX's winning performance is to try it with one of your toughest programs—and benchmark it against the challenger of your choice.

If our past record is any indication, there's no doubt about who'll be faster.

The only question is, by how much.

For more information, send the coupon or contact: Digital Equipment Corporation, 129 Parker Street, PK3/M-56, Maynard, MA 01754. 617-493-9797.

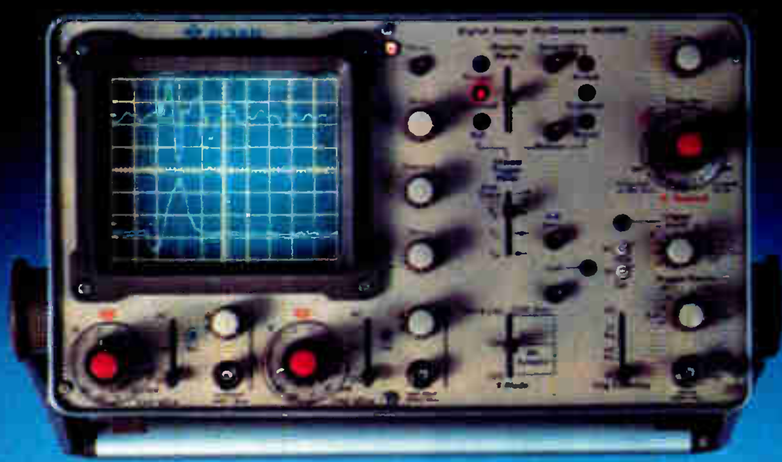
☐ I'd like to benchmark my program on VAX—please contact me.
☐ Please send your new VAX OEM brochure.

Name ____________ Title ______
Company ____________
Address ____________
City ________ State ______ Zip ______
Telephone ____________

Send to: Digital Equipment Corporation, 129 Parker St., PK3/M-56, Maynard, MA 01754. Or call: (617) 493-9797. In Europe: 12 av. des Morgines, 1213 Petit-Lancy/Geneva. Tel. 93 33 11. In Canada: Digital Equipment of Canada, Ltd. N-6-7-9

digital

Circle 191 on reader service card



Extend your storage capabilities beyond the conventional.

Now Gould offers a range of digital storage oscilloscopes that offer a world of advantages over conventional tube storage technology, beginning with being able to capture transient or "one-time" events and store them indefinitely for display or hardcopy printout. This makes them ideal for electronic, electromechanical, educational, and biophysical applications.

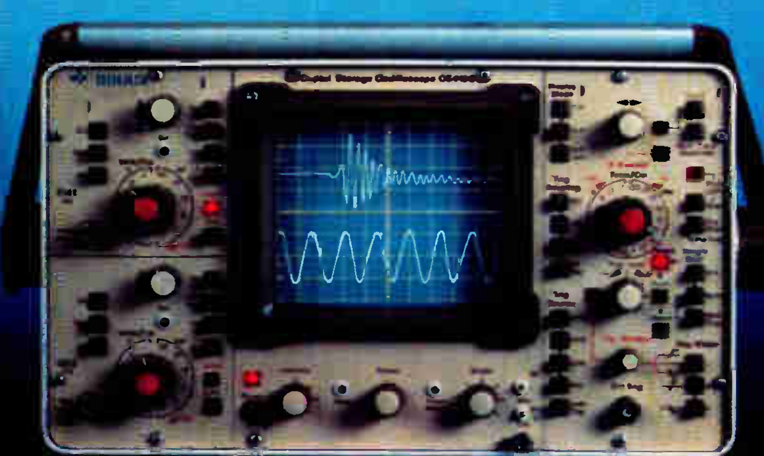
Both the OS4000 and the new OS4100 combine the capabilities of semi-conductor memory with a bright, stable, flicker-free display. This technique allows analysis of signal build-up and decay characteristics through pre- and post-trigger viewing. Expansion of the display after storage permits detailed study of specific areas of the trace.

The new model—OS4100—also offers you stored X-Y displays, channel sum or difference and a maximum of 100μV per cm sensitivity with noise suppression. A unique trigger window circuit assures capture of transients of unknown polarity.

Other outstanding features include automatic operation, display of stored and real time traces simultaneously and hard copy memory output in digital or analog form. And IEEE488 is available for compatible interfacing.

If features like these aren't enough to lure you away from less sophisticated instruments, remember that Gould scopes are backed by a two-year warranty of parts and labor, exclusive of fuses, minor maintenance and calibration. And application assistance, customer training and worldwide service centers are part of Gould's customer support program.

GOULD



Circle 192 on reader service card

New products

Computers & peripherals

Multiport memory merges minis

Shareable main memory is flagship for a fleet of processors and peripherals

As minicomputer users become more sophisticated they require of their systems increased performance and availability. One way to meet those needs is to run multiple processors in parallel, a technique now supported by a shared, multiport memory system introduced by Modular Computer (Modcomp) Corp.

The new memory system with its expansion cabinet increases the main memory of Classic models 7860 and 7870 to a maximum of four megabytes. And it allows those models to share the same memory, a technique often referred to as tightly coupled processing and one that has been in use in several mainframe computers. But the technique is relatively new to minicomputers—only a few other minicomputer vendors offer it.

With the Modcomp system, the computers can share either the memory located in one of the computer cabinets or the one in the separate memory expansion cabinet. Each computer is able to hold one or two of the interface cards that are connected to interface cards at the shared memory. The memory expansion cabinet holds up to four interface cards.

According to Howard Hayakawa, product marketing manager, shared memory is supported by the Max IV operating system. But users must write software to specify and control the detailed use of the shared memory locations, as well as interprocessor communications.

The memory system is just one of a series of products introduced to bolster the Classic computer line which is more than a year old (*Electronics*, March 16, 1978, p. 48). Filling out the line are the model 7830 central processing unit that is priced at $23,800 and the 7835 CPU, which includes high-speed floating-point hardware and sells for $29,500. Jim McKeon, product marketing manager, notes that what he calls the arithmetic accelerator, "provides about 50% more performance at just 25% more in price." The new units will compete with machines such as DEC's PDP 11/34 and Data General's Eclipse S/250.

Modcomp is also unveiling a time-sharing executive/transaction processing software package called TSX and a data-base management system dubbed Infinity. Using a "virtual terminal" technique, TSX allows interactive applications programs to be independent of the terminal. The package has a single-time licensing fee of $5,000.

Infinity supports multi-user access to data-base files through the standard operating system's I/O structure. It includes special data definition and manipulation languages for

creating data bases and working with them. When used with the Maxnet software, it supports distributive data-base management configurations. Its license fee is $10,000.

Finally, a new Winchester disk drive, the 4173, is being added to the line in 21- and 67-megabyte versions, as is a removable media drive, the 4174, in 67- and 253-megabyte configurations.

Software and the 7830 and 7835 CPUs will be delivered starting in the third quarter, followed by the multiport memory which is due in the fourth quarter of this year.

Modular Computer Systems Inc., P.O. Box 6099, Ft. Lauderdale, Fla. 33309 [361]

System supports 128 terminals

Ease in upgrading is the name of the game in business computers these days, and Wang Laboratories has just hit home with an addition to its VS (for virtual storage) line. Announced this week, it may prove to be one of the most powerful business systems available yet.

Dubbed the VS100, the system can support 128 terminals, 4.6 billion bytes of on-line disk storage, and up to 2 megabytes of main memory.

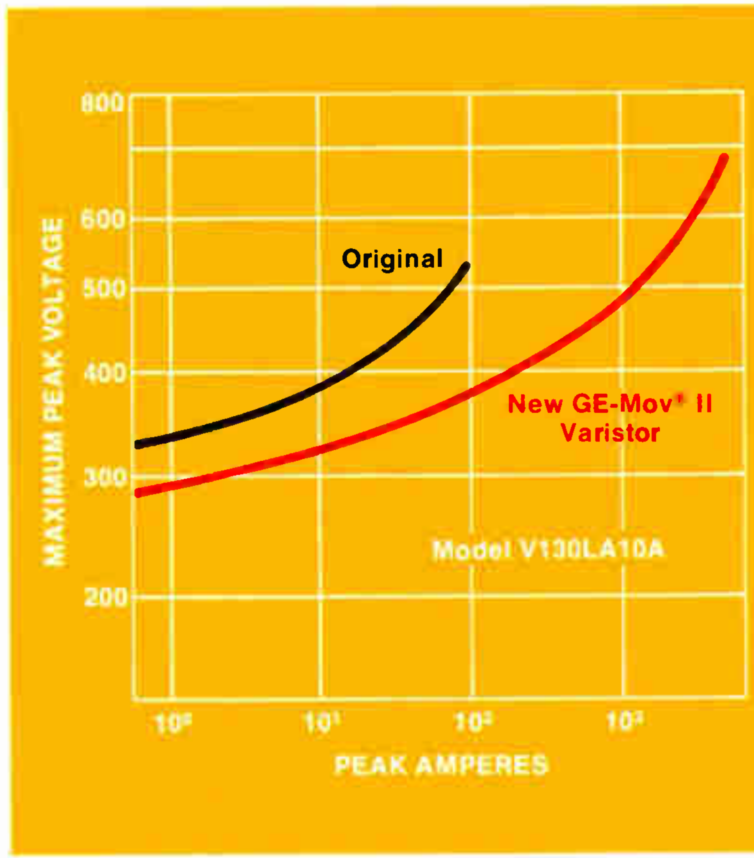
"The new CPU (VS100) is completely compatible, both upward and downward. No software conversion is needed, so object programs and data files are transportable without change," says Peter E. McElroy, product-line manager, market planning and development. "This is somewhat unique in the business, from the end-user's point of view," he points out, and notes that, "it's usually very expensive to effect that kind of conversion."

The current VS system can support up to 32 cathode-ray-tube and keyboard terminals (work stations) with up to 512 kilobytes of main memory and 2.3 billion bytes of on-line disk storage. Input/output processors are integral parts of the VS system, controlling peripheral devices as well as providing communication capabilities. The current VS model can manage eight I/O processors; the new system is able to handle twice that number.

In fact, the VS100 employs a new architecture that enables more of these I/O processors to be used, thus increasing the capacity of the system. "We're using a high-speed bus adapter," notes McElroy. "The VS100 has eight I/O processors per bus adapter, and can have two bus adapters. The job throughput is eight times that of the current VS—it's a lot faster," he adds.

The virtual-storage—or virtual-memory—capabilities of the system, enable the VS100 (and all previous VS machines) to fit a program into

New GE-MOV® II Varistors for improved transient protection... via tighter clamping.



New GE-MOV® II varistors incorporate improved processing methods which offer significant performance advances in (1) clamping voltages, (2) current handling, (3) transient energy dissipation . . . and yield the best combination of parameters for increased protection against voltage transients and improved circuit reliability.

For example, the popular 120 volt V130LA10 has been upgraded in energy from 10 to 30 joules, peak current handling from 1000 to 4000 amps . . . and with no price increase!

GE-MOV® II varistors clamp dangerous voltage transients and dissipate them as harmless heat thereby protecting expensive and voltage sensitive components.

GE-MOV® II varistors are available from any authorized GE Semiconductor Distributor or from any GE Electronic Components Sales Office.

Stop by the General Electric exhibit, 2536-38, at Electro '79.

For a free design kit and sample of your choice, write, stating your application, current and voltage requirements, to General Electric Semiconductor, Box 4, West Genesee Street, Auburn, New York 13021, or in Europe contact, International General Electric Co. of New York, Dundalk, Ireland (042) 32371, Telex 33816. 222-10

*Registered Trademark of General Electric Co.

There's more to GE semiconductors than meets the eye

GENERAL ELECTRIC

available memory. The VS system uses a 2-kilobyte page-frame division to partition the memory. As the system is upgraded and becomes more powerful, the memory access times are enhanced. Current VS systems allow each user access to 1 megabyte of memory.

Wang has added both Fortran and PL/1 as software language options for the entire VS family. Currently supported by compilers are RPG-II, Basic, Cobol, and assembler. Data files are language-independent, and automatic data compaction saves up to 50% of the space in memory, according to McElroy. The work stations provide an attractive means of communicating with the computer. "It's a highly interactive system," notes McElroy. "System operators or computer operators aren't needed. Ordinary people can use it."

Wang expects the new VS100 to be used primarily in business environments, competing heavily with IBM's newly announced 4341. "The VS100 offers considerably more performance than the 4341," says McElroy. "For a user contemplating [buying] IBM's 4341, the VS product line is a viable alternative for implementing distributed processing."

A VS100 with a 1-megabyte central processing unit will cost $93,000, compared with a current VS system with 512 kilobytes of main memory, which sells for $61,000. Initial shipments are scheduled to begin in July 1980.

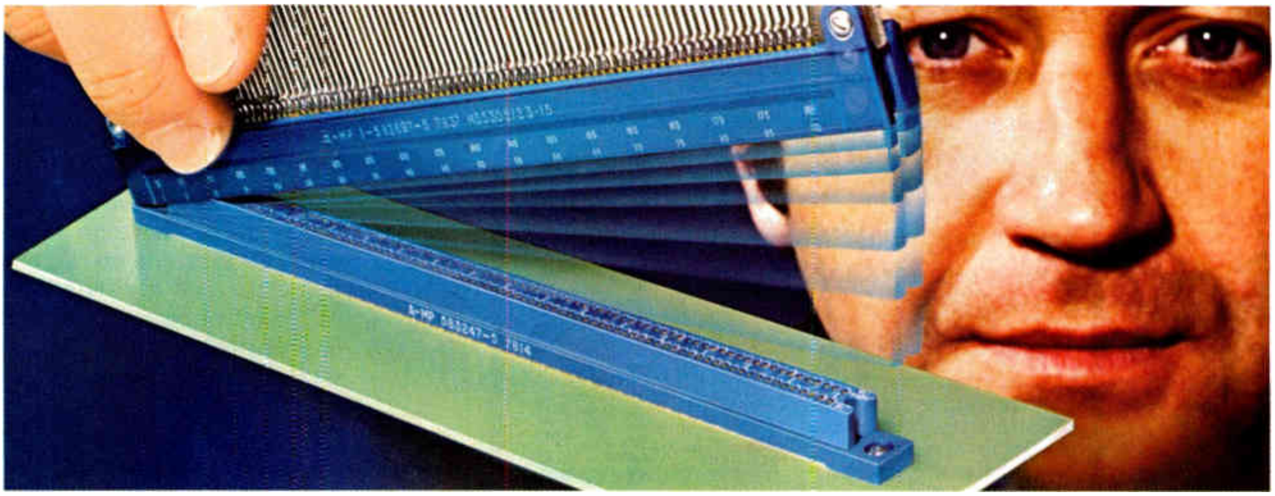
Wang Laboratories Inc., One Industrial Avenue, Lowell, Mass. 01851. Call Mike Anctil at (617) 851-4111 [362]

Terminal line grows wider

Designers at Honeywell Information Systems have broadened the VIP7800 line and the results are on display this week at NCC. The family began last year with the VIP7801—an asynchronous, microprocessor-based terminal with a 12-in.-diagonal cathode-ray-tube screen. This year's added width is in the form of three terminals with

"When can I get a MIL C-55302 connector with a high pin count and a low failure rate...one that's easy to insert and extract?"

Right now. AMP Box Connectors.



You can order AMP Box Contact Connectors with a pin count as high as 240 and still rest easy about their reliability. We've sold millions of them in the last 12 years. And not one operational failure has been reported in all that time.

At the heart of these remarkably flexible connectors is a unique four-beam receptacle contact that accepts square, rectangular, round or formed pins. Contact redundancy insures performance in shock and vibration situations.

The entire design is so forgiving you can literally peel the connector halves apart. Even with such low insertion and extraction forces you have the further option of graphite lubrication. This is an AMP exclusive which significantly reduces contact mating forces by impregnating the pin contact during the manufacturing process.

AMP Box Contact Connectors are available in .050", .075" and .100" center-lines...in both MIL C-55302 and commercial versions.

Convinced? Need more information? Call the Box Connector Information Desk at (717) 564-0100, Ext. 8400. Or write AMP Incorporated, Harrisburg, PA 17105.

AMP has a better way.

AMP

Circle 197 on reader service card

improved features: the 15-in.-screen asynchronous 7802, the 12-in. CRT synchronous 7804, and the 15-in. synchronous 7805.

One of the key improvements over the original 7801 is the communications rate—increased from 9,600 to 19,200 bits per second. "The standard 19,200 bit/s ensures fast, direct communication where you're not limited by telephone lines," says Stephen N. Robinson, manager of marketing support, terminals marketing operations. All four VIP7800 terminals will now operate at switch-selectable rates between 75 and 19,200 bit/s.

The other new, optional features for the VIP7800 family include: a printer-buffer adapter that allows 66 lines of 132 columns of print to be stored until hard copies are made; a 72-line vertical scrolling feature, which allows the user to display up to 24 lines at a time; and a direct connection feature, which permits the user to connect a terminal to a computer up to 1,000 feet away using a Multiple Interface Unit.

The VIP7800 terminals have an 80-character-by-24-line display (the 15-inch models have larger screens, but do not display more characters), with the 25th line on the bottom of the screen used as a status line.

The user may opt for either white or green phosphor for the display at the time of purchase, and inverse video, true underlining, and blinking functions are standard features.

The 12-inch, synchronous model 7804 sells for $3,060, while the 15-inch asynchronous model 7802 sells for $3,195 and the 15-inch synchronous model 7805 is priced at $3,360. The original VIP7801 carries a price tag of $2,885. The VIP7804 will be available in August, while shipments for both 15-inch models will begin by the end of the year. Robinson expects that more features will be added to the terminals in the future. All software is in read-only memory, "so we just have to add firmware to increase capability," he says.

Honeywell Information Systems, Inc., 200 Smith Street, MS 486, Waltham, Mass., 02154. Phone Steve Robinson at (617) 890-8400 [363]

Here's a benefit you can't get with any other counter.

Tektronix.

Made by Tektronix. One benefit that no other manufacturer can offer. And, one benefit that separates TM 500 Counters from the rest of the pack. Quality design, manufacturing expertise and a nation-wide sales and service organization support every piece of instrumentation carrying the TEK name.

TM 500, from Tektronix, is a line of nearly 40 modular plug-in test and measurement instruments. Five versatile TM 500 Counters are joined by DMM's, pulse, function and specialized generators, power supplies, oscilloscopes, calibration instruments and amplifiers.

Each TM 500 Counter is designed with a different combination of specifications. The TM 500 Counter family includes two universal counter/timers, a low-cost instrument, and two communications-oriented, high-frequency counters.

These modular counters can be mixed and matched with any of the other TM 500 Plug-ins to create test sets customized to your application. Choose six different mainframes: three sizes of benchtop mainframes, a suitcase-like Traveler Mainframe or a standard, rackmountable mainframe.

There's only one family of counters that offers you all this performance and the name to prove it. TM 500 from Tektronix.

For additional information about TM 500 Instruments, please call Tektronix' automatic answering service (toll free) at 1-800-547-1512. Oregon residents call collect on 644-9051. For even faster service, call your local Tektronix Field Office.

In Europe write: Tektronix Limited, P.O. Box 36, St. Peters Port, Guernsey, Channel Islands.

TM 500
Designed for Configurability

Tektronix®
COMMITTED TO EXCELLENCE

For Technical Data Circle #199
For Demonstration Circle #264

For immediate action, dial our toll free automatic answering service 1-800-547-1512

1000 line color as fast as you can say Ramtek.

Here's a 1000 line color monitor with a pixel rise time of 7 nsec and off-the-shelf delivery. Nobody but Ramtek can deliver that kind of speed.

Ramtek delivers more, too. Compare our color monitors with any other high performance color monitor. Point for point, you'll see there is only one choice—Ramtek, the world's largest supplier of

1000 line color monitors.

Then, give us a call. For high resolution color or b/w monitors. For immediate delivery. Or, for a color graphics and imaging display generator that opens a new world of color graphics possibilities, ask about our new high performance Ramtek 9400 Series. Whatever you need in color graphics displays, Ramtek can show you more.

	Ramtek	Aydin	SRL
Diagonal Screen Size	19" and 13"	19"	19"
Compatible Monochrome Monitor	Yes	No	No
Power Supply	Internal	Internal	External 75# 19" w 20¼" d 8¾" h
Input Power Required	250 VA	250 VA	500 watts
RGB Video Bandwidth	50Hz to 40 MHz +1/—3db with DC restoration	50Hz to 25 MHz +2db	50Hz to 43 MHz +2db
Composite Sync	Yes	Yes	No
Separate Horizontal and Vertical Drive	Optional	No	Standard
Pixel Fall/Rise Time	7 nsec	30 nsec	12 nsec (TTL only)
Physical Size (Rackmount)	85# 19" w 20" d 17½" h	100# 19" w 21½" d 17½" h	75# 19" w 22" d 17½" h

Ramtek

585 N. Mary Avenue, Sunnyvale, CA 94086
Tel. (408) 735-8400

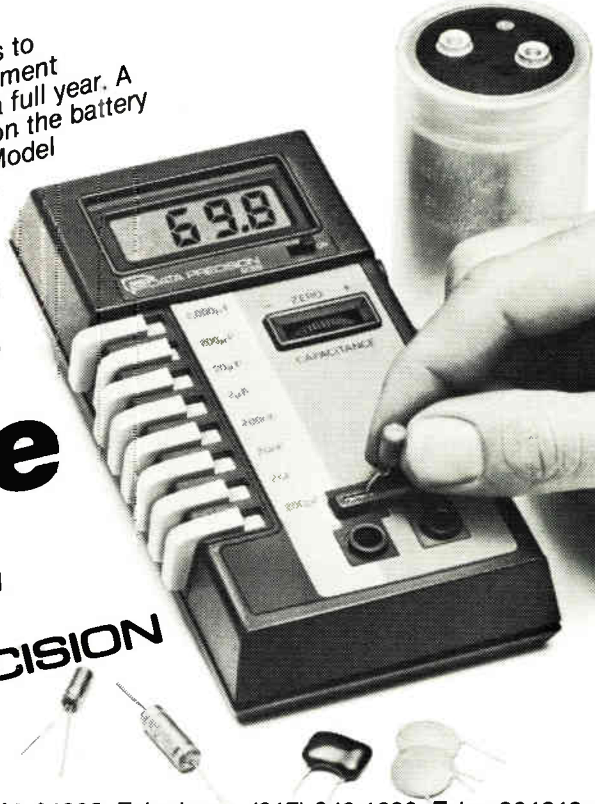
REGIONAL OFFICES:
Sunnyvale, California (408) 735-8400 • Newport Beach, California (714) 979-5351 • Dallas, Texas (214) 422-2200 • Maitland, Florida (305) 645-0780 • Huntsville, Alabama (205) 837-7000 • Chicago, Illinois (312) 956-8265 • Cleveland, Ohio (216) 464-4053 • Washington, D.C. (301) 656-0350 • Metropolitan N.Y. (201) 238-2090 • Boston, Massachusetts (617) 862-7720 • West Germany (0611) 771070

Circle 200 on reader service card

Plug in the capacitor, push the appropriate range button, and read the value to 0.1% accuracy. With the Data Precision Model 938 digital capacitance meter it's that easy. The 8 easy pushbutton ranges cover 0.1 picofarads to 1999 microfarads, and the exclusive "Δcharge/Δvolt" measurement circuit (patent pending) holds its ±0.1% basic accuracy for a full year. A 0.5" high liquid crystal display is easy on the eyes and easy on the battery — up to 200 hours operation on a standard 9V battery. The Model 938's small size and light weight make it easy to carry where you need it.

But best of all, it's easy on the budget — only $149.00 (USA) — complete with a 2-year warranty. Just what you expect from Data Precision.

Available from stock at all Data Precision local distributors and representatives.



Capacitance Made Easy-$149.

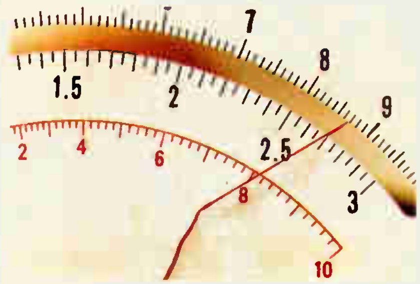
DATA PRECISION

Data Precision Corporation, Electronics Avenue, Danvers, MA 01923. Telephone: (617) 246-1600, Telex 921819.

 Circle 41 for demonstration

Circle 42 for additional information

Finally, you can have all the advantages of DMMs and none of the disadvantages of analogs for about the same price.



Our new 169 is a tough, lightweight, battery-powered digital multimeter for use in the field or on the bench. It is a 3½-digit, full 5-function DMM with respectable .25% DC accuracy.

Its low-parts-count, high-efficiency design keeps power consumption to a minimum for longer component life and fewer failures. MTBF is 20,000 hrs. or about 10 years.

You've pinned your last needle.

All 5 functions are fully protected – 1400V peak on DCV and ACV, 300 V on Ω, 2A (250V) on DCA and ACA. The fuse is externally accessible for quick replacement. Extensive vibration stress-testing assures the 169 will stand up to all the mechanical shock and abuse normally associated with tough applications.

Cost-conscious ease of maintenance is so thoroughly designed into the 169 that only one calibration adjustment a year is required. That adds up to a cost-of-ownership no other competitive DMM can touch. For example, the 169 needs only one battery change per year at a cost of about $3.50. Its nearest competitor requires 10 changes costing three times as much.

When you factor in features like function and range annunciation right on the display, auto-zero, auto polarity, 60% larger display than other DMMs and the easy-to-read, color coded front panel, we think you'll get the point. No analog meter or DMM can match the price/performance of the new 169. It costs **$149.**

For information on the 169 or any Keithley DMM call (800) 321-0560 Telex: 98-5469. In Ohio, call (216) 248-0400.

Circle #201 for literature
Circle #275 for demonstration

Price U.S.A. only.

KEITHLEY

Keithley Instruments, Inc.
28775 Aurora Road
Cleveland, Ohio 44139
(216) 248-0400
Telex: 98-5469

Keithley Instruments, GmbH
Heiglhofstrasse 5
D-8000 München 70
WEST GERMANY
(089) 714-40-65
Telex: (841) 5212160

Keithley Instruments SARL
44, Rue Anatole France
F-91121 Palaiseau Cedex
FRANCE
(01) 014-22-06
Telex: (842) 204188

Keithley Instruments Ltd.
1, Boulton Road
GB-Reading, Berkshire RG2 ONL
UNITED KINGDOM
(0734) 86-12-87
Telex: (851) 847047

The Transient Clinic™

Microprocessors

"Dear Dr. Spark:
My microprocessors are experiencing both upset and failure from static discharge and line transients..."

"Dear Customer:
Static discharge is characterized by very fast rise times (2,000 volts per nanosecond) and peak voltages to 20,000 volts. CMOS circuitry can fail with transients as low as 25 volts for 100 nanoseconds. Our TransZorb® transient voltage suppressors have a proven track record of protecting integrated circuits in a transient environment. For your microprocessor protection application, we recommend our MPT series of TransZorbs. A new 4-page designer data sheet is now available . . ."

GENERAL SEMICONDUCTOR INDUSTRIES, INC.

2001 West Tenth Place • P.O. Box 3078 • Tempe, Arizona 85281 • 602-968-3101 • TWX 910-950-1942

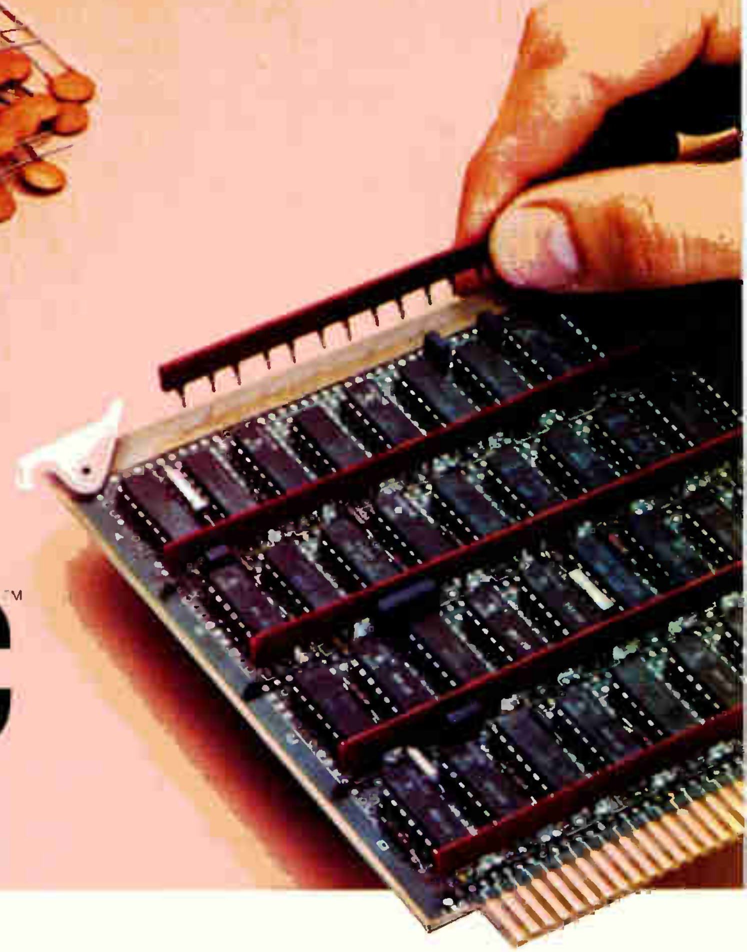
TransZorb® is a registered trademark of General Semiconductor Industries, Inc.

Circle 202 on reader service card

NOW...

obsolete decoupling capacitors

with Q/PAC™



New, high capacitance Q/PAC* power distribution elements are the exciting, revolutionary way to eliminate decoupling capacitors from printed circuit boards. Rugged Q/PAC elements are easy to install and increase system reliability through reduced part count.

Q/PAC elements are available in capacitance values up to 0.05μf per inch in lengths up to 16 inches. Configurations allow for either vertical mounting or horizontal installation under DIP packages.

*Patent Applied For

Q/PAC elements eliminate the need for on board power traces and extra board layers. They maximize packaging density and minimize signal interconnection problems.

Q/PAC elements feature a low dissipation factor, low inductance and low impedance.

Pack more on static and dynamic MOS memory boards, more on critical random logic boards.

Contact the Q/PAC Product Specialist at (602) 963-4584.

ROGERS

Rogers Corporation
Chandler, Arizona 85224
EUROPE Mektron NV Gent Belgium JAPAN Nippon Mektron Tokyo

FOR IMMEDIATE NEED CIRCLE 262

FOR INFORMATION ONLY CIRCLE 203

New products

Instruments

$5,495 unit tests 8048 family

Tester checks programs stored in microcomputer against user's PROM

Manufacturers who use dozens of types of microprocessors have no problem justifying the cost of a large, general-purpose automatic testing system for the devices. But for low-volume system builders who only use one or two chip types, such a tester is too expensive.

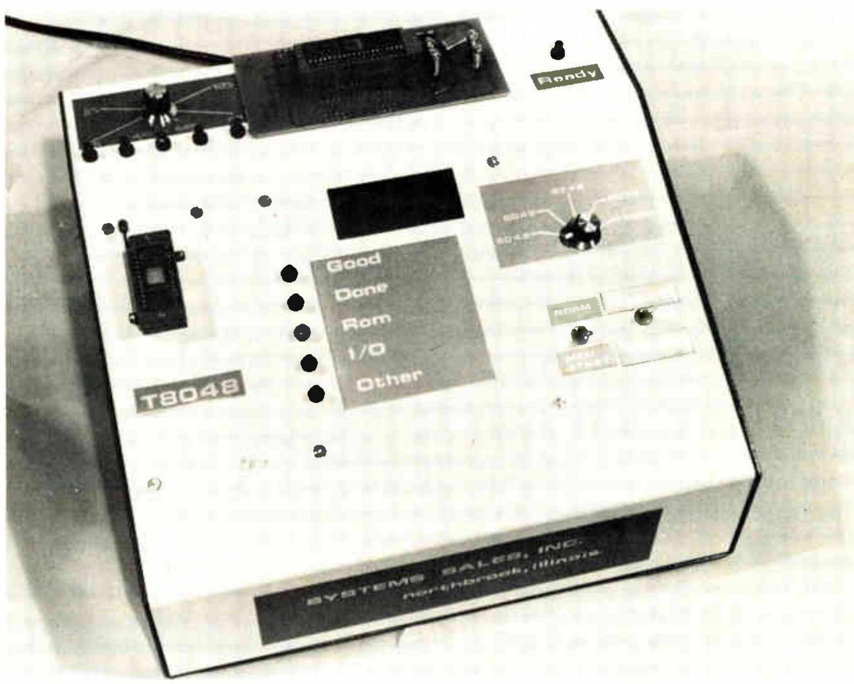
Until recently, the only alternative small users had was to put the processor in the system and see if it worked. If it did not, time-consuming trouble-shooting ensued. Observing this state of affairs, Systems Sales Inc. decided to build affordable, dedicated testers and, late last year, introduced a 3870 tester.

With the lessons learned from that profitable device, the company is now introducing a $5,495 unit that can test members of the 8-bit, 8048 microcomputer family, including the 8048, 8049, 8039, 8035, and the 8748. The unit, called the T8048, checks the operation of the arithmetic and logic unit, the instruction set stored in and the operation of any on-chip read-only memory, the interrupt structure, the reset circuit, and input/output pin functioning.

To use the tester, an operator inserts a programmable ROM with the coding that should be in the microcomputer, the microcomputer itself, and a crystal of any desired clock frequency between 1 and 11 MHz. He can set the supply voltage in increments of ¼ volt between 4.5 and 5.5 V to see the effects of source voltage variation on operation. When the ready indicator comes on, he pushes a toggle switch to test; within about 5 seconds testing is complete, if no failures occur.

If a failure occurs, one of three lamps lights up: ROM, I/O, or Other. For ROM failures, any discrepancy between the code in PROM and that in the microcomputer is shown in the alphanumeric display as a hexadecimal memory address. The pin number is shown in the display for input/output failures.

When the Other lamp lights, the display shows a number that refers to a table of failure types, such as clock oscillator failure, supply over-



ONLY LEXAN FL1800 FOAM RESIN RATES WITH UL-478.

The only foam qualified to replace metal in large computer-room parts is LEXAN FL1800, a GE Engineering Structural Foam resin.

That's because LEXAN FL1800 is the only foam that complies with today's stringent UL-478 flammability specifications.* Which means it exhibits a low flame spread index, a high oxygen index and low smoke generation.

What's more, LEXAN FL1800 delivers unsurpassed impact resistance, excellent heat deflection to 290°F, flexural modulus of 375,000 psi, double insulation and significant weight reductions.

Best of all, since LEXAN FL1800 is so rigid, strong and stable, it enables you to design and mold a large part that combines a beautifully stylish side with an incredibly functional side in a single piece.

So unlike metal, LEXAN FL1800 resin eliminates costly secondary parts, materials and operations. And reduces costly shipping weight.

To introduce you to LEXAN FL1800, GE is prepared to assist you with complete design and production expertise and facilities.

For data or assistance, contact Structural Foam Resins Section 315, Plastics Division, General Electric Company, One Plastics Ave., Pittsfield, MA 01201.

Do it today. You can't afford metal one more day.

*This rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

WHAT THE WORLD IS COMING TO: GE ENGINEERING STRUCTURAL FOAM

LEXAN® NORYL® VALOX®

GENERAL ELECTRIC

Circle 205 on reader service card

current, operational code, or RAM address. Users can continue testing by pressing the test button again.

The T8048 comes with an RS-232 interface so that test results can be logged externally. Its delivery time is six to eight weeks.

Systems Sales Inc., 3330 W. Dundee Rd., Northbrook, Ill. 60062 [351]

Unit generates pulses with 50-ps rise time

Intended for precision testing of high-speed circuitry and for applications such as high-resolution time-domain reflectometry, the TD-50PA is a tunnel-diode step generator whose pulse output has a risetime of 50 ps or less. It can deliver a positive-going pulse of at least 200 mv into a 50-Ω line.

Pulse duration is a minimum of 1 μs and the output period is typically 15 μs. For the first 800 ps following a pulse, droop is within a low −4% ±2%; this figure continues to decrease until, after 1.5 ns, it is less than ±0.5%. The pulse output is available at an SMA connector.

Two BNC connectors at the rear of the 6-by-3½-by-1½-in. generator provide pretrigger and trigger information.

The pretrigger signal is nominally 85 ns ahead of the output pulse, with pretrigger-to-pulse jitter 20 ps or less. Pretrigger, trigger, and pulse outputs are 50-Ω reverse-terminated to minimize reflections.

The TD-50PA contains its own power supply and therefore can be used with any oscilloscope. It is priced at $449 and is available from stock.

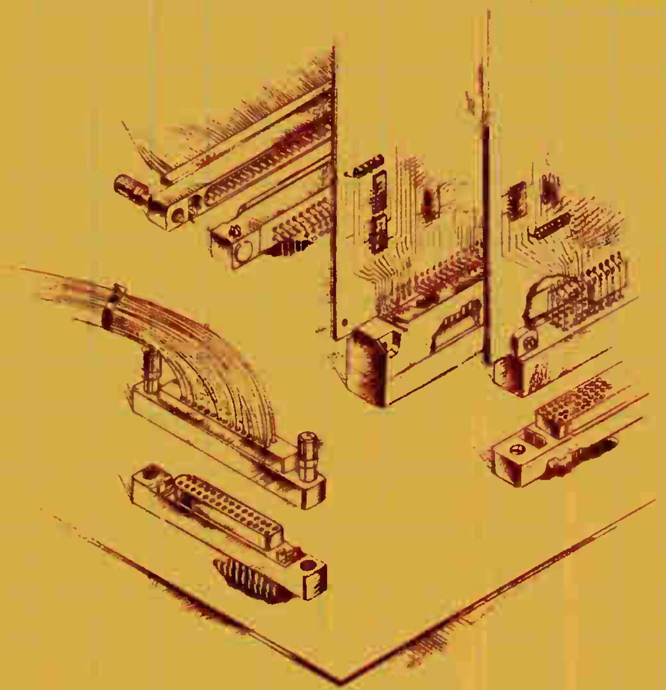
Colby Instruments Inc., P.O. Box 84379, Veterans Administration Branch, Los Angeles, Calif. 90073. Phone (213) 476-6139 [354]

Selectable-frequency unit plugs into TM-500 frame

Plugged into a TM-500 mainframe, the model 8131 oscillator provides a stable output frequency that is selectable at 0.1, 1.0, 5.0, or 10 MHz. A digital front panel control permits resolution to within as little as 1 part in 10^{10}.

The frequency output can be fed to a plug-in counter through a rear connector to provide it with an external time base. When used with a plug-in 8163 WWVB receiver, the

PCB Flexibility with Bendix Brush Connectors.



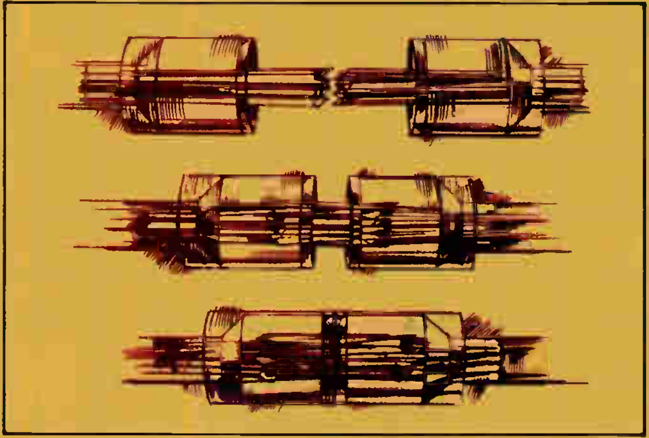
A low mating force connector with up to 400 contacts. 4 body styles. 3 contact variations with options. Superior electrical characteristics and long mechanical life. That's flexibility! And Bendix has one for your high-contact needs. The Brush Connector. Here's what you get.

Bendix Brush Connectors increase circuit count per board.
- Reduce number of boards by allowing more circuits per board.
- Greater board effectiveness by providing exact circuit counts up to 400 contacts in only one connector!

Bendix Brush Connectors reduce mating force 70% to 90%.
- Less complex board supports.
- Secondary actuators eliminated.
- Extended mechanical life. Up to 20,000 mates/unmates.
- Fewer damaged boards.
- Eliminates fixture mounting need of multiple smaller connectors.

Bendix Brush Connectors—a broad product line.
- Mother Board, Daughter Board, Input/Output, PC receptacle body styles.
- 2, 3 and 4 row configurations.
- 90° and straight PC, solderless wrap, crimp removable terminations with multiple lengths and plating options.

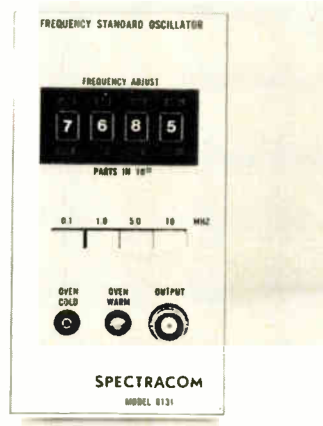
Bendix Brush contacts improve electrical characteristics.
- Highly redundant contact sites with multiple electrical paths and wiping action.
- Gold plated wire bristles mesh together intimately with gas-tight junctions.
- Stable contact resistance even after extreme mechanical durability abuse to 20,000 matings.



For full information, call (607) 563-5302, or write The Bendix Corporation, Electrical Components Division, Sidney, New York 13838.

Bendix

We speak connectors.



resultant instrument is traceable to the National Bureau of Standards.

Use of a proportional oven control speeds oscillator warm up; use of the 8131 with the 8132 accessory battery power supply eliminates warm-up. When the oscillator output is stable to within 2 parts in 10^8, a front-panel indicator lamp lights. The unit's temperature stability is within ±7 parts in 10^9 and it is designed to work from 0° to 55°C.

The model 8131 is priced at $1,300. Delivery is from stock to 45 days.

Spectracom Corp., 1667 Penfield Rd., Rochester, N. Y. 14625. Phone (716) 381-4827 [355]

Small scope measures signals to 30 MHz

The latest addition to the Miniscope line [*Electronics*, June 23, 1977, p. 156] is the MS-230, a portable, dual-trace oscilloscope that can display 30-MHz signals. With batteries, the unit weighs a mere 3 lb and measures only 2.9 by 6.4 by 8.5 in.

Time-base settings are selectable

Meet the Analyst. An improved version of an old friend.

Since its introduction, the Fluke 8020A has virtually become the industry standard for value in hand-held digital multimeters. And now the 8020A boasts a new set of features making it an even better buy—and a more powerful performer. So powerful, we call it the Analyst.

Now 0.1% benchtop DMM accuracy in a hand-held instrument. A crystal-controlled A/D converter insures accurate, steady, noise free measurements and a basic dc accuracy of 0.1%. That's 25 times better than you'll find in most analog VOM's.

Here's something new that won't shock you. The Analyst boasts a new Fluke-designed test lead system with finger guards on the probe and shrouded contacts on the connectors to discourage accidental contact with circuit voltages.

We prove our reliability with a two-year confidence warranty. With well over 100,000 8020A's in the field, we know the Analyst is rugged and reliable. So we now back the Analyst with an exclusive limited two-year warranty and NBS traceable calibration with prompt service from over 45 factory authorized service centers worldwide.

There's more to the price than you might expect. You'd expect to pay more money for the Analyst's added features. After all, the 8020A already boasts 26 ranges for seven functions including conductance. This capability is a unique way to measure high resistance—a must for checking leakage in capacitors, pcb's, cables and insulators, and general use above 20 MΩ. High and low-power ohms functions, easy one-hand push button operation and full over-voltage and over-current protection are all included. In fact, over 20% of the instrument's components are devoted to input protection.

But the price is still $169*. And it now includes a deluxe carrying case and an improved operator's manual. The kind of value in performance, features, and accessories that only the industry leader can provide.

Here's how to get your hands on one. Contact the Fluke office, representative, or authorized distributor in your area. In the U.S., CALL TOLL FREE (800) 426-0361. (For residents of Alaska, Hawaii, and Washington, the number is (206) 774-2481.)

In Europe, contact: Fluke (Nederland) B.V., P.O. Box 5053, Tilburg, The Netherlands. Telephone (013) 673973. Telex: 52237.

For immediate response, fill out the attached coupon.

FLUKE®

John Fluke Mfg. Co., Inc.
P.O. Box 43210
Mountlake Terrace, WA 98043

☐ Please have a salesman call.
☐ Please send 8020A Analyst data.

Name ____________________
Title ____________ Mail Stop ________
Company ____________________
Address ____________________
City ________ State ______ Zip ______
Telephone ( ) ____________ Ext. ______

El 6/79

*U.S. Price Only

For Technical Date, circle 209 on Reader Service Card
For Demonstration, circle 208 on Reader Service Card

from 0.05 μs to 0.2 s in 21 steps, and 12 settings are provided to cover the vertical sensitivity range of 0.01 to 50 V per division; verniers provide continuous adjustment of these parameters. The scope operates in alternate, chopped, and separate sweep modes, and traces can be triggered internally or by an external source.

The MS-230 comes with probes and a battery charger that permits operation from line. Accessories include a 10:1, 10-MΩ probe and leather carrying case.

The scope's price is $559. Deliveries, from stock, will begin in July.

Non-Linear Systems Inc., P. O. Box N, Del Mar, Calif. 92014. Phone (714) 755-1134 [356]

Dc-to-1-MHz amplifier puts out 75 W continuously

Taking an input signal whose frequency can vary from dc to 1 MHz, the model 7500 amplifies it to provide a continuous output of up to 75 W. Frequency response is typically flat to within 0.1 dB, and total harmonic distortion is less than 0.1% at full power up to 10 kHz.

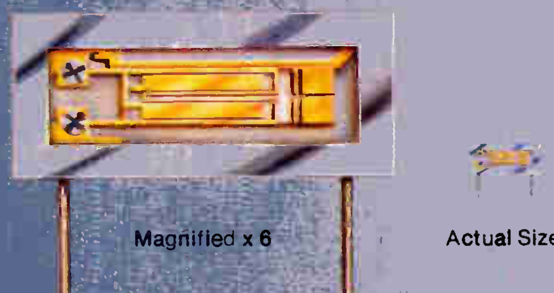
Front-panel controls let users select fixed gains of 20 or 40 dB or continuous gain variation from 0 to 40 dB, as well as dc or ac coupling of the input. Output power is provided by stacked, high-voltage transistors that are protected from shorts by a modified fold-back current-limiting technique.

The model 7500 is priced at $1,500. Delivery takes 30 to 60 days.

Krohn-Hite Corp., Avon Industrial Park, 255 Bodwell St., Avon, Mass. 02322. Phone (617) 580-1660 [357]

Our tiny new 68c* quartz crystals just made your dream product possible . . .

. . . because now you can abandon the old price and design limitations on precision oscillators.



With our new CX series low-frequency quartz crystals, you can now design ultra-accurate timing circuits that are even cheaper — overall — than LC and RC oscillators. They will fit in the smallest spaces in the roughest, toughest environments. And will give your product the prestige and glamour that accompanies the phrase "Controlled by Quartz Crystal."

CX crystals are an order of magnitude cheaper, smaller and stronger than any low-frequency crystal currently available. They come in frequencies from 350 kHz *all the way down to 10 kHz* — in the same miniature package!

Statek crystals are totally different from conventional crystals. The design is patented and they are made in California by advanced semiconductor-type processing techniques. And they incorporate everything we've learned from producing 17 million quartz crystals since 1973.

To discuss your application, write or call Jeff Upton at Statek Corporation, 512 N. Main, Orange, California 92668. (714) 639-7810.

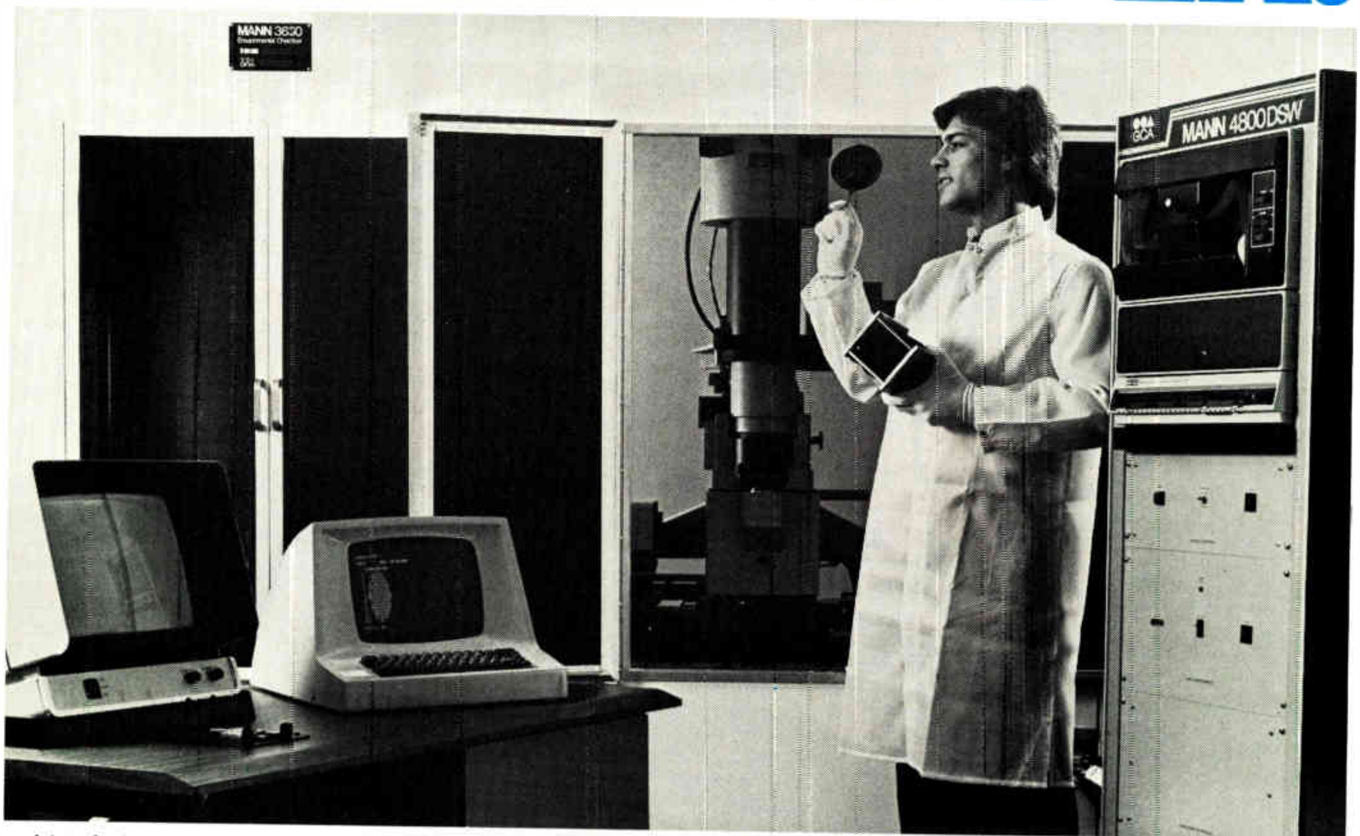
*Prices range from 68¢ to $1.17 in 100,000 quantity. See EEM and Gold Book for details.

STATEK *Innovators in Frequency Control*

[illegible] • FRANCE: [illegible] Cite des Bruyeres, Rue [illegible] • W. GERMANY: [illegible] Enatechnik GmbH [illegible] • NETHERLANDS: Tekelec Air[illegible] • SWITZERLAND: Dimos AG [illegible] • UNITED KINGDOM: Interface Quartz [illegible] 2578

Circle 26 on reader service card

THE DSW WAFER STEPPER.™



A lot of micro-imaging systems have delicate natures and complicated controls. But the DSW, for all its state-of-the-art sophistication, is remarkably rugged and surprisingly easy to use.

The DSW provides high throughput, high yield, day-in and day-out production.

You don't have to worry about daily adjustments. Once it's set to go, you just can't stop it.

You don't have to worry about wafer handling, either. It's automatic.

And no matter where you're located, we can give you immediate, on-the-spot service. Or we can train your own people to maintain it.

Over fifty systems have already been ordered by over twenty-five IC manufacturers. If you'd like to know why, ask us for literature. If you'd like to see why, ask for a demonstration. Write Bill Tobey at GCA/Burlington, 174 Middlesex Turnpike, Burlington, Massachusetts 01803. Or call him at (617) 272-5600. Telex: 94-9352.

GCA

GCA CORPORATION
Burlington Division
174 Middlesex Turnpike
Burlington, Mass. 01803
(617) 272-5600
Telex: 94-9352
Part of the GCA/IC Systems Group

WE MADE IT HARD TO BREAK AND EASY TO USE.

We can give you the power to solve a hot problem.

Heat is a rechargeable battery's biggest enemy. At about 45° C life starts to shorten dramatically. The new Polytemp™ is a NICAD® nickel-cadmium battery designed to take the heat and give long life. Satisfactory life to 70° C.

Polytemp's long life in high temperature applications makes it an ideal battery for backup power in memory circuits, emergency lighting and alarms, telephone and telegraph equipment, electronic instruments and process control equipment.

And Polytemp batteries have a unique negative electrode construction which means less voltage depression during overcharge than sintered nickel matrix types. A radial compression seal gives greater protection to surrounding circuits.

A battery that leads a hot life doesn't have to lead a short life. Now there's Polytemp from Gould. The company that makes more different types of batteries than anyone else in the world.

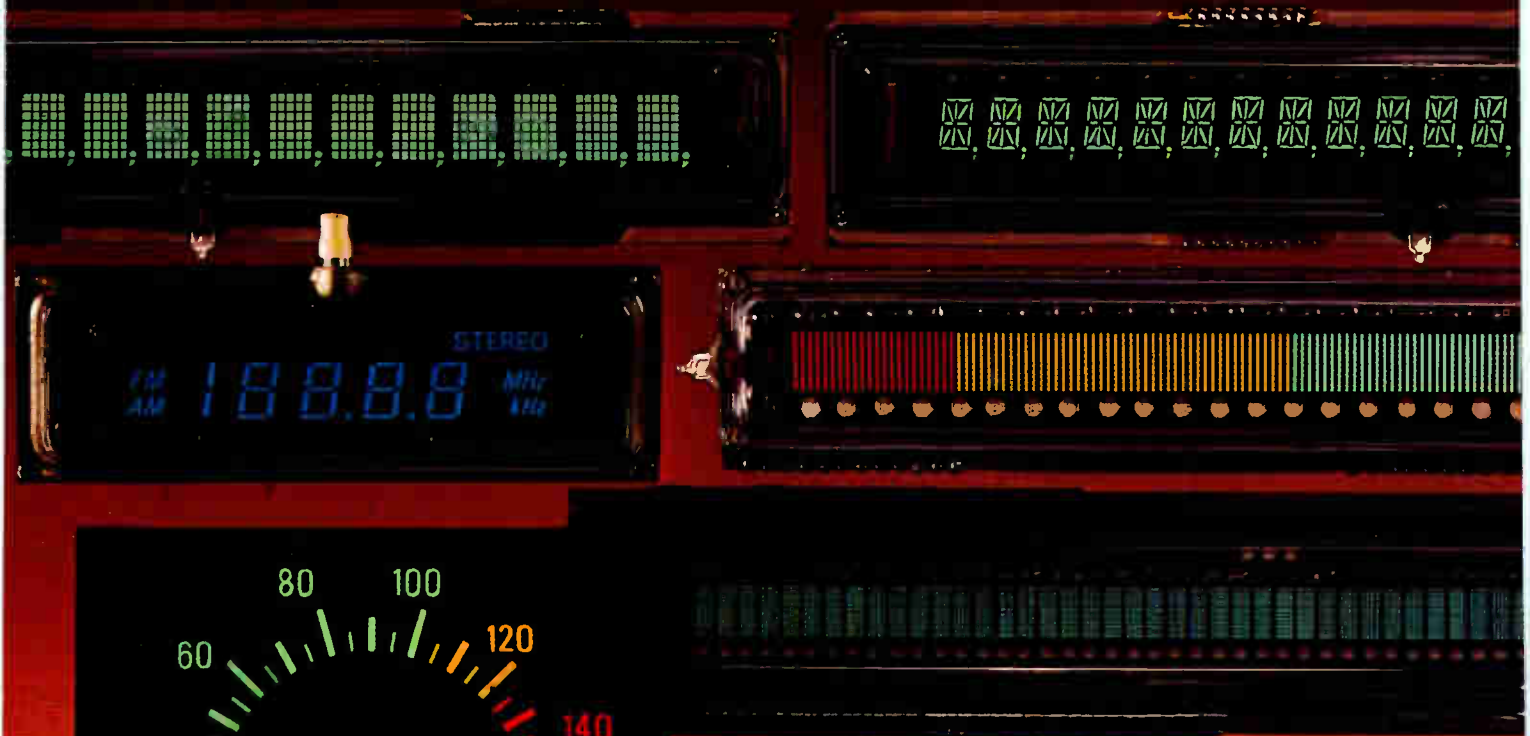
Available in sizes "½ AAA" to "F." (0.070 amp. hours to 7 amp. hours.) For complete design spec's write: Applications Engineering Mgr. Gould Inc. 931 Vandalia St. St. Paul, MN 55114

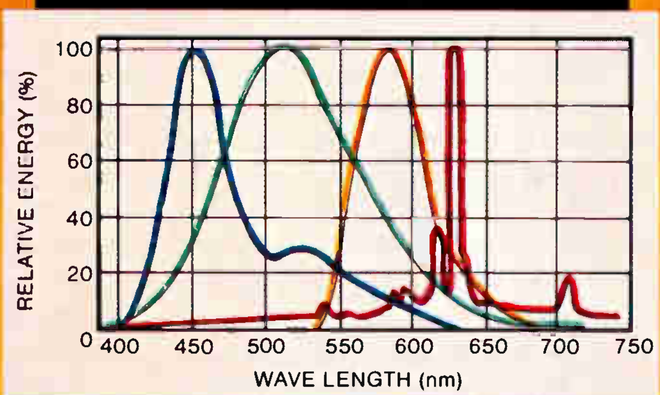
GOULD

An Electrical/Electronics Company

Circle 213 on reader service card

Make your readouts outstanding with the latest Itron innovations.





Multi-color configurations. Red, blue, yellow and blue-green arrays. 5 x 12 dot matrices for upper/lower case alphanumerics and 5 x 7 dot matrix displays. High density dot and bar graphic panels. 14-segment alphanumeric units. These latest, and all the other Noritake Itron advancements, are sure to open up new readout innovation opportunities for you.

And you'll realize all the advantages offered by Itron Fluorescent units over ordinary digital displays. Their cost-effective pricing and simple, fast installation will save you time and trouble, as well as a great deal of money. Interfacing with peripheral circuits is easy too; further reducing costs. They operate at low voltage and consume little power. Their bright fluorescent output and flat-glass packages make for easy readability, at a distance and at wide viewing angles, even under high ambient light conditions.

What's more, Itron displays have a proven long-life track record for reliable performance under stringent conditions. And we can quickly and economically fabricate custom configurations. Since there's much more you should know to make an optimum display selection, contact us for all the particulars.

itron®

FLUORESCENT DISPLAYS

Patented and manufactured by
ISE ELECTRONICS CORP.

INTERNATIONAL REPRESENTATIVES

WEST GERMANY: Neumuller GmbH, Eschonstr 2, 8021, Taufkirchen, Munich Phone. 089/6118-245 Telex. 522106

FRANCE: Europavia, France, 5 Avenue Leon Harmel 92167 Antony Cedex Phone. 666-21-10 Telex. 42204381

UNITED KINGDOM: ITT Meridian, West Road, Harlow, Essex CM20 2BP Phone. 0279-35351 Telex. 817202

SWEDEN: AB Nordqvist & Berg, Box 9145 S-10272, Stockholm Phone. 08-690400 Telex. 10407

HONG KONG: Phone 5-232420 TAIPEI: Phone. 351-0293

NORITAKE ELECTRONICS, INC.

L.A. OFFICE: 22410 Hawthorne Boulevard, Torrance, CA 90505, (213) 373-6704, Telex: 67-4910
N.Y. OFFICE: 41 Madison Avenue, New York, NY 10010, (212) 481-3440, Telex: 12-5469

NORITAKE COMPANY, LIMITED

JAPAN: 1 - 1 Noritake Shinmachi, Nishiku, Nagoya-Shi, (052) 561-7111, Telex: J59738
EUROPE: Burotel Belgium SA, Rue de la Presse 3-5, 1000 Bruxelles, (02) 217-83-60, Telex: 4626962

Circle 248 for demonstration
Circle 214 for literature only

New products

Communications

Phone system takes a message

Private branch exchange routes interoffice memos via its redundant computer

The common office phrase "take a memo" may soon join sleeve garters and green eyeshades if ROLM Telecommunications has its way. The ROLM electronic message system (REMS), available for evaluation in October, can send, process, store, and deliver interoffice memoranda via its CBX office telephone system.

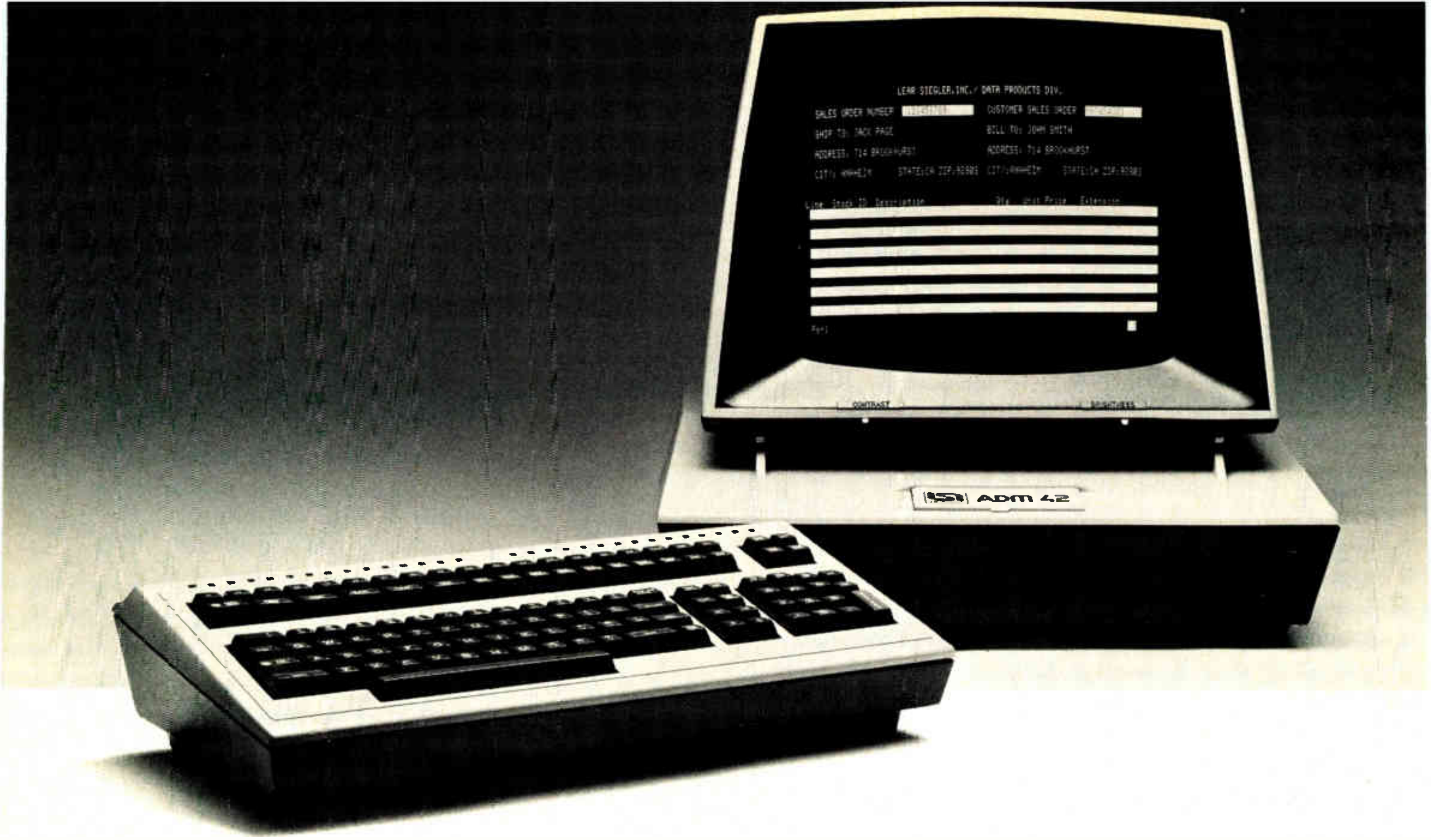
"The system integrates written communications with the phone system by connecting video display and hard-copy terminals to a message processor through standard office telephone wires," explains Richard Moley, vice president of marketing. "It's ideal for the short, five-to-ten-line memos that are so profuse in every office," he claims.

Users with the correct password can access the system; they can send and receive messages by plugging a video or hard-copy terminal into a ROLM digital telephone. The phone communicates with a redundant computer that can be added to ROLM's CBX system or purchased with it; the message system software turns it into an applications processor. Even while messages are being transmitted to the computer, the phone can still be used to make and receive calls.

ROLM believes that the cost of the system will more than be paid for by the time it saves executives. "It has been estimated that 95% of managerial work is devoted to written and oral communications," Moley states. "Studies have shown that for every 16 telephone conversations completed each day, an additional 41 calls are incomplete. The shadow functions of telephoning—misdials, busy signals, out-of-office, and the like—consume 8 to 10% of the time spent in communications activities, reaching a conservative average of 30 lost minutes per day."

In addition, the system should cut written communications to a minimum, thus saving significant amounts of time that would otherwise be devoted to memo preparation, executive-clerical interreaction, and clerical effort. "Information can be transferred from originator to recipient at the convenience of each," Moley observes.

Existing ROLM CBX systems that already have dual-processor control



Almost perfect.

Our new ADM-42 doesn't have quite everything. But it comes so close, you might never notice.

Because it's a complete, semi-intelligent terminal for just about any application you can name. And it does just what you want it to do, just when you want it done.

The ADM-42 is completely self-contained, and provides you with flexibility of format, security, editing, interface, and transmission. It also features a full two-page display as standard equipment. Not as an option. And it comes with a truly staggering array of options.

THE MORE YOU USE IT, THE SMARTER IT SEEMS.

We gave the ADM-42 a bright, easy-to-read 2000 character display. A full 128 ASCII character set. 16 function keys for 32 separate commands. And five separate cursor control keys.

The 42's behavior modification gives you a factory installed personality for an alternative ESC sequence lead-in — in addition to the standard ESC. And End Block character. A New Line character sequence. A field separator. And even a function sequence preamble.

Its status displays on the screen give you a conveniently wide range of information at a glance. While its special symbols indicate the entry of control characters in memory. Also, all control characters can be stored using the escape sequence or program mode. And the Field Protect Mode allows rapid data entry into forms or instruction pages.

THE ADM-42 WILL HAND YOU ANOTHER LINE.

The terminal's displayed data is formatted in 24 lines per page, 80 characters per line. And, to top it off, it comes with a 25th line established and reserved exclusively for status indicators and messages of up to 79 characters.

As if all this weren't enough, the ADM-42 has an impressive list of options. Like synchronous transmission with various line protocols. An extended memory capable of adding data space up to a maximum of 8 pages. And programmable function keys, to name but a few.

THE ADM-42 IS ONE TOUGH ACT TO FOLLOW.

The ADM-42 has just about everything. Including a microprocessor that increases reliability and ease of operation. Any way you look at it, in fact, it's one pretty smart buy.

So if you're thinking of upgrading to a more intelligent terminal, at a more than reasonable price, call us today. Or better yet, contact your local distributor.

We'll show you how easy it is to move up to the ADM-42.

The terminal that's so smart, you'll swear it's got a mind of its own.

ADM 42

Getting smarter all the time.

LEAR SIEGLER, INC.
DATA PRODUCTS DIVISION

Lear Siegler, Inc./Data Products Division, 714 Brookhurst Street, Anaheim, CA 92803; (800) 854-3805. In California (714) 774-1010. TWX: 910-591-1157 Telex: 65-5444.

Circle 216 on reader service card

need only terminals, a floppy disk system, the ETS-100 digital phone, and controlling software to become a REMS. Delivery of production systems will begin January 1980, and prices will depend on equipment needs.

ROLM Telecommunications, 4900 Old Ironsides Dr., Santa Clara, Calif. 95050 [401]

Terminal talks and listens on fiber optic lines

The M-3000 series consists of terminals for use with fiber-optic DS-3 transmission lines. The modular units contain two transmitters, two receivers, and two power supplies.

The terminals also house alarm, test, and auxiliary/local orderwire modules for fault diagnosis and system maintenance. They can work in conjunction with repeaters spaced at 6.5 to 9.5 km and in systems that require more than one protected DS-3 channel. The units are available either separately or as part of a complete fiber-optic system.

Harris Corp., Box 37, Melbourne, Fla. 32901. Phone Harry Blackford or David Hemmings at (305) 724-3600 [407]

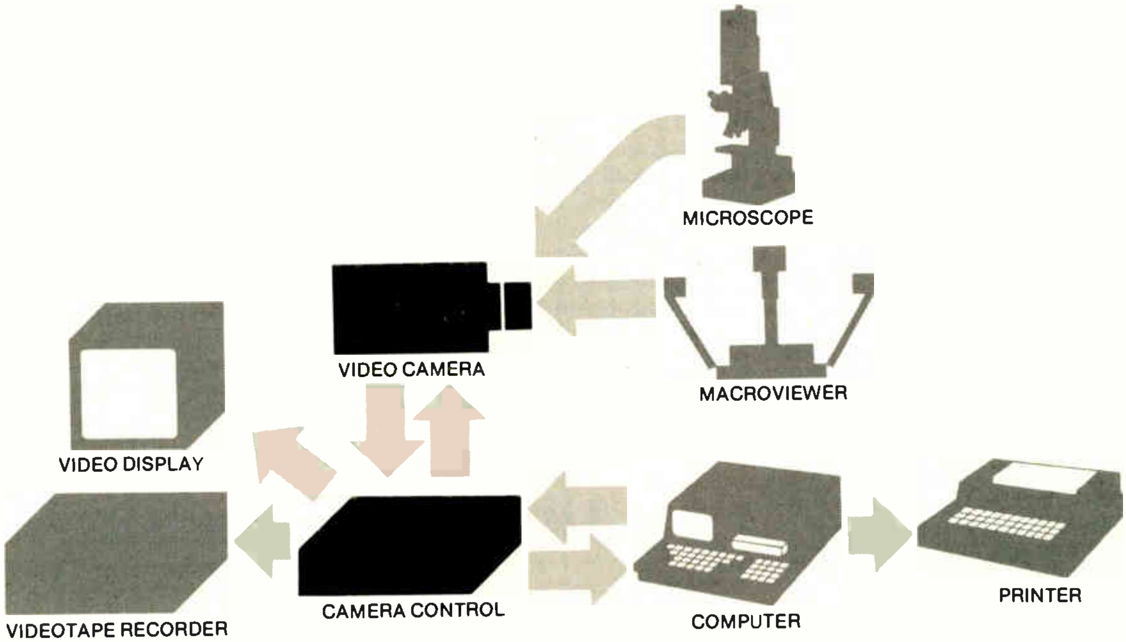
2-to-6-GHz GaAs FET matches 50Ω input lines

Few can resist a product that makes their work easier. Such a product is a gallium-arsenide field-effect transistor available in a 70-mil microstrip package (AT-8110) or as a 15-by-19-mil chip (AT-8111). The transistor, designed for low-noise amplification in the 2-to-6-GHz range, has an input impedance match of approximately 50Ω at 4 GHz. Therefore, designers need only a simple transmission line as the input circuit to a moderate-bandwidth amplifier.

At 4 GHz, the device has a noise figure of only 1.3 dB at a gain of 11 dB and +18-dB linear (1-dB gain compression point) output power. The latter feature is particularly useful in radar applications.

In small quantities, the transistor

C-1000 COMPUTER COMPATIBLE VIDEO CAMERA



Transfers visual information directly into your computer for processing and analysis • Repeatedly • Accurately • Conveniently

The C-1000 Camera solves the problem of converting visual images into digital data for image processing and analysis. Video data generated by the Camera is converted into a digital signal within the C-1000 control module. This signal then is transferred directly into your computer through a plug compatible interface.

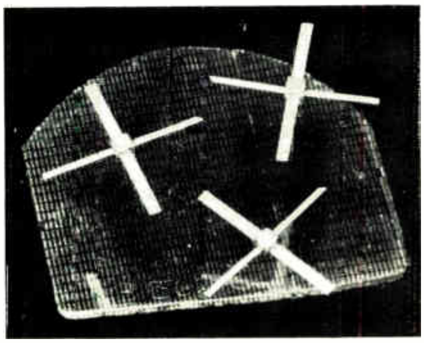
Standard interfaces are now available for most widely used minicomputers manufactured by Digital Equipment, Data General and Hewlett-Packard, plus personal computers, the IEEE 488 GPIB and others. One million data points and 256 gray levels provide your computer with precise video data automatically, directly.

Applications Include:
Particle analysis, inspection and quality control, production control, robot direction, medical and industrial research.

CALL OR WRITE FOR BROCHURE

HAMAMATSU

HAMAMATSU CORP. • 420 SOUTH AVENUE • MIDDLESEX, NEW JERSEY 08846 • (201) 469-6640



costs $130 in microstrip package and $110 in chip form. Delivery is from stock.

Avantek Inc., 3175 Bowers Ave., Santa Clara, Calif. 95051. Phone Bob Christensen at (408) 249-0700 [406]

SAW-dispersive delay lines come in standard sizes

Designed to increase resolution in maximum-range radar and frequency-agile spread-spectrum communications systems, the SAW-DDL series consists of standard surface-accoustic-wave(SAW)–dispersive delay lines (DDL). Units in the series

cover the range from 20 to 300 MHz.

The devices improve system resolution or reduce transmitter power by factors ranging from 15:1 to 350:1, according to the manufacturer. Insertion losses for the devices range from 30 to 55 dB. Typical sidelobes are 25 to 32 dB.

Units are available with either bandpass Taylor or flat weighting. They are designed for use with SMA connectors or for printed-circuit-board mounting and operate from −45° to +85°C. They range in size

Suddenly your last year's Electronics Buyers' Guide is as outdated as last year's phone book

1979 Electronics Buyers' Guide. Completely new listings of catalogs, new phone numbers, new addresses, new manufacturers, sales reps, and distributors! The total market in a book—four directories in one!

1.

Directory of products. Over 4,000 products, over 5,000 manufacturers.

2.

Directory of catalogs. Includes six post-paid catalog inquiry cards for 10-second ordering.

3.

Directory of manufacturers. Local sales offices, reps, and distributors, with phone numbers. Number of employees and engineers, dollar volume, name of company contact.

4.

Directory of trade names of products and their manufacturers. You can trace a product by its trade name only.

The only book of its kind in the field.

If you haven't got it, you're not in the market.

To insure prompt delivery enclose your check with the coupon now.

Electronics Buyers' Guide
1221 Ave. of the Americas
New York, N.Y. 10020

Yes, please send me ______ copy(ies) of 1979 EBG.

☐ I've enclosed $30 per copy delivered in the USA or Canada.

☐ I've enclosed $40 per copy for delivery elsewhere ($52 if shipped by Air).

Name ______________________

Company ______________________

Street ______________________

City __________ State __________ Zip __________ from 1 by ½ in. to 6 by 1½ in.

In 100-piece lots, standard devices range in price from $400 to $1,000. MIL-qualified devices are available, and, in addition, custom devices can be shipped in from 12 to 15 weeks. The delivery time for the standard devices is six to eight weeks.

Rockwell International, Electronic Devices Division, 4311 Jamboree Rd., Newport Beach, Calif. 92663 [405]

Transmission line tester can work at 20 megabits/s

As digital data links push to higher and higher transmission speeds, so must the equipment that tests them. A tester that can meet these demands is the model 604M data transmission test set. The unit can measure transmission line operation at rates up to 20 megabits per second with an external clock. It also monitors and displays bit errors, bit error rates, the number of errors per block and per second, and the test duration either in total number of blocks or seconds. The user selects block size, test duration, and the block or time thresholds that are part of the criteria for errors.

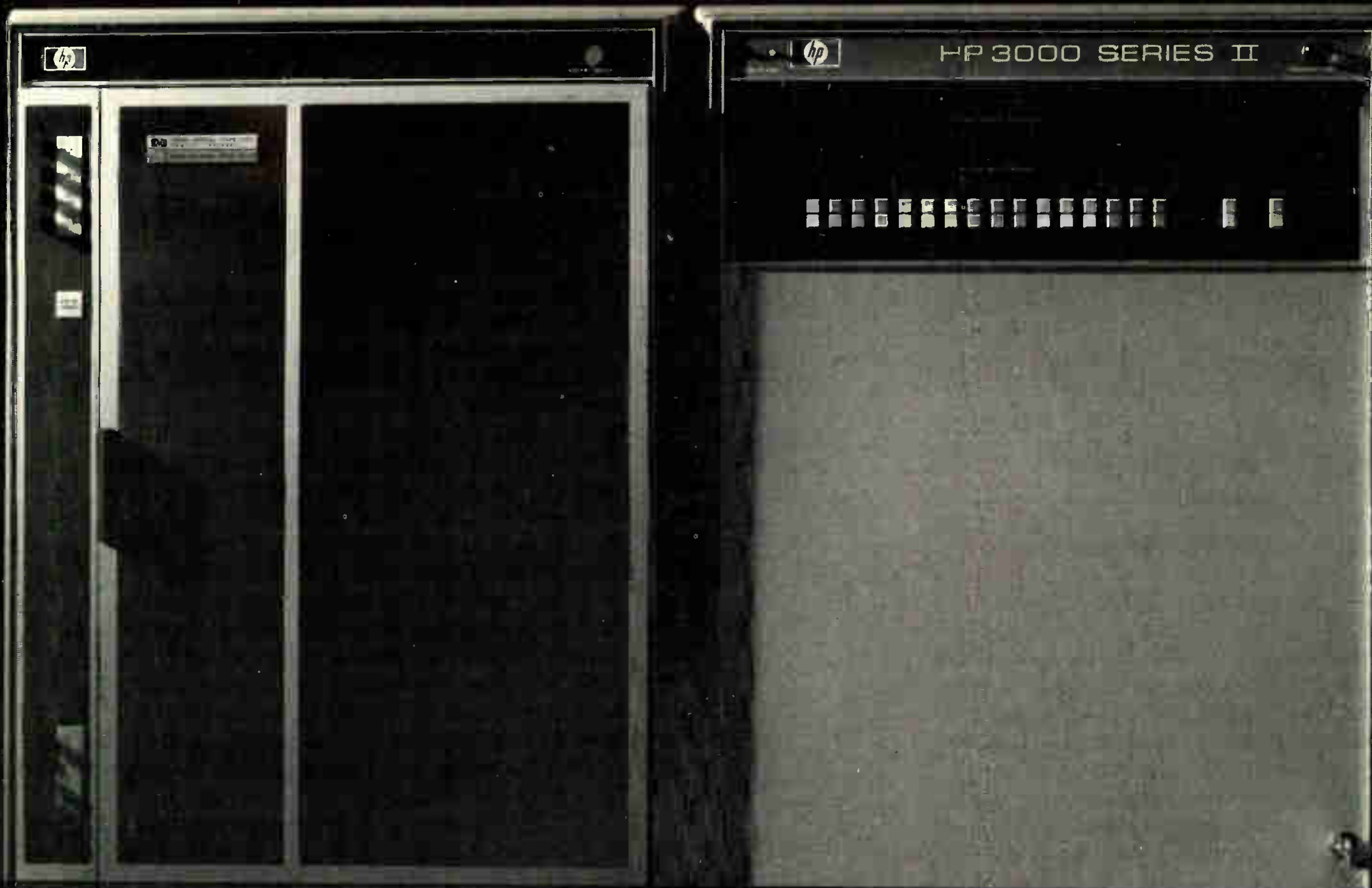
The tester generates pseudorandom patterns of 2^9-1, $2^{11}-1$, $2^{15}-1$, or $2^{20}-1$ bits; it also provides random words of 9, 11, 15, or 20 bits and repeating words: 1111, 0000, 1010, 1000, and 1100. Its 19 switch-selectable clock rates range from 1.2 to 12,928 kilobits/s and it accepts external clock rates from 10 bits/s to 20 megabits/s.

With its self-diagnostics, the unit can check for errors in its clock rate and data loopback, data insertion, and synchronization. Sync is automatically maintained even with 25% line error. The unit also provides a parallel binary-coded-decimal output for interfacing with a 10-column printer, as well as outputs for external counters and recorders.

In single quantities, the 604M is priced at $6,250.

Aydin Monitor Systems, 401 Commerce Dr., Fort Washington, Pa. 19034. Phone (215) 646-8100 [404]

Circle 69 on reader service card



WHEN HEWLETT-PACKARD WANTED TO PROTECT THEIR MEMORIES, THEY REMEMBERED US.

When a computer loses power, its volatile memory goes blank. Plain, simple, and costly.

It doesn't have to happen.

Because Gates Energy cells and batteries provide dependable standby power. They furnish the energy when the local power company can't.

That's why more and more major computer manufacturers are making Gates an integral part of their products.

Our energy cells have outstanding capability for float charging. So, they're always at peak power for emergency situations.

And, for portable instrumentation, Gates Energy cells offer safe, reliable sealed lead-acid construction and extended discharge service.

Learn more about Gates Energy. Send for our comprehensive information packet full of design data, spec sheets and application notes. Circle our Reader Service Number, or write us directly.

Gates Energy Products, Inc., 1050 South Broadway, Denver, CO 80217. Phone (303) 744-4806.

GATES ENERGY

"NEED DESIGN ASSISTANCE. HAVE ENGINEER CALL." Circle 222.
"SEND LITERATURE" Circle 70 EM-6

ELECTRONICS REPRINTS

No. of copies wanted

Articles

___ R-901 1979 world market survey and forecast 24 pp $4.00
___ R-829 Special report: New networks tie down distributed processing concepts 16 pp $3.00
___ R-827 Tackling the very large-scale problems of VLSI: a special report 15 pp $3.00
___ R-825 1978 technology update special issue $4.00
___ R-821 Codecs answer the call 18 pp $4.00
___ R-817 How bit-slice families compare 18 pp $3.00
___ R-816 Packaging technology responds to the demand for higher densities 9 pp $3.00
___ R-815 Higher power ratings extend V-MOS FETs' dominion 8 pp $2.00
___ R-813 Data-link control chips: bringing order to data protocols 10 pp $3.00
___ R-811 Multiplexing liquid-crystal displays 10 pp $3.00
___ R-809 New methods and materials stir up printed wiring 10 pp $3.00
___ R-807 Here come the big, new 64-K ROMs 14 pp $3.00
___ R-805 Why and how users test microprocessors 8 pp $3.00
___ R-801 World market report 1978 24 pp $4.00
___ R-734 Microcomputer families expand 20 pp $4.00
___ R-730 Special report—Automotive electronics gets the green light 10 pp $3.00
___ R-728 Flexible circuits bend to designers' will 10 pp $3.00
___ R-724 Special report—Technologies squeeze more performance from LSI 22 pp $3.00

Charts

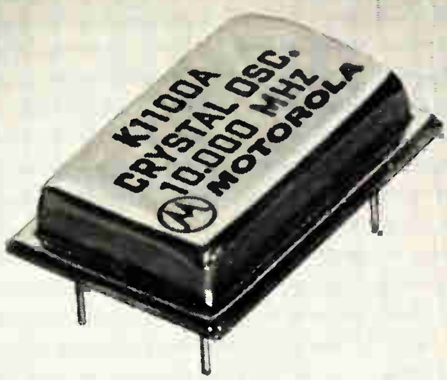
___ R-823 Communications satellites $3.00
___ R-516 Electronic symbols $2.00
___ R-213 Electromagnetic spectrum (updated 1976) $3.00
___ R-326 Optical spectrum (6-page report and chart) $3.00

Payment must accompany your order

Make check or money order payable to Electronics Reprints. All orders are shipped prepaid by parcel post. Allow two to three weeks for delivery. For additional information call (609) 448-1700 ext. 5494.

Mail your order to:
Janice Austin
ELECTRONICS REPRINTS
P.O. Box 669
Hightstown, N.J. 08520

GOOD AS GOLD.



Gold keeps the Motorola 1100 Series crystal clock oscillators on frequency longer.

In our 1100 series, the Motorola hybrid crystal clock oscillator is best in its class because it performs better and lasts longer —from 250 kHz to 70 MHz with a tolerance of ±1.0% to 0.0025%.

We ensure that our oscillators stay on frequency by using gold plating. Gold doesn't oxidize as rapidly as most other metals, and oxidation changes the mass on the crystals. When the mass changes, the frequency changes. You don't want that. Nor do we.

Because dust on a crystal will change the oscillator frequency, we assemble them in a Class 100 Clean Room. The atmosphere is controlled to keep dust out and hold the temperature and humidity at the correct level. And because we demand perfection, we grow our own perfect quartz. The result is an oscillator that stays on frequency longer. All this at a price that's lower than you'd expect.

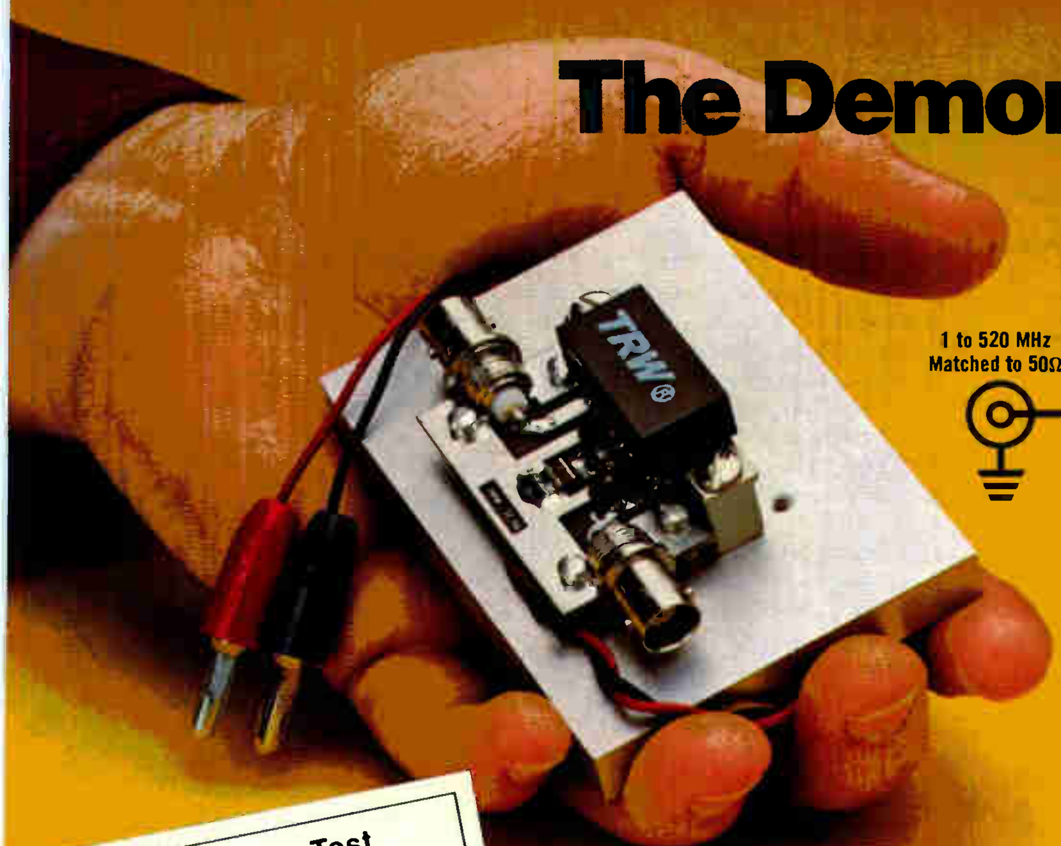
If only the best is good enough for you, we'll be happy to send you a price list, rep list, and more data than you'll find on any other oscillator data sheet. Call Barney Ill at (312) 451-1000, or write Motorola, Component Products Department, 2553 N. Edgington, Franklin Park, Illinois 60131.

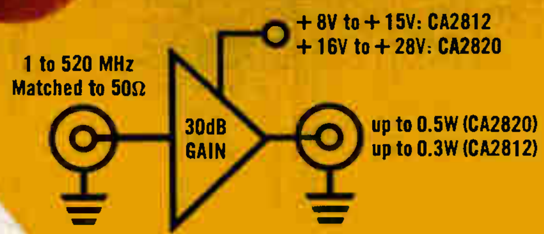
MOTOROLA INC. **Component Products**

Circle 224 on reader service card

Special wide band amplifier offer!

The Demonstrator





Evaluation Test Fixture and Wide Band Amplifier. A $126.25 value, ONLY $39 COMPLETE.* (limit one to a customer)

We want to show you that TRW's wide band hybrid amplifiers are ideal for all sorts of analog and digital applications. *The Demonstrator* will prove it to you. Instantly.

Whatever type of instrument or system you're working on, chances are you'll have to boost an RF signal somewhere—and with minimum distortion. Before you spend hours or days designing and debugging a discrete component amplifier, spend $39 and send for *The Demonstrator*. It's a special evaluation test fixture (worth $100) with a TRW CA2820 or CA2812 RF Linear Wide Band Hybrid Amplifier priced at $26.25, (25-99). Both are yours for only $39.00. Just plug in *The Demonstrator* and you'll see how well a TRW hybrid will perform in your application.

The hybrids feature linear phase response, 50dB reverse isolation and are available in a hermetic package. They're unconditionally stable into all load impedances. You can simplify your design and save PCB space. And our low, low OEM prices will slash costs.

What's more, if our wide band hybrid amplifier isn't demonstrably superior for your application, return *The Demonstrator* for a full refund, no questions asked. Send us your $39 or send for complete data sheets now. Or contact your local TRW Distributor. You can't lose.

*U. S. Price

TRW RF Semiconductors
An Electronic Components Division of TRW Inc.
14520 Aviation Boulevard, Lawndale, CA 90260

Enclosed is my purchase order or check for $39.00 for The Demonstrator. Send me the model checked: ☐ CA2812 ☐ CA2820

☐ Please send data information on TRW's complete line of thin film RF hybrid amplifiers.

NAME

MAIL STOP

COMPANY NAME

ADDRESS

CITY STATE ZIP

TRW RF SEMICONDUCTORS
ANOTHER PRODUCT OF A COMPANY CALLED TRW

Circle 225 on reader service card

New products

Packaging & production

Wire-wrap boards hold more ICs

For use with paging systems, boards offer higher ratio of off-board access per chip, too

As semiconductor manufacturers pack greater capability onto less silicon, mainframe makers increase the computational power of their products geometrically by cramming more chips onto each board. Augat Inc. sees this industry truism as a capital statement, and plans to profit with two series of wire-wrapped boards, the largest of which can hold up to 360 16-pin integrated circuits.

"That's double the number of ICs that could previously be put on a continuous plane," states Russel Petit, product manager for boards and packaging systems. Designated the PG400 and the PG300, the boards fit Augat's Horizontal and Vertical Paging Systems, which allow users to leaf through the boards for easy access while servicing them.

As chips increase in functional density, so the need for input/output access off board increases. "The normal I/O [to IC] ratio is 2:1," Petit says, "but these boards have a high I/O capability: about three I/O pins for each IC." At the top of each board, grouped in four blocks of six double-pin rows each, is a total of 960 feedthrough wire-wrappable pins that make it easy to connect the chips on board to external lines.

Both series of boards "are for bigger applications involving more than 180 ICs," Petit explains. The PG300 series boards can hold up to 360 16-pin dual in-line packages, while the PG400 boards can contain up to 315 DIPs with the same number of pins. Both series contain boards that can handle 40-pin packages as well as universally patterned boards that will take on a mixture of 16- and 20-pin DIPs.

The two-layer boards were designed also to maximize the copper foil area on the power and ground planes. To do so, all nomenclature was silk-screened onto the board, rather than etched on the plane, and the etching clearance around each pin was minimized.

Dc power entry is possible at two locations on each board. The user may decouple the power at these entry points, where there are holes for installing capacitors.

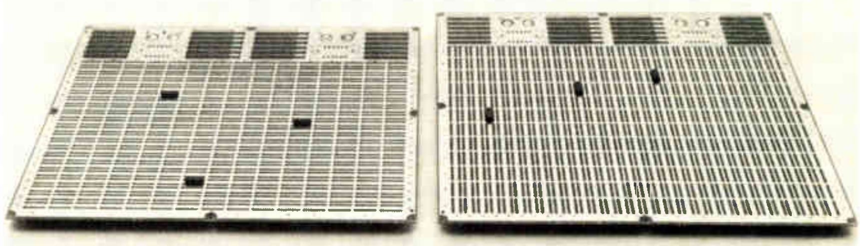
Petit expects that both series of boards will have military, industrial, and commercial applications and adds that boards for Schottky- and emitter-coupled logic are now in the works. The series also contains mirror-image boards for easier interconnection with facing boards.

The PG300 boards measure 15.3 in. wide by 16 in. deep and the PG400 units are 14 by 16 in. The former sell for $691.25 in quantities of 10 to 25 and, in the same quantities, the latter are priced at $584.75. Delivery time is six to eight weeks.

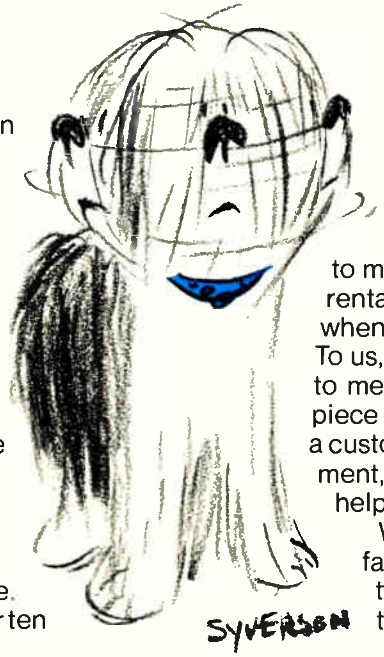
Augat Inc., 33 Perry Ave., P. O. Box 779, Attleboro, Mass. 02703. Phone Russel Petit at (617) 222-2202 [391]

Microwave conductors add adhesive to ease soldering

Designed for use in microwave circuits, these copper-foil conductive strips are coated on one side with a



If All Rental Companies Look Alike, How Do You Choose?



Need an oscilloscope or logic analyzer in a hurry? Do you have a short term need for a microprocessor development system? Chances are you've already discovered that renting the electronic equipment you need makes sense. But which rental company?

When you call Rental Electronics, you're tapping a multi-million dollar inventory of electronic equipment from Hewlett-Packard, Tektronix, Intel and every other major manufacturer. So we're sure to have what you need—even the newest equipment.

Our on-line real-time computer lets us give you immediate availability information while you're still on the phone. Even if what you need is at another of our ten stocking centers across North America.

Renting from Rental Electronics makes good economic sense, too. We're big enough to be as flexible as you need us to be, with competitive short term rates, lower rates for extended periods, even a selection of rental/purchase plans.

But there's an even better reason to make Rental Electronics your equipment rental company. It's called service. It starts when our rental experts answer your phone call. To us, service means going that extra step to meet your particular needs—for a special piece of equipment, a tight delivery schedule, a customized rental or rental/purchase arrangement, or just straight answers and a helpful attitude.

When it comes to service we're positively fanatical. And it pays off. During the past twelve months, for example, 92% of our first-time customers have come back for more.

Next time you consider renting, consider Rental Electronics. Give us a shot at your business. We're confident we'll turn you into a repeat customer.

Test and Measurement Instruments

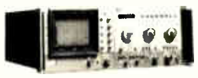
Here is just a small sampling of the test and measurement equipment available today from Rental Electronics. For a complete list, use the coupon opposite.

Hewlett-Packard 1640A Serial Data Analyzer. Identifies and locates failures to the component level; RSC 232C; 2048 characters, monitor buffer, plus 1024 characters transmit message buffer; Sync or Async.

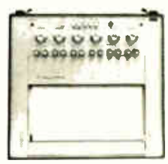
Biomation K 100 D Logic Analyzer. 16 channels; 1024 word memory; clock rates up to 100 MHz; signal timing resolution to 10ns; built-in display and keyboard control.

Honeywell 101 Recording System. 7 or 14 tracks depending on head assembly; ½ in. (7 tracks) or 1 in. (14 tracks) tape; 8 tape speeds from 0.937 ips to 120 ips; direct bandwidth to 2 MHz (wide band) and to 600 kHz (intermediate band); FM bandwidth to 80 kHz (wide band) and to 40 kHz (intermediate band); reel size 10½ to 15 in., coaxially mounted.

Tektronix 465 Oscilloscope. BW 100 MHz; display 8 x 10; 5 mV/div to 5 V/div sens.; sweep rate 50 ns/div to 0.5 s/div; x10 magnifier; dual trace; delayed sweep; x-y operation.



Hewlett-Packard 8565A/100 Spectrum Analyzer. 0.01 to 22 GHz with internal mixer; 14.5 to 40 GHz with 11517 external mixer; 100 Hz and 300 Hz resolution bandwidth; Absolute Amplitude Calibration: −110 dbm to +30 dbm.



Brush 260 Strip Chart Recorder. 1 mV to 500 V; chart speeds 125 mm/sec. to 1 mm/min., incl. four event markers; pressurized ink; response: DC to 100 Hz.

Rental Electronics, Inc.
An AMERICAL company

...a different breed.

thermoplastic adhesive that will not swell or ooze when heat from a soldering iron is applied to them. Rather, the manufacturer states, the adhesive liquifies and flows away from the soldering area when sufficient heat is applied.

At temperatures of 100°F, the adhesive softens and thus allows the elements to be repositioned. Their propagation characteristics are almost indistinguishable from those for etched lines of the same dimensions, making them useful for breadboarding, one-shot production units, repair, and other applications.

The elements come as lines, bends, and 16-lead flat-pack patterns. They are mounted on a plastic strip from which they are easily removed. Various types of design-aid kits are available including the 1000 introductory kit, with 30-, 60-, and 122-mil lines and bends and 10 16-lead flat-pack patterns, and the 1005 and 1006 (bulk) kits that come in sheets and rolls. The preformed kits cost $75 each and the bulk kits cost $36 (sheet) or $45 (roll) each.

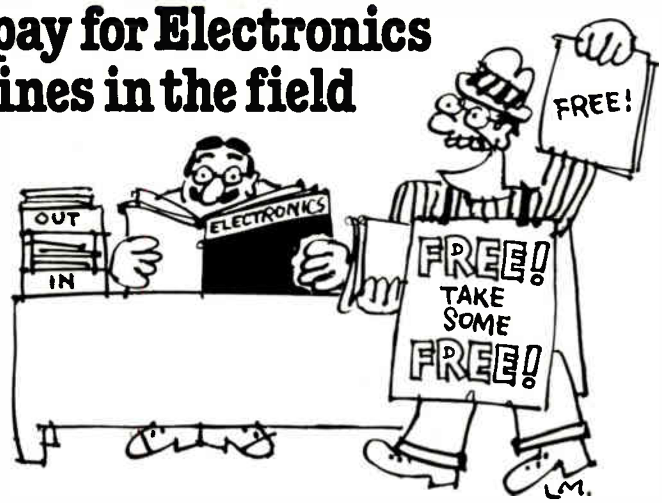
3M Co., P. O. Box 33600, St. Paul, Minn. 55133. Phone (612) 733-9214 [393]

Universal board has four power planes

The UMB is an epoxy-glass board with 0.043-inch plated through-holes and foil patterns on both sides. It incorporates four independent power planes that are each bused to as many as 264 pad positions.

The four power-distribution buses allow combinations of circuit types

Why should I pay for Electronics when other magazines in the field are free?



Think of it this way: Would the other publishers in the field give away their magazines if they could sell them?

Another question: Would 93,067* worldwide subscribers pay to read Electronics if it weren't a far better magazine than the "giveaways"?

And finally: If Electronics is worth your time (which you are investing in the magazine right now), isn't it worth 58 cents? That's the cost per copy based on a one year U.S. subscription. Based on our long-term subscriptions, the cost is even less.

Send in a subscription card from this magazine. If someone has beat you to them, write subscription department, Electronics, McGraw-Hill, 1221 Avenue of the Americas, New York, N.Y. 10020.

*ABC Publisher's Statement—June 1978

Electronics Magazine.
The one worth paying for.

New Pressure Transducer Catalog

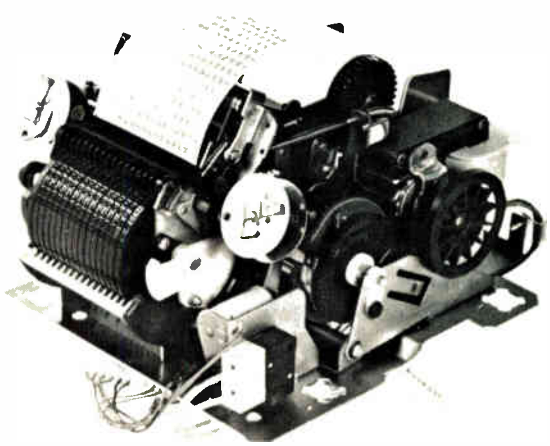
If you measure pressure, you'll want this condensed catalog. It describes a wide range of pressure transducers and related instruments. All units are built to exacting quality standards for reliable, trouble-free operation in the toughest environments. And at prices you have to like. Send for catalog of stock models.

DATA INSTRUMENTS INC.
Successor to TYCO Instrument Division

4 Hartwell Place, Lexington, Mass. 02173
617-861-7450 TWX 710-326-0672

Circle 215 on reader service card

Parallel Entry Printer



Prints 3 lines per second, 11 character locations per column with a capacity up to 16 columns. Numeric or limited alpha. Print mechanism is small (5¼" x 10" x 8").

Options available: Serial or parallel BDC interface
Attractive case
Power supply

ADDMASTER
CORPORATION

416 Junipero Serra Drive • San Gabriel, California 91776

Circle 204 on reader service card

to be used in both analog and digital applications. For example, in mixed digital applications, one side of the board can provide 0- and +5-volt power and the other distributes −15- and +15-V power. This reduces crosstalk between the power distribution planes.

Depending on the requirements of a circuit or system, dual in-line packages with as many as 66 pins can be accommodated on the board. Other packages that can be put onboard are 12 16-pin dual in-line packages, four 24-pin packages, or two 40-pin packages.

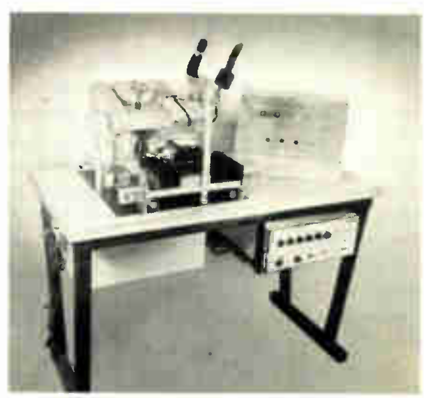
The construction of the board allows soldered circuits to be changed without destroying plated pad areas. The grid's 792 holes are spaced on 0.100-in. centers in both the X and Y axis. The 4.5-in.-by-4.0-in. boards sell for $11.90 each in quantities of 100. Delivery is from stock to six weeks.

Midgard Electronics, 175 California St., Newton, Mass. 02158. Phone (617) 964-4545 [394]

Automatic dicing saw has programmable index system

The Accu-Cut 5250 is an automatic saw system that is designed for the production dicing of alumina ceramic, glass, ferrites, silicon, and other semiconductor substrates. According to the company, the fully automatic system includes a programmable index system that eliminates operator error and allows a dramatic increase in throughput.

Mounted on a hydraulically driven



Step Up To 18-Bits

Hybrid Systems Introduces the Industry's First 18-Bit Hybrid Digital-to-Analog Converter

No matter where the application—land, sea or air—Hybrid Systems is the prime source for high reliability data converter products. And for 18-bit resolution in the smallest package, *prime* source means *only* source.

Our DAC374-18 is the only unit available that packs 18-bit resolution, ±0.0008% linearity and 50μS settling time into a metal 32-pin triple-wide hybrid package. It's a fraction the size, weight and power consumption of your next best choice. And with true hermetic sealing, it's a giant step forward in converter packaging.

DAC374-18. It's just the beginning. Eventually other suppliers will follow in our footsteps.

For performance, experience and reliability, go with the leader,

Hybrid Systems
CORPORATION

Crosby Drive,
Bedford, MA 01730
Phone (617) 275-1570
(TWX 710-326-7584 HYBRIDSYS BFRD)

In Europe: Hybrid Systems GmbH.
61 Darmstadt, Luisenplatz 4, Germany
Tel. 6151-291595
(TELEX 419390 HYSY D)

In the United Kingdom:
Hybrid (Component) Systems U.K. Ltd.
12A Park Street, Camberley, Surrey
Tel. (0276) 28128
(TELEX 858720 HYBRID G)

table, the saw system can accommodate blades up to 5 in. in diameter and accepts diamond wheels ganged in groups up to 4 in. in width. Using a ⅓ horsepower motor, the machine can cut dice as fast as 8 in. per second. It can index over 6 in. substrates and dice them in 0.005 in. increments.

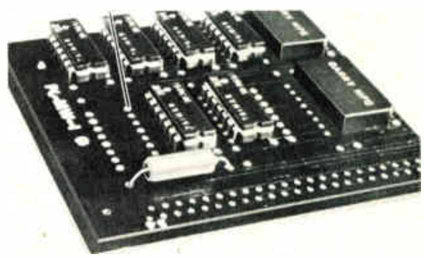
The 5250 system sells for $10,990 and delivery time is 8 to 10 weeks.

Aremco Products Inc., P. O. Box 429, Ossining, N. Y. 10562. Phone Herbert Schwartz at (914) 762-0685 [395]

Terminal converts plated through-hole to socket

This precision-spring terminal will convert any plated through-hole in a printed-circuit board into a plug-in socket. Called the Spring-Loc terminal, the device replaces the conventional IC socket receptacle with a gas-tight, solderless termination that permits easy removal of components without the usual desoldering problems.

Spring-Loc terminals produce holes larger in diameter than plated

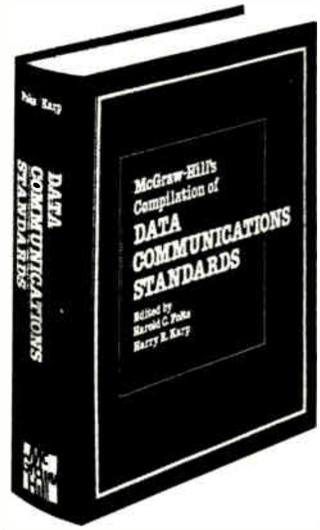


through-holes for component and integrated-circuit leads. This allows for increased tolerances in pc board automatic component-insertion equipment. The terminals can be loaded and seated at a rate of 1,000 terminals per minute and are replaceable. They are made of spring-tempered beryllium copper.

Depending on quantity, the devices sell for from $15 to $50 in thousands. Upon receipt of order, delivery time is two to four weeks.

Garry Manufacturing Co., 1010 Jersey Ave., New Brunswick, N. J. 08902. Phone Harry A. Koppel at (201) 545-2424 [396]

Instant access to all American and International Data Communications Standards



Data communications standards are undeniably necessary and helpful. But... the proliferation of standards by the many committees and groups has left the data communications equipment user and designer searching through numerous publications to find the applicable standards for each job.

Now: that time- and effort-wasting trial is over.

With the publication of this landmark resource, you can quickly and accurately determine exactly which standards apply to the project at hand, and speedily integrate those standards into your own network requirements.

Presents all relevant data communications standards promulgated by:

- Consultative Committee for International Telephone and Telegraph (CCITT)
- International Organization for Standardization (ISO)
- American National Standards Institute (ANSI)
- Electronic Industries Association (EIA)
- Federal Telecommunications Standard Committee (FTSC)

Need to know the latest standards for...

- data transmission over public data networks?
- computers and information processing systems?
- peripheral equipment?
- signal quality and analog and digital interfaces?

It's all here, and more, complete with introductory descriptions of the groups that promulgate the standards... and relational charts of similar interfacing standards produced by different groups.

Edited by
HAROLD C. FOLTS, data communications standards consultant; and
HARRY R. KARP, Editor-in-Chief, *Data Communications*, McGraw-Hill Publications Company
1133 pages

Design Engineers
Find the technical specs you need instantly.
Planning Engineers
Determine which standards apply to a vast range of networks and components.
Operations Managers
Learn whether the equipment you're buying will operate at all applicable standards.

Order today using this coupon!

Return coupon to:
Data Communications Standards
P.O. Box 669
Hightstown, New Jersey 08520

McGraw-Hill

Send me _______ copy (copies) of **DATA COMMUNICATIONS STANDARDS** (099782-9) on a 10-day money-back guarantee. I understand that if I am not absolutely satisfied, I may return the book(s) within ten days at no further obligation. Otherwise, McGraw-Hill will bill me $165. for each copy, plus applicable sales tax, shipping and handling charges.

Name ______________________
Title ______________________
Company ______________________
Address ______________________
City ____________ State ____________ Zip ____________

SAVE MONEY! Enclose payment in full, plus local sales tax, and McGraw-Hill pays all regular shipping and handling charges. Ten-day money-back guarantee still applies.

_____ Check enclosed _____ Bill me _____ Bill my company _________ Company purchase order #

This offer subject to acceptance by McGraw-Hill.

EL 1

Siemens adds fast ECL RAMs for computers

Looking to fill sockets in large mainframe computers, Siemens AG of West Germany is expanding its line of emitter-coupled-logic random-access memories. **On tap are a 1,024-by-1-bit device with an 18-ns access time and a 1,024-by-4-bit RAM with a 20-ns access time.** The former comes in two versions—the GXB10415 and GXB100415—whose supply voltage and input/output levels are identical with 10K and 100K specifications, respectively. They sell for about $25 each in 100-unit lots with 16-pin dual in-line ceramic or plastic packages. The 4-bit version, GXB100475, is compatible with 100K specifictions. It comes in a 24-pin ceramic flatpack or plastic DIP and sells for $100 apiece in 100-unit lots. Both RAMs will be available in the U. S. shortly.

BCD-output instrument hooks to Keithley DMMs

For $130 it's possible to convert the displayed reading of some of Keithley Instruments Inc.'s digital meters to **an electrically isolated, latched, and buffered parallel binary-coded-decimal format.** The Cleveland company's model 1792 will operate in the field or factory with the 179 digital multimeter (combined price $429), the 177 DMM (combined price $529) and the 480 digital picoammeter (combined price $459). Additional data includes sign, overrange, and busy (update in process). The 1792 is available from stock.

Four-bit-slice microprocessor is 23% to 26% faster

National Semiconductor Corp., Santa Clara, Calif., is introducing the third generation of the popular 2901 4-bit-slice microprocessor. The IDM2901A-2 is a good deal faster than its predecessors, though it is not meant to replace the second-generation IDM2901A-1. **Due to be available in sample quantities in August, the A-2 can perform a simple addition in 67 ns and a complex addition and shift in 78 ns.** In comparison, the A-1 handles these tasks in 87 and 105 ns, respectively. Prices for the Schottky-Coupled-Logic device in ceramic packages are $16.50 each for 100 or more and $13.10 apiece in plastic packages for the same quantities. With cycle times of 60 to 80 ns, the 2901A-2 is 45 to 65 ns faster than the recently announced low-power Schottky 2901B. National is planning to introduce new microsequencer products and applications aids later this year to make it easier for users to employ complex double-pipelined architecture when designing bit-slice–based systems.

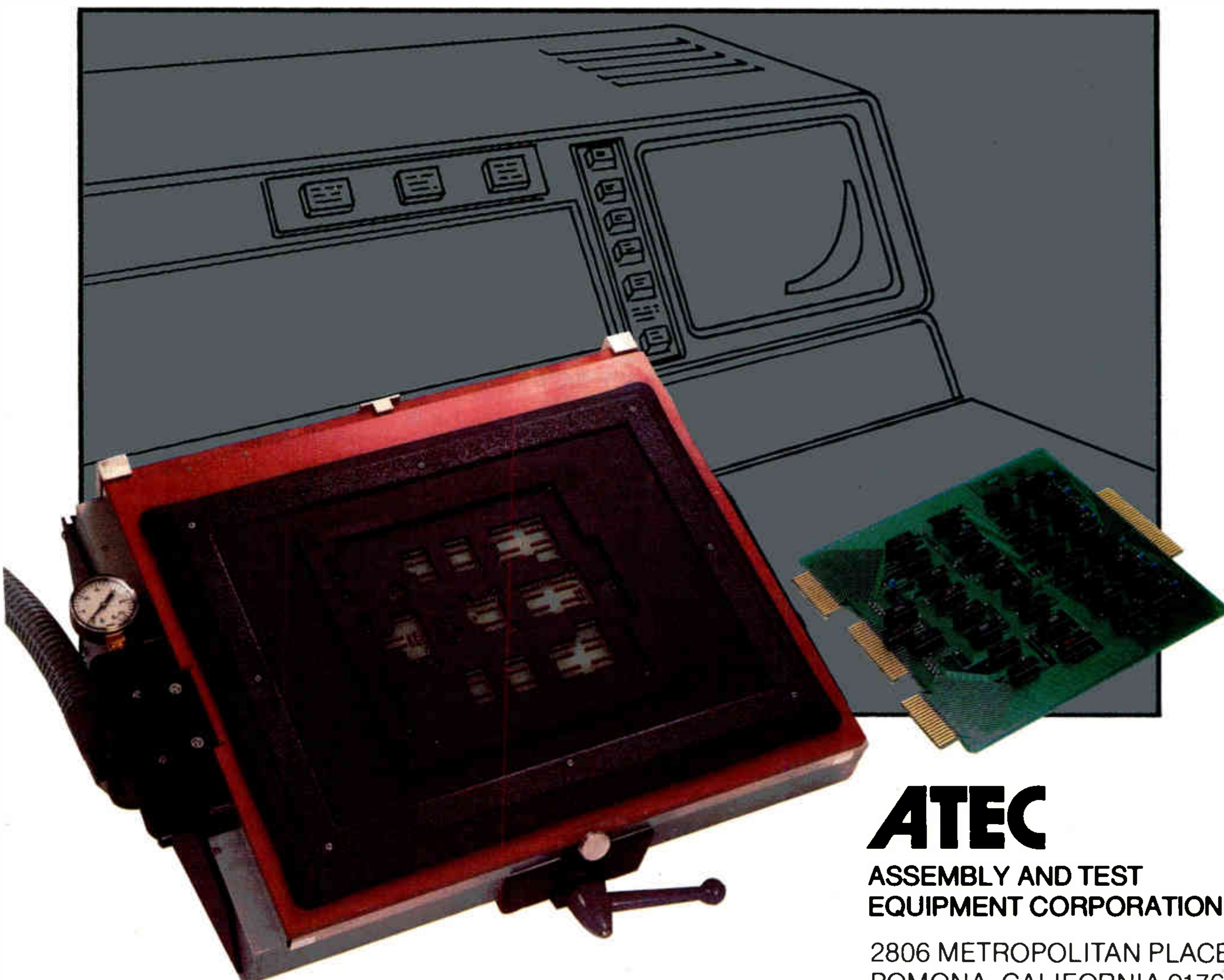
HP and IBM lead memory price war

Prices for computer main memory are continuing their downward slide. Hewlett-Packard Co. used to have the industry's lowest prices until IBM introduced memory selling for $15,000 per megabyte with its 4300 computers [*Electronics*, Feb. 15, p. 85]. But this month HP's Cupertino, Calif., Data Systems division is lowering prices on main memory for its HP 1000 line of computers. **Standard-performance memory (595-ns cycle time) without error correction is now $18,000 per megabyte, down 43% from the previous $32,000 price; the error-correcting version is $23,000, down from $37,000.** The faster memory (350-ns cycle time) is tagged at $22,000, a reduction of 35%; with error correction, it now sells for $26,000, some 41% less than before. One catch—these prices don't apply to the company's HP 3000 line of computers marketed by the General Systems division.

WHATEVER TEST SYSTEM YOU'VE GOT . . . WE'VE GOT THE "*Perfect Mate*"

You've got the test system and the products to be tested. We've got the perfect way to mate them to assure a highly reliable test. The Series 33 Test fixturing system accepts a variety of product sizes by simply changing the test head on the interface adaptor. No other interface adaptor needed to access boards of up to 10" x 14", 16" x 18" or 20" x 24".

BY ATEC
AN EVERETT/CHARLES COMPANY



ATEC

ASSEMBLY AND TEST EQUIPMENT CORPORATION

2806 METROPOLITAN PLACE
POMONA, CALIFORNIA 91767
714 593-2541
TWX 910-581-3838

E/C EVERETT/CHARLES, INC

THE EVERETT/CHARLES COMPANIES:
The names are new the service and quality traditional.

New products/materials

A two-part epoxy adhesive, Eccobond 104, may be used at temperatures up to 450°F (232°C) and for short periods up to 550°F (288°C). The material contains no solvents or

volatile matter and is suitable for bonding a wide variety of porous or nonporous materials. It adheres well to such materials as aluminum, stainless steel, carbon steel, brass, ceramics, glass, and many thermoset plastics. Eccobond 104 sells for $8.45 per lb in 10-lb quantities.

Emerson & Cuming Inc., Dielectric Materials Division, Canton, Mass. 02021 [478]

A mineral-reinforced nylon is believed by the Du Pont Co. to be the toughest material of its kind. The engineering thermoplastic, Minlon 12T, is under development for use in power-tool housings and computer-tape reels. Compared with the toughest mineral-reinforced nylons now available, Minlon has a Gardner impact two times greater at 290 in.-lb and a notched Izod of 2.4 ft-lb/in. versus 1.5 for others. The notched Izod impact test shows it to be 60% stiffer and 140% tougher than unmodified nylon. Minlon 12T can be processed in conventional molding machines at a cycling rate sometimes 20% to 40% higher than that required for most other reinforced thermoplastics.

Some specifications for the nylon include a tensile strength of 11,500 psi when measured in dry air and 8,800 psi at 50% relative humidity. The flexural modulus is 665,000 psi and 255,000 psi, respectively, under the same conditions. The melting point of the material is 256°C (493°F). Minlon 12T sells for $1.03 per pound in large quantities.

Du Pont Co., Room 37270-PA, Wilmington, Del. 19898 [479]

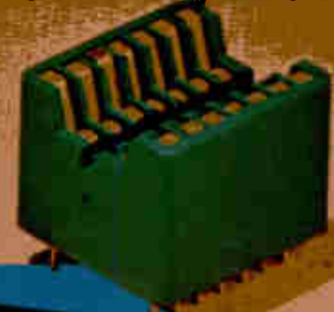
Whatever you need in an IC socket...
RN has 'em all!

—and with "side wipe" reliability

PRODUCTION SOCKETS

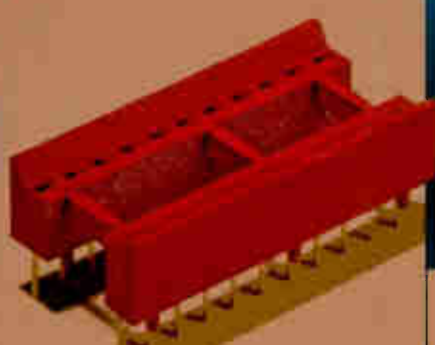
BURN-IN, TEST SOCKETS

NEW! ICL Series
26% lower profile—.150" Ideal for high density, high volume configurations, provides maximum vibration resistance. Solder type, single leaf "side-wipe" contacts. 8 to 40 contacts.



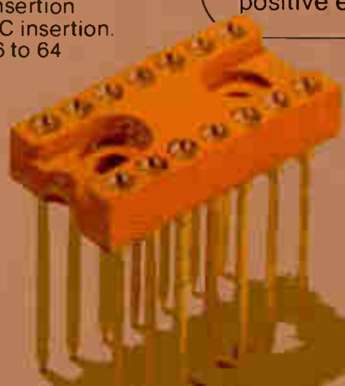
TS Series
very long contact life. Very low insertion force. Ideal for incoming inspection. With 14 to 40 contacts. Also strip sockets up to 21 positions.

RN HIGH RELIABILITY eliminates trouble. "Side-wipe" contacts make 100% greater surface contact with the wide, flat sides of your IC leads for positive electrical connection.

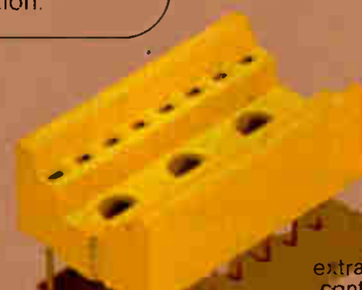


ICN Series high reliability general-purpose sockets. Low insertion force allows automatic IC insertion. In solder or wire-wrap. 6 to 64 contacts. Dual leaf "side-wipe" contacts.

IC Series
moderate cost, long life. Designed for general test and burn-in up to 350°C. With 14 to 40 contacts.



ICA Series
high reliability pin socket contacts. Low profile in solder or wire-wrap. 8 to 40 contacts.



ICN/S2 Series
lowest cost burn-in socket available. Designed to accept IC extraction tool. With 8 to 40 contacts, with strip sockets up to 25 positions.

WRITE TODAY for latest R-N "Short Form" Catalog...

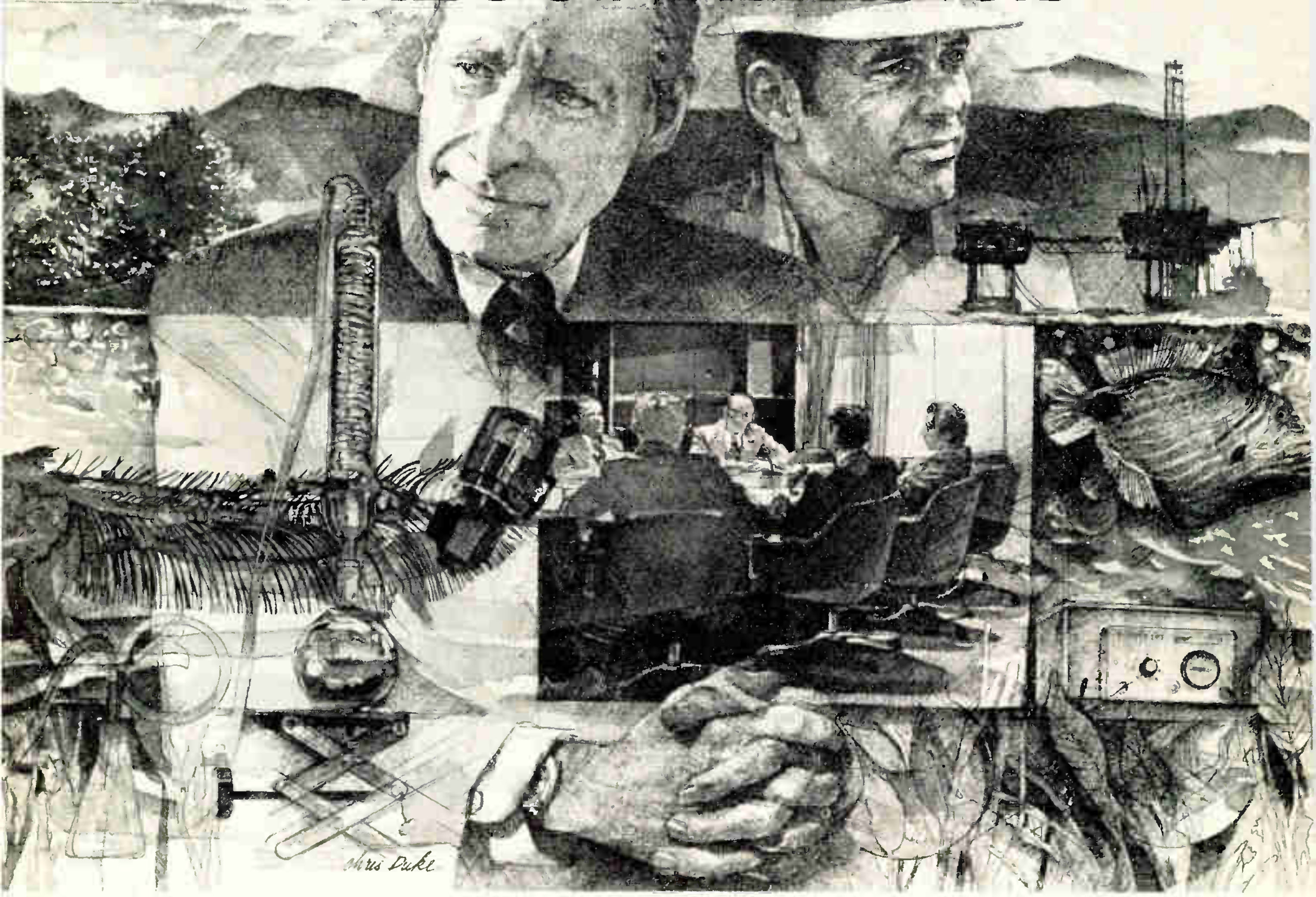
... of R-N production DIP sockets. Contains full specs, dimensions and material data. Get yours now.

RN® ROBINSON NUGENT, INC.

ROBINSON-NUGENT, INC. • 800 East Eighth Street • New Albany, Indiana 47150 • Phone: (812) 945-0211

THE EXPERIENCE OF THE GEOLOGICAL SURVEY WITH THE

TELECONFERENCE



There's an unusual teleconference network in operation at the Geological Survey—the first of its kind. In its initial six months of operation, this network saved enough in travel to equal its cost.

Steve Frantz, Bell System Account Executive assigned to the Geological Survey's Conservation Division, explains: "Every Monday morning, the division managers in Reston, Virginia talk to field staffs at four regional offices.

"They conduct a meeting—a teleconference.

"These key people from Reston carry on a round table review of new policy, new regulations. In turn, the field people report in on their programs, problems, and needs.

"All this means that management has more effective control and can react faster than before.

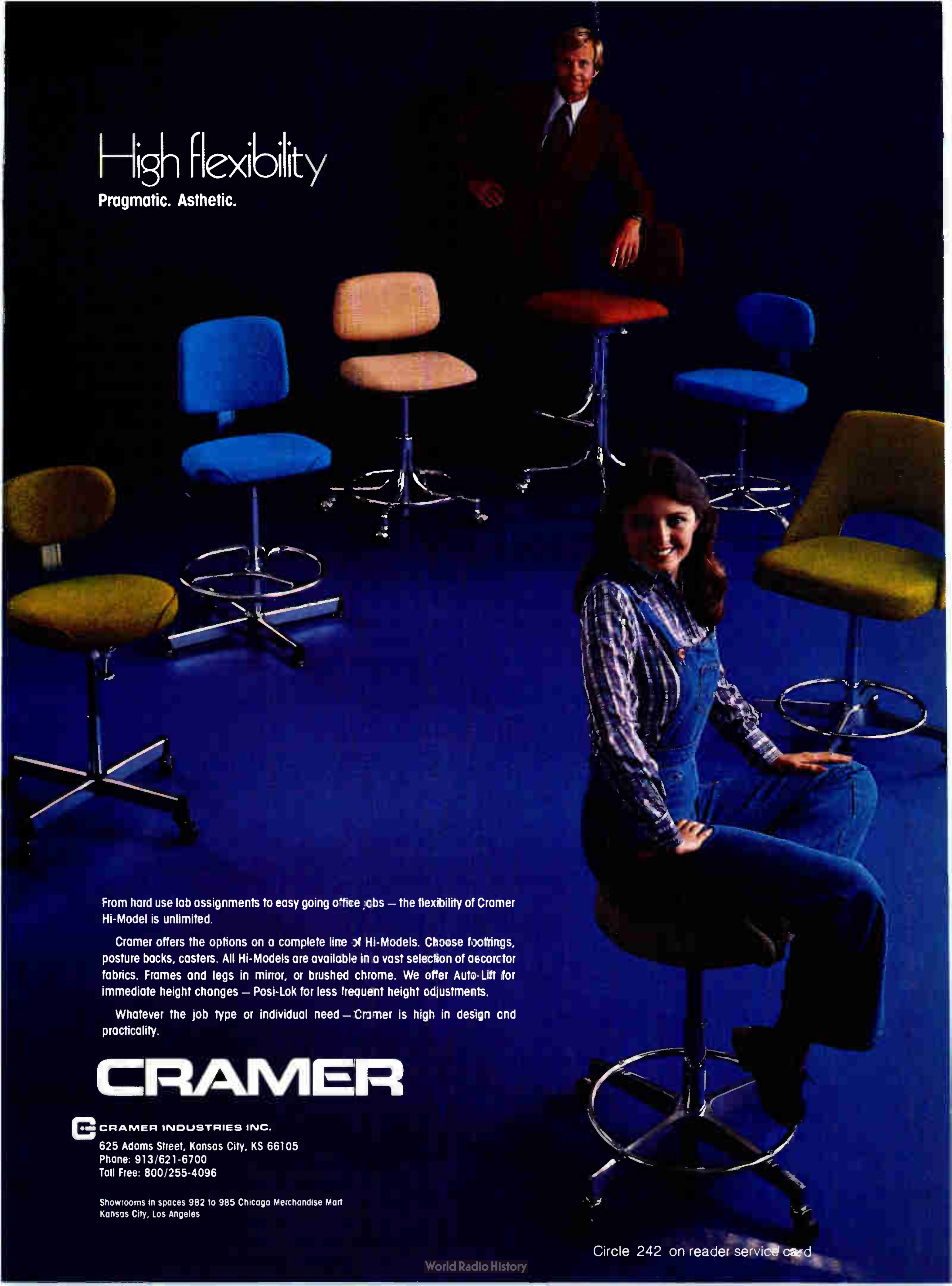
"It means that travel is reduced—and with it, travel costs. Instead of being seated in an airplane, people remain seated at their desks.

"Another unusual thing about this network," Mr. Frantz points out, "is that you can dial a point outside the circuit. So it's easy to call a field location as remote as Alaska. And add it to the conference."

To get the same kind of help that the Geological Survey got, talk to your problem-solving Bell Account Executive. The Account Executive can bring Bell expertise to your problem and is the point of contact that opens the resources of the Bell System to your needs.

Bell System

Circle 240 on reader service card


High flexibility
Pragmatic. Asthetic.
From hard use lab assignments to easy going office jobs – the flexibility of Cramer Hi-Model is unlimited.
Cramer offers the options on a complete line of Hi-Models. Choose footrings, posture backs, casters. All Hi-Models are available in a vast selection of decorator fabrics. Frames and legs in mirror, or brushed chrome. We offer Auto-Lift for immediate height changes – Posi-Lok for less frequent height adjustments.
Whatever the job type or individual need – Cramer is high in design and practicality.
CRAMER
CRAMER INDUSTRIES INC.
625 Adams Street, Kansas City, KS 66105
Phone: 913/621-6700
Toll Free: 800/255-4096
Showrooms in spaces 982 to 985 Chicago Merchandise Mart
Kansas City, Los Angeles
Circle 242 on reader service card

Micro power

Touch Tone® detection in MOS-LSI. That's Rockwell Micropower.

CRC-8030, Rockwell's MOS-LSI digital Touch Tone® detector, provides a low-cost, high performance solution for dual tone multi-frequency (DTMF) detection.

A product of Collins high-technology telecommunications experience coupled with Rockwell's extensive MOS-LSI production capability, CRC-8030 has been in quantity production for three years. Besides telephony systems, it is being used in terminals for signaling and in control systems.

CRC-8030 reduces costs (in some cases as much as one fifth the cost) and adds LSI size and reliability benefits. You get: detection in 22-39 MS; on-chip oscillator operating at 3.579545 MHz color burst crystal frequency; binary or 2-of-8 coded outputs; operation with single or dual power supply.

The CRC-8030 performs the key critical functions of DTMF detection. To implement a complete DTMF receiver, a number of front-end band-split filters are available. And, if you need DTMF to dial pulse conversion use the CRC-8030 in conjunction with Rockwell's MOS-LSI Binary-to-Dial Pulse Dialer, the CRC-8001.

For more information, contact your nearest Hamilton/Avnet distributor or write Dept. 727- F7 Microelectronic Devices, Rockwell International; P.O. Box 3669, Anaheim, CA 92803 or phone (714) 632-3729.

Touch Tone is a registered trademark of AT & T.

Rockwell International

...where science gets down to business

New literature

Power converters. Information on more than 1,000 power converters, including dc-dc types that can handle up to 150 watts of power, miniature hybrid converters, and ac-dc single- and triple-phase converters handling up to 200 W of power, is given in a catalog. Tecnetics Inc., 1625 Range St., P.O. Box 910, Boulder, Colo. 80306. Circle reader service number 421.

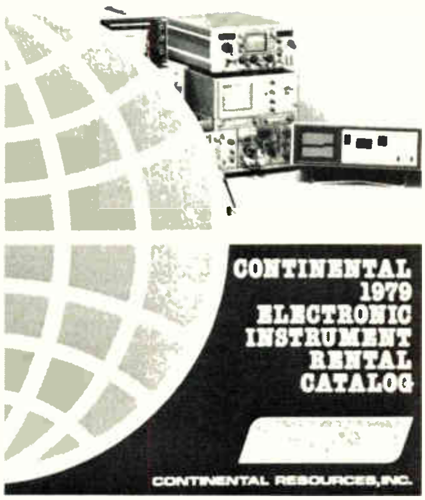
PROM. The "PROM User's Guide" is divided into two sections. The first, "Selecting a PROM," goes briefly into the technology and structure of erasable and nonerasable programmable read-only memories, diode arrays, field-programmable logic and gate arrays, and programmable-array logic devices. This section also contains selection aids that tabulate and cross-reference commercial and military part numbers, configurations, and pinout patterns for all programmable devices. The 94-page guide's second section, "Selecting a PROM Programmer," deals with manual and automatic programming methods, design and service environment considerations, and equipment selection criteria. This guide is available at no charge when requested on company letterhead from Pro-Log Corp., 2411 Garden Rd., Monterey, Calif. 93940 [422]

Business computing. Business Computing Press is offering two publications that can instruct businessmen and professionals on effective use of microcomputers in business. "Business Computing Review" provides detailed reports on business computers and applications software and reviews major products. The second publication, "Evaluating Small Business Software," enumerates characteristics needed in software packages. Specific criteria are provided for general ledger, accounts receivable, accounts payable, payroll, and inventory control packages. "Business Computing Newsletter" is sent to subscribers of "Business Computing Review" and is also available free of charge at computer stores around the country. "Business Computing Review" is obtainable at an annual subscription rate of $25 and "Evaluating Small Business Software" sells for $15 per copy. Both are available from Business Computing Press, P.O. Box 55056, Valencia, Calif. 91355

Keyboards. A line of keyboard pads that can accommodate either 12 or 16 keys, configured in either a three-by-four or four-by-four array, is described in a 20-page catalog. In addition, the catalog mentions pushbutton switch modules that can be stacked in an array on the keyboard to customer specification. The modules contain either one, two, three, or six buttons. Features, specifications, and ordering information are provided for each type of keyboard pad. Diagrams are also included. Grayhill Inc., 561 Hillgrove, La Grange, Ill. 60525 [424]

Computer security. Thirty-two studies and reports dealing with computer security are catalogued in "Computer Security Publications," a 14-page bibliography. Topics discussed include cryptography, data-base security, general computer security, network security, and security controls and safeguards. The National Bureau of Standards Institute for Computer Sciences and Technology, Administration A200, Washington, D. C. 20234 [425]

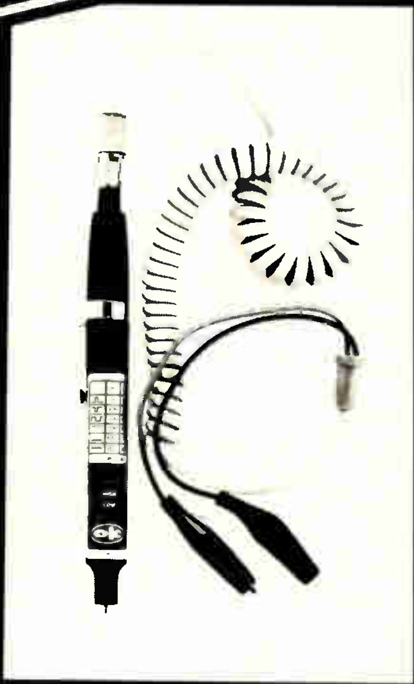
Rentals. More than 1,000 electronic test instruments that can be rented by the month are listed in the 64-page "Continental 1979 Electronic Instrument Rental Catalog." They



include oscilloscopes, recorders, logic analyzers, microprocessor test systems, power meters, function generators, and telecommunications test sets, among others. Specifications for each instrument listed are also given. Continental Resources Inc., 175 Middlesex Turnpike, Bedford, Mass. 01730 [426]

Mixers. A 24-page brochure provides information on mixers, mixer preamplifiers, and frequency doublers. In addition to specifications and drawings on standard and special mixer products, the 24-page brochure presents typical performance curves and data for each product group. There is also an applications section providing information on the various ways to use the devices. Aertech Industries, 825 Stewart Dr., Sunnyvale, Calif. 94086 [427]

NEW!



PRB-1 DIGITAL LOGIC PROBE

Compatible with DTL, TTL, CMOS, MOS and Microprocessors using a 4 to 15V power supply. Thresholds automatically programmed. Automatic resetting memory. No adjustment required. Visual indication of logic levels, using LED's to show high, low, bad level or open circuit logic and pulses. Highly sophisticated, shirt pocket portable (protective tip cap and removable coil cord).

$36.95*

- **DC to > 50 MHZ**
- **10 Nsec. pulse response**
- **120 K Ω impedance**
- **Automatic pulse stretching to 50 Msec.**
- **Automatic resetting memory**
- **Open circuit detection**
- **Automatic threshold resetting**
- **Compatible with all logic families 4-15 VDC**
- **Range extended to 15-25 VDC with optional PA-1 adapter**
- **Supply O.V.P. to ± 70 VDC**
- **No switches/no calibration**

* ADD $2.00 FOR SHIPPING
(N. Y. CITY AND STATE RESIDENTS ADD TAX)

OK MACHINE & TOOL CORPORATION
3455 Conner St., Bronx, N.Y. 10475 (212) 994-6600 / Telex 125091

Circle 246 on reader service card

Upward mobility.

When are you going to get your very own, personal subscription to Electronics?

It could be very important to you. And we're not just referring to your status in the office hierarchy.

You (and we) are in a quick-moving business. News breaks frequently. Change is the name of the game. Awareness is the way to win.

You've got to follow what's going on beyond your specialty. Your career may have to last longer than your specialty.

If change is the game, obsolescence is the penalty for losing. Obsolescence of products, of technology and, unfortunately, of people. We can't change this fact. But we can help you cope with it.

Give us one hour of reading time every two weeks and we will keep you aware of what's going on around you and around the changing world of electronics technology.

Move up. Fill out one of the subscription postcards in this issue.

Electronics Magazine.
The one worth paying for.

What makes Northern Ireland work for the electronics industry?

More than 40 firms in the industry are at work in Northern Ireland today. Companies headquartered in the U.S., Europe, and Great Britain are engineering everything from appliances to sophisticated components.

The industry is long established. Support services are in place for research and development as well as for manufacturing. And there are special grants available for R&D.

There is no shortage of skills in the work force of Northern Ireland. American companies who have come here find that people bring to work not only experience, but also a deep sense of company loyalty, a good labor relations record, and positive attitudes toward attendance and productivity.

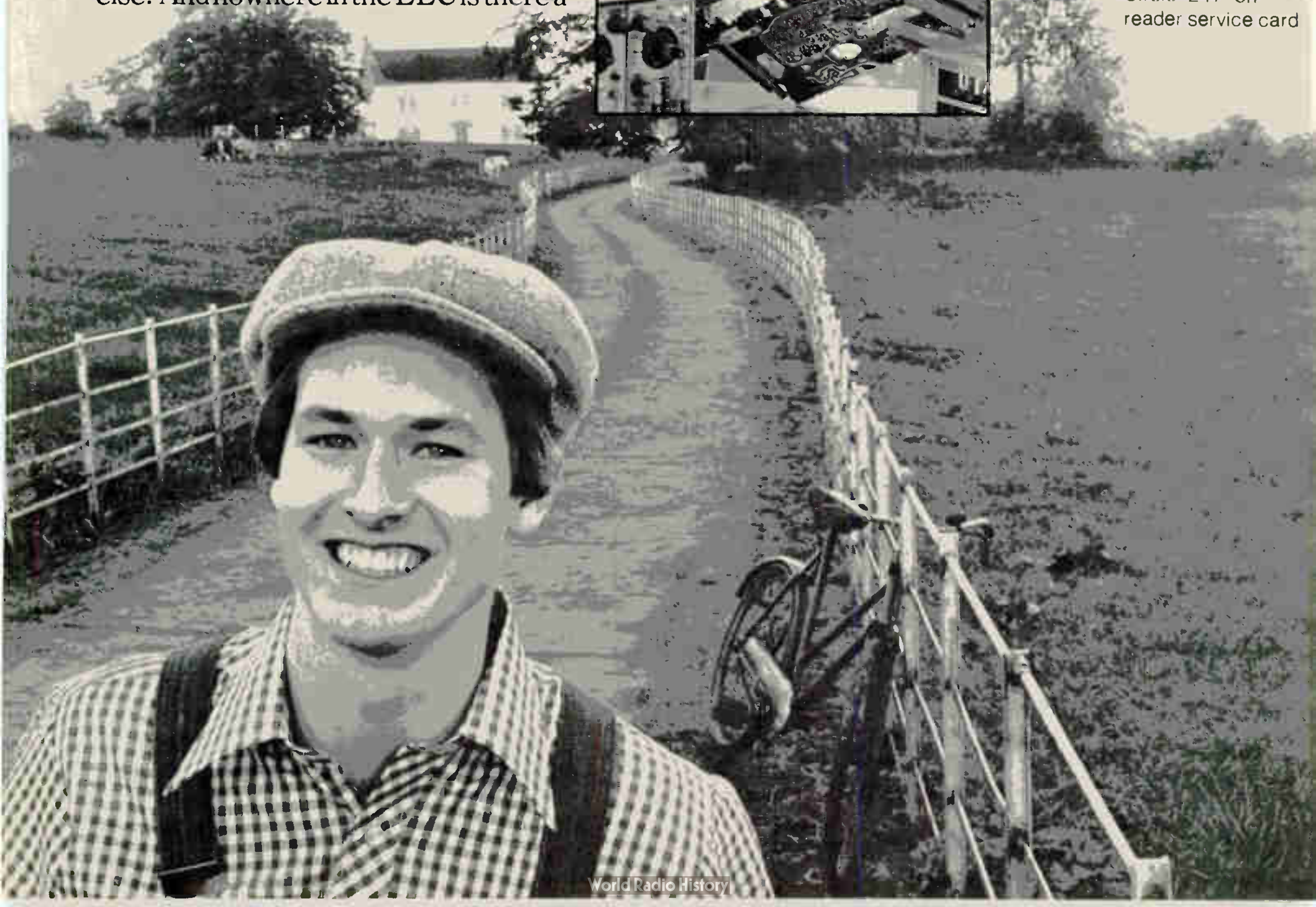
New arrivals also find transportation links and first-class telecommunications that make it easy to do business in the Common Market or anywhere else. And nowhere in the EEC is there a better overall package of incentives to help you succeed. Including provisions for joint ventures and for buy-back equity.

Find out how the people and the province can work for you. Get the facts from Reg Browne or Marcus Robinson at the Northern Ireland Industrial Development Office in New York. They can quickly tailor an offer of assistance to suit your plans. Call (212) 593-2258. Or write: NIIDO, British Consulate-General, 150 E. 58th Street, New York, NY 10022.

Kieran Fitzpatrick works. An apprentice for the past year, he's building a career in electronics.

Northern Ireland works.

Circle 247 on reader service card



Classified section FOR ENGINEERING/TECHNICAL EMPLOYMENT OPPORTUNITIES

CLASSIFIED SALES REPRESENTATIVES — **Sales Manager—Mary Ellen Kearns—212/997-3306**

Atlanta 404/892-2868; Boston Jim McClure 617/262-1160; Chicago Bill Higgens 312/751-3733; Cleveland Mac Huestis 216/781-7000; Dallas Mike Taylor 214/742-1747; Denver Shirley Klotz 303/837-1010; Detroit Mac Huestis 313/873-7410; Houston Mike Taylor 713/659-8381; Los Angeles Ana Galaz 213/487-1160; New York Larry Kelly 212/997-3594; Philadelphia Dan Ferro 215/568-6161; Pittsburgh Dan Ferro 412/391-1314; San Francisco Peter McGraw 415/362-4600; Stamford William Eydt 203/359-2860

Call toll-free 800-257-7850. In N.J. 1-800-322-8650.
Ask for number under phone symbol in ad you're interested in.

Electronics Engineers for Optical Communications Systems

Exxon Optical Information Systems is leading the way... Join us!

We're the new and explosively growing division of Exxon Enterprises, Inc., recently a page one story in the New York Times, Electronic News and Computerworld for announcing the most comprehensive product line for semiconductor lasers. We are committed to developing lectro-optical components and systems which will revolutionize modern information processing. We're looking for uniquely talented people to help us exploit an unequaled edge product technology—people who get excited by developing a new industry instead of just working in it.

■ Analog Circuit Designer

MSEE or BSEE required. Duties include design, breadboarding and testing of discrete and integrated small signal wideband amplifiers and communication circuits. Reply Attention Department EF FS 1.

■ Digital Circuit Designer

BSEE or MSEE required. Must have a working familiarity with MOS and bipolar logic families. Will be responsible for development of digital interface circuits required in apvanced data communication systems. Reply Attention Department EF FS 2.

■ Communication Systems Designer

BS or MS in Physics or EE required. Duties include analysis of error rates and analog S/N. Also design of optimal coding schemes, data interfaces and protocols required in distributed data communication systems. Reply Attention Department EF FS 3.

■ Electro-Optical Systems Engineer

BS or MS in Physics, EE or ME required, preferably with communications background to perform analysis and measurements of optical parameters for communications systems. Reply Attention Department EF FS 4.

■ Manufacturing Engineer

BS in EE, ME or Physics required. Will be responsible for implementation and fabrication of circuit and system designs. Position requires experience with printdd circuit card, and hybrid chip assembly processes. Reply Attention Department EF FS 5.

Qualified applicants may send a confidential resume including salary history/requirements to: Employee Relations, Optical Information Systems, Exxon Enterprises, Inc., 350 Executive Boulevard, Elmsford, N.Y. 10523

Optical Information Systems
EXXON Enterprises Inc.

We are an equal opportunity employer, m/f

ENGINEERS

ELECTRONIC ENGINEERS, $18,000-$45,000. For the electronics engineer, New England offers the widest diversity of positions available anywhere. As one of the largest, long established (15 years) technical placement organizations in the area, we can represent you with a wide variety of clients, large and small, for positions ranging from entry level to senior management. Nationwide representation is also part of our service. Contact Bob McNamara, E. P. REARDON ASSOCIATES, 888 Washington St., Dedham, MA 02026 (617/329-2660).

DESIGN ENGINEERS to $38K. Central Penna. Design connectors/terminals, micro-processors. Outstanding relocation packages. Prompt confidential reply. MECK ASSOC. PERSONNEL, 1517 Cedar Cliff, Camp Hill, PA 17011 (717/761-4777).

ENGINEER MANAGEMENT to $45K. Selected companies throughout U.S. need superstars. Design, porject, management levels. Reply in strict confidence. Call collect. John Ruck, CAREER ASSOCIATES, 583 State Rd., N. Dartmouth, MA 02747 (617/997-3311).

ENGINEERS, $18,000-$42,000. Over 200 openings in New England & Northeast. 18 years experience in placing people in electronics field. Send resume & salary in confidence to AAA PERSONNEL ASSOC., 14 Hayestown Ave., Danbury, CT 06810. Fee paid.

ENGINEERS, $15K-$40K. West Coast & nationwide positions entry level thru mgmt. Design, Inst., Application, Test, etc. Reply in confidence. Call or send resume to GLENN ENGLISH AGENCY, 7840 Mission Center Ct., San Diego, CA 92108 (714/291-9220).

ENGINEERS. WHY not LIVE, WORK and PLAY in tax-free New Hampshire? Numerous career opportunities at all levels with salaries form $15,000 to $30,000++. Contact AVAILABILITY PERSONNEL CONSULTANTS, 160 South River Rd., Bedford, NH 03102 (603/669-4440).

all positions fee-paid

npc NATIONAL PERSONNEL CONSULTANTS

E.E.'S

Many positions in the electronics industry throughout the U.S. Affiliate and employer contacts in every major marketing area.

Positions available in **ENGINEERING MANAGEMENT, DESIGN ENGINEERING, MANUFACTURING, DATA PROCESSING, SALES** and **MARKETING**. Salaries range from $18 to $40K D.O.E.

Let us help you **PLAN** a career change. For effective and confidential representation we offer you over 19 years of industrial recruiting experience. All positions fee paid by client companies. Contact in confidence:

(315) 451-0121
E.B. HENDRICK & ASSOCIATES, INC.
Village Mall, Vine Street
(MGH-1)
Liverpool, NY 13088
(Suburb of Syracuse, NY)

Engineers—SE Locations, Process, Power Light, Software, Hardware, Systems, Instrumentation, Facilities. Fee Paid. No Contracts. 12 yrs. experience. Send resume to Ted McCulloch.
Beall Associates
P.O. Box 5042
Spartanburg, S.C. 29304

The Engineer's Index

Systems Engrs.
Data Processing
Electronics

Salaries to $46,000

- Manufacturing Engrs.
- ECM Engrs.
- Tool Design Engrs.
- Air Traffic Contr'l. Syst. Engrs.
- Rotating Devices Engrs.
- Thermometric Engrs.
- Digital CKT Design Engrs.
- Power Systems Engrs.
- Sr. Military Systems Engrs.
- Field Engrs.(Electronic Equip.)
- Digital Systems Engrs.
- Production Control
- Programmers/Mgrs.
- QA and/or QC Engrs.
- Technicians

Companies Assume Our Fees.
Submit Resume, Call or Visit:
THE ENGINEER'S INDEX
133 Federal Street, Suite 701
Boston, Massachusetts 02110
Telephone (617)482-2800

CALIFORNIA INSTITUTE OF TECHNOLOGY

Research Fellow position in the Power Electronics Research Group, to contribute to theoretical and experimental studies of switching-mode converters and regulators. **Ph.D. required, with experience in the field. Apply to: Professor R. D. Middlebrook, 116-81 Caltech, Pasadena, Ca. 91125. An Affirmative Action/Equal Opportunity Employer.**

NORTHROP

engineering

challenge... research... discovery...

...it's the world of ECM.

It's our world here at Northrop Defense Systems Division. And it's a world to which you should aspire.

If you're intrigued and inspired by the new, the innovative, the state-of-the-art...you'll want to know that we at Northrop have committed ourselves to these ideals for the past twenty-five years. They've led us to our position as a renowned leader in the research, design and manufacture of sophisticated electronic countermeasure (ECM) systems.

By maintaining an environment that encourages creative freedom, coupled with our consistent procurement of long-term contracts and outstanding financial compensation — we've succeeded in building one of the finest engineering teams in the world.

But we need YOU. If you're trained and experienced in one of the following areas, investigate the potential at Northrop:

ENGINEERS

PRODUCT DESIGN
SENIOR ENGINEERS
PROJECT ENGINEERS
ENGINEERS

SOFTWARE
ENGINEERS
ANALYSTS
PROGRAMMERS

PRODUCT ASSURANCE
RELIABILITY
MAINTAINABLITY
QUALITY ASSURANCE

SYSTEMS
SENIOR ENGINEERS
PROJECT ENGINEERS
ENGINEERS

AUTOMATIC TEST ENGINEERS
DIGITAL TEST
ANALOG TEST
RF (MICROWAVE TEST)

We offer outstanding compensation packages including complete benefits, unlimited growth potential and the opportunity to combine the career of a lifetime with off-hours enjoyment in Chicago, one of the most exciting, culturally alive and highly liveable areas in the nation. For further information, please forward your resume stating salary history and requirements, in confidence, to:

Employment Manager, Dept. E679
NORTHROP CORPORATION
Defense Systems Division
600 Hicks Road
Rolling Meadows, IL 60008
equal opportunity employer m/f

Call toll-free 800-257-7850. In N.J. 1-800-322-8650.
Ask for number under phone symbol in ad you're interested in.

ELECTRONIC ENGINEERS

Nationwide opportunities are available to talented & degreed Electronic Engineers looking for a career. Reply in confidence to Stu Hopard for prompt & confidential service.

TAFT Personnel Agency
521 5th/43St, NYC 10017
212-697-0100

NATIONWIDE ELECTRONICS PLACEMENT

Digital Ckt Dsgn * Hardware Sys Dsgn
Analog Ckt Dsgn * Software Sys Dsgn
Quality Reliability * Test Equipment Mtnce
Entry Level through Management
All Fees are Exclusively Employer Paid

E. J. STEPHEN ASSOCIATES
1601 Concord Pike, Suite 86, Wilmington, DE 19803
(302) 654-5350

SUN BELT MGRS. & ENGRS.
Electronic & Electrical

Enjoy living in the energy rich South/Southwest. Confidential representation. 25 years' industry experience.

JOHN WYLIE ASSOCIATES, INC.
Professional Recruitment Consultants
522 S. Boston, Tulsa, OK 74103
(918) 585-3166

ELECTRONICS SYSTEMS
DESIGN & DEVELOPMENT
ENGINEERS

Move Up To Technically Challenging Career Expanding Opportunities With

GENERAL ELECTRIC

Philadelphia, PA

General Electric's Power Systems Management Dept. is engaged in an extensive program involving the design and development of state-of-the-art electric power protection systems utilizing the most advanced digital and analog technology. You couldn't choose a more advantageous time to join G.E.

DESIGN ENGINEER

Solid State Protective Relays

Responsibilities include designing solid state protective relays of analog or digital design, as well as providing support for manufacturing, quality control, and marketing. Qualifications include a B.S.E.E. degree and experience with electronic circuit design.

DEVELOPMENT ENGINEER

Digital Systems

Responsibilities include the development and design of complex new products utilizing advanced digital systems technology for applications to protect and control electric power systems. Requires B.S.E.E. in Electronics (M.S.E.E. in Electric Power Systems or Digital Systems preferred) and experience in digital hardware, protective relaying and control, and microprocessor and systems design.

---

senior research engineer

An excellent opportunity to join a company ranked 6th in the U.S. in private R&D spending.

We seek a senior research engineer with an MS, EE or Physics degree with 5 years industrial experience in electro-optics. This should include three years in adaptive optics, electronic interferometry and autoalignment techniques.

You will serve as project engineer, formulating and conducting a wide variety of electro-optical research programs.

Full range of company benefits in a picturesque New England setting.

Please submit detailed resume and salary requirements to: A. E. Marcin

UNITED TECHNOLOGIES RESEARCH CENTER

UNITED TECHNOLOGIES

303R

Silver Lane, East Hartford, CT 06108

An equal opportunity employer

Job-seekers... be the first to know with McGraw-Hill's Advance Job Listings

By having our weekly ADVANCE JOB LISTINGS sent to your home every Monday you can be the first to know about openings both in and out of your field. AJL will enable you to contact anxious recruitment managers BEFORE their ads appear in upcoming issues of 21 McGraw-Hill publications. To receive a free sample copy, plus information about our low subscription rates, fill out and return the coupon below.

ADVANCE JOB LISTINGS / P.O. BOX 900 / NY 10020

PLEASE SEND A SAMPLE COPY OF ADVANCE JOB LISTINGS TO

NAME ______ ADDRESS ______

CITY ______ STATE/ZIP ______

MANAGER DIGITAL SYSTEMS ENGINEERING

The successful applicant must have a proven managerial background in digital hardware and electric power systems. Responsibilities will include managing a joint effort directed towards a digital protection and control system for a transmission substation. In addition, excellent communication skills and the ability to interface effectively with all levels of personnel is necessary. A B.S.E.E. degree and expertise in electric power systems, digital systems, digital hardware, and a knowledge of protective relaying are required. (Advanced degree desirable.)

QUALITY EQUIPMENT ENGINEER

Analog & Digital Equipment

Responsibilities will include the design of new, advanced solid-state analog and digital equipment, providing programming for microprocessor-based automatic test equipment. Requires a B.S.E.E. degree and related experience. 20% travel required.

QUALITY EQUIPMENT ENGINEER

Solid-State Test

This position will involve the design of new and advanced solid-state test equipment with provisions for automatic data retrieval, and will provide programming for microprocessor-based automatic test equipment. Requires a B.S.E.E. degree with specialization in microprocessor technology, and hardware/software capability. Background should include familiarity with analog and digital microprocessor circuitry.

While enjoying an excellent starting salary and comprehensive benefits, realize your career goals working on challenging and rewarding long-term projects. For immediate consideration send your resume or write to: Recruitment Manager, Dept. SWE.

GENERAL ELECTRIC

POWER SYSTEMS MANAGEMENT DEPT.
6901 Elmwood Avenue, Philadelphia, PA 19142

An Equal Opportunity Employer m/f/h/v

304R

Electronic Engineers

310R

Stanford University is seeking engineers (4) to participate in a research project in Antarctica. The program provides opportunities for individuals to participate in all phases of research including design and testing of electronics systems, field operations, data analysis, and interpretation of results. The program also provides unique opportunities for acquiring thesis material for the PhD in electrical engineering or physics.

Employment covers period from August 1, 1979 to March 15, 1981. Approximately 14 months of this period will be spent in Antarctica during which time the salary per month will be $1875. All foul weather clothing, food, living accomodations and transportation will be provided at no cost to the individual.

Qualifications: electrical engineers and or physicists who have successfully completed their undergraduate studies or equivalent; on-hand electronic experience; familiarity with RF systems, minicomputers, analog and digital circuits, and antennas.

Submit resume to: Sheri E. Renison, Old Pavilion, Serra & Galvez Streets, Stanford University, Stanford, CA 94305. Equal Opportunity Employer Through Affirmative Action.

STANFORD UNIVERSITY

COMPUTER TECHS AND CUSTOMER ENGINEERS

$17K - $28K

Our client, a major Fortune 100 company specializing in Space Flight Simulation Systems, has numerous, immediate openings for the right individuals. If you have good computer and peripheral experience, particularly on INTERDATA and UNIVAC hardware, witn 2 years' experience or equivalent, and are looking to launch yourself into a growth oriented career with a major aerospace industry leader, we'd like to talk to you IMMEDIATELY!

Initial interviews will be conducted in major U.S. cities with follow-ups taking place near the Johnson Space Center outside of Houston. These positions offer excellent compensation and benefits with all the amenities of SUNBELT LIVING!

If you are ready for a quantum leap into the 80's....

casey & hanning

CALL 800-257-7850
or send resume in strict confidence to:

SAN FRANCISCO
50 California St., Ste. 3255
San Francisco, CA 94111
(415) 981-7000

HOUSTON
5373 W. Alabama, Ste. 307
Houston, TX 77056
(713) 961-5500

DALLAS
10300 North Central Expwy.
Meadow Park Central, Bldg. 5
Dallas, TX 75231
(214) 691-3900

BOSTON
300 Bear Hill Road
Waltham, MA 02154
(617) 890-6500

301R

All fees assumed by our client company

Call toll-free 800-257-7850. In N.J. 1-800-322-8650.
Ask for number under phone symbol in ad you're interested in.

Set your sights on tomorrow... TODAY!

Experts agree that telecommunications WILL BE the fastest growing field in the electronics industry during the 1980's and well into the 1990's.

As a world leader in the engineering and manufacturing of computer-controlled telecommunications equipment. Northern Telecom offers you a chance to operate on the forefront of technology. We currently have openings for:

Software Development

Manager of Software Development

As Manager of Software Development, you will provide technical direction to the software development team of our Advanced Products Group. Other activities will include staffing your department, assistance in design development concepts and management of our support funciton after market introduction. In addition, you will assume budgetary and scheduling responsibilities.

Your experience must include 7-10 years of software engineering experience and an MSEE or computer science degree. We prefer experience in Real Time telecommunications software design and at least three years of line management experience.

Software Development Engineer

You will provide solutions to software problems for our Business Communications Division, interface between marketing, field engineering and other software designers, design software for Real Time telecommunications feature enhancements, establish software tools for systems development and manage field trials of new generics.

We desire a combination of hardware and software experience. We prefer a degree in electronic engineering or computer science.

Hardware Development

Manager, Design Engineering

Advanced Products

You will assume responsibility for advanced products design enhancement and sustaining engineering. You will make capital equipment recommendations for test and design aids equipment, and be responsible for advanced products circuit and software design reviews and acceptance. Also, you will provide guidance to hardware and software design engineers.

We prefer 5-10 years' experience in circuit and software design and analysis combined with management responsibilities. BSEE, MSEE.

Senior Project Engineer

You will design hardware interface for microprocessor-controlled equipment, provide direction to design cost efficient test equipment and provide information to engineering in proper design practices.

PBX or related telephony experience and an MSEE and 3-8 years of related experience.

Electronic Design Engineer

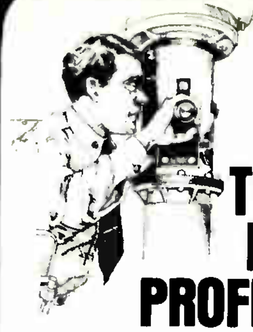
You will design and develop digital and analog circuitry for our stored program EPABX system. You should have knowledge of microprocessors and/or computer based systems. BSEE.

You will receive a comprehensive benefits package including medical coverage, dental insurance, life insurance, educational assistance, short and long term disability, credit union, exceptional pension plan, savings plan and additional company benefits.

For immediate confidential consideration, please call **VINCENT SCATURRO, Employment Manager, COLLECT, at (408) 988-5550** or send your resume to **2305 Mission College Blvd., Santa Clara, CA 95050.** We are an equal opportunity employer, m/f/h.

nt northern telecom

Call toll-free 800-257-7850. In N.J. 1-800-322-8650.
Ask for number under phone symbol in ad you're interested in.



Explore the Undersea World of Electric Boat

TOP JOBS FOR TOP PROFESSIONALS

The world's foremost designer and builder of submarines has career openings now for engineers with experience in these areas:

- ELECTRONICS AND ELECTRICAL SYSTEMS
- FLUID AND MECHANICAL SYSTEMS
- COMPONENT PROCUREMENT
- COMMAND/CONTROL SYSTEMS
- SHIP CONTROL
- FIRE CONTROL, SONAR AND COMMUNICATIONS
- SOFTWARE DEVELOPMENT AND TEST
- STRUCTURAL AND PIPING DESIGN
- STRUCTURAL ANALYSIS
- ACOUSTICS AND VIBRATION
- NAVY OPERATIONS ANALYSIS

302R

SEND YOUR RESUME TODAY!

If you would like to know more about the exciting professional careers at Electric Boat, our superior compensation and benefit programs, and the opportunities to keep moving ahead in your profession, send your resume to John M Hardink, Professional Placement Manager.

U.S. Citizenship required — an Equal Opportunity Employer M&F

GENERAL DYNAMICS

Electric Boat Division

Groton, CT 06340

ELB152

ELECTRONIC DESIGN ENGINEERS

Our suburban Hinsdale Engineering Center, located just west of Chicago, has openings available for Electronic Design Engineers in our Electronic Systems Engineering Group. A background in analog and digital design is required. Experience in feedback control theory and micro-computer application is desired. We require a BSEE or MSEE with emphasis and experience in electronics.

Recent graduates will be considered. We offer an excellent salary and benefits package. Please send resume to:

Personnel Services Manager

INTERNATIONAL HARVESTER

7 S. 600 County Line Rd.
Hinsdale, Illinois 60521
equal opportunity employer m/f/h

Your Career Path Leads To Honeywell-Phoenix

Located in the heart of Arizona, not only will you have the opportunity to join the staff of a company that is the nucleus of tomorrow's computer technology, but you will also have the chance to live in an area that has everything to offer in recreational facilities with perfect weather in which to enjoy them.

Therefore, the people we're looking for must be familiar with today's processes and still be innovative enough to develop tomorrow's systems.

LOGIC ENGINEERS FOR ADVANCED COMPUTER HARDWARE DESIGN

Background should include succeessful performance as Logic Engineer, experience with the conceptual design and implementation of large scale central processors working closely with the systems architecture staff. Requires 5 years experience in the design of large scale processors with architectural exposure. Experience in the design of microprogrammed processors using latest technologies, (TTL, ECL, etc.) is very desirable. BS/MS or equivalent is desired also.

The roads lead in many directions in today's world. If you're ready to take one that will be the most beneficial to you, send your resume with salary requirements in complete confidence to:

HONEYWELL LARGE INFORMATION SYSTEMS
Manager, Recruitment & Placement
P.O. Box 6000
Mail Station Y-38
Phoenix, AZ 85005

Honeywell

A Equal Opportunity Employer M/F/H

Intermedics Inc.

(On the Texas Gulf Coast)

Intermedics, Inc., the fastest growing major medical devices company in the United States today, and the world's second largest manufacturer of cardiac pacemakers, has expansion openings for the following:

SENIOR RELIABILITY ENGINEERS

Requires BSEE or BS in Physics with 3 to 5 years of experience in reliability and components applications. Must be able to perform circuit analysis and component application studies. Will also perform worst case analysis, failure modes, and effect and criticality analysis. (FMECA) Experience working with timesharing systems would be a plus.

STATISTICAL RELIABILITY ENGINEER

Requires BS in EE, Physics, or Statistics. Will perform statistical studies on reliability functions such as math modeling, design of experiments and ANOVA. Will also perform circuit analysis and represent Reliability Department in design reviews.

QUALITY ENGINEERS

BSEE or BSME with ASQE-CQE a plus. Desired experience would be in areas of quality auditing, nonconformance reporting, process capability analysis and corrective action systems. Aerospace experience or experience in commercial electromechanical systems preferred.

Several positions with excellent growth potential and top salary opportunities based on qualifications and experience. Full relocation, company paid benefits, and excellent working conditions await you.

Submit resume in confidence to Scientific & Professional Staffing Mgr.

No Agency Resumes Please

Intermedics Inc.

P.O. Box 617
Freeport, Texas 77541
An Equal Opportunity Employer M/F

305R

Call toll-free 800-257-7850. In N.J. 1-800-322-8650.
Ask for number under phone symbol in ad you're interested in.

WHERE DO YOU FIT?

In today's job market, that is. One way to see if you're in demand is to check the employment opportunities contained in ELECTRONICS' Classified Section.

Another way to get a reading is to place a blind (box number) Position Wanted ad there. The cost is low (only $1.25 per line) and the results are often rewarding.

For more information call or write:

ELECTRONICS Post Office Box 900, New York, N.Y. 10020 • Phone: 212/997-2556

FACULTY POSITIONS VACANT

Electronics Instructor, Electronics Technology Instructor for 2 year Associate Degree program. Masters degree in electrical engineering preferred. Minimum of 5 years field and/or teaching experience required. Basis electronics plus communications, digital systems, microprocessors and instrumentation. Position begins August 20, 1979. Send letters of applications to: Vice President of Academic Services, Lincoln Land Community College, Springfield, IL 62708. Equal Opportunity Employer.

Applicants are invited for a faculty position in Electronics at Centralia College to begin September 10. Centralia College is situated in a rural community 1½ hours from both Portland and Seattle. Bachelor's degree in electronics or related field with two years applied experience in semi-conductor physics, digital logic and micro-processors desired. To apply, send resume, transcripts and arrange for three letters of recommendation to be forwarded to S. Scott Horner, Personnel Officer, P.O. Box 639, Centralia, WA 98531. Screening will begin June 11, 1979. An Equal Opportunity Employer.

POSITIONS VACANT

POSITION VACANT

Electronic Engineers. Several manufacturers in the Pacific Northwest require staffing. Nonprocessors, analysts, programmers. Salaries open. Send resumes to: National Personnel Service, Box 537, Edmonds, WA 98020. No fees.

Engineers and Designers—Florida positions urgently need electronic experience. PCB, Analog, Electronic Packaging, and logic design experience desired. Permanent or long term contract positions. All fees paid. Salaries 15K to 30K. Rush confidential resume and earnings history to: J. C. Dayvault, President, R. P. Rita Inc., 1211 N. Westshore Blvd #107, Tampa, Florida 33607.

Electronic Engineer, Sun Belt, excellent opportunity, salary & benefits. Murkett Assoc., Box 527, Montgomery, AL 36101.

• EMPLOYMENT SERVICES

M.E.s, I.E.s, E.E.s, Ch.E.s—Let our search firm represent you to our clients in Northern Calif. If you are seeking a more prestigious position with increased responsibilities and a better Future, send a resume or request a position profile and at no charge we will provide you with interview opportunities. Register in our exclusive Executive Search Program. All replies strictly confidential. All Fees employer paid at Management Recruiters, 1900 Point West Way, Suite 281, Sacramento, CA 95815. (916) 920-0441.

BUSINESS OPPORTUNITIES

How To Earn Money As A Consultant (including specimen contracts) $31.00. Business Psychology Int'l, 890/44 National Press Bldg., Washington, D.C. 20045.

"Before we interview you, interview us."

Most aerospace companies want the same things we want. Ideas. Experience. Talent.

In short, you.

Naturally, you want the company that offers the most. We think we're that company. So, we decided to show you our resume before you show us yours.

Pick up the phone and start prying. Ask us about our 1,500 exciting programs: from R&D to electro-optical systems applications.

Bring up benefits. And you'll find company funded dental, health, major medical and life insurance. About our credit union that typically pays 7% interest. And much more.

Cross examine us on career opportunities. There's plenty of room for advancement. And with our massive backlog, you couldn't pick a more secure place to take your career.

Pose a question on challenges. Creative, imaginative problems are endlessly needing solutions. And we're always seeking engineers and scientists who thrive on these kinds of challenges.

Give us a call.

If you find you like our qualifications, we'd appreciate the opportunity to discuss yours.

Engineers for Manufacturing Division, El Segundo:
- Electronics
- Senior Project
- Electro-Optical
- Microprocessor
- Control Systems
- Test Equipment
- Process
- Quality Assurance
- Production
- Industrial
- Facility

Call us at **(213) 641-5510** or send your resumé to Hughes Professional Employment, Electro-Optical & Data Systems Group, Manufacturing Division, P.O. Box 92746, Airport Station, Dept. EL, Los Angeles, California 90009.

Engineers for Research & Development, Culver City

Laser Systems
- Gas/Solid State Lasers
- Electrical/Chemical Lasers
- Image Processors
- IR Sensors
- Control Systems
- Circuits/Servos Design
- Rangefinders/Target Designators

Electro-Optical Systems
- IR Sensors/Imaging Systems
- Microprocessors/Computers
- Analog/Digital/Design
- Circuit Analysis/Servos
- Electronic Packaging
- Structural Dynamics
- Signal Enhancement/Processing

Computer Systems
- Software Development
- Processor Architecture
- Circuit/Hardware Design
- Test/ATE
- CAD

Components & Materials
- Material/Process Development
- Device Design/Application
- Test/Reliability
- Failure Analysis
- Product Evaluation
- Problem Solution

Call us at **(213) 391-0543** or send your resumé to: Professional Employment, Hughes Electro-Optical & Data Systems Group, Research & Development, 11940 W. Jefferson Blvd., Dept. E L, Culver City, CA 90230.

Call toll-free 800-257-7850. In N.J. 1-800-322-8650. Ask for number under phone symbol in ad you're interested in.

Call us. You'll like what you hear.

HUGHES
HUGHES AIRCRAFT COMPANY
ELECTRO-OPTICAL AND DATA SYSTEMS GROUP

All positions require an appropriate engineering or technical degree from an accredited university. U.S. Citizenship Required. Equal Opportunity M/F/HC Employer.

ENGINEERS SOLID-STATE POWER CONVERSION

The Advanced Product Development Division of Allen Bradley Company is seeking engineers in all phases of solid-state power conversion. We're offering highly visible positions within a unique and dynamic organization with attractive opportunities. Our present needs include:

Senior Project Engineers

You'll be working on the development of advanced power conversion equipment with primary application to AC motor control. Responsibilities include overall system design and the coordination of electronic design engineers. The successful candidates will have a working knowledge of variable speed motor controls, multi-variable feedback systems and power semiconductors. Design experience with analog IC's and digital logic is required. Familiarity with microprocessor controllers is desirable. You should have 8-10 years experience and have demonstrated a high level of achievement with minimum supervision. BS degree in EE required, MS desirable.

Electronic Design Engineers

We need creative engineers with extensive hands-on experience developing power conversion circuits, dedicated analog and digital feedback control circuits, or microprocessor based real-time controllers. You will be working on the development of state-of-the-art inverter circuits and systems in small project teams, working under minimum supervision. Familiarity with electromagnetic machine fundamentals and computer-aided design is also desirable. BS degree in EE and 3-5 years experience is required. MS desirable.

We are located in Milwaukee, Wisconsin, a metropolitan area with many cultural activities, excellent schools, major league sports, and we are within minutes from lakes, state forests, and many other attractions that have made Wisconsin a top vacationland and an exciting and friendly place to live. These highly visible positions offer technical challenge along with a generous salary and benefits package.

For immediate and confidential consideration, please submit your resume with salary history to:

ALLEN-BRADLEY
Manager, Salaried Employment
ALLEN BRADLEY COMPANY
1201 So. 2nd Street
Milwaukee, WI 53204

307R

AN EQUAL OPPORTUNITY EMPLOYER M/F

Call toll-free 800-257-7850. In N.J. 1-800-322-8650.
Ask for number under phone symbol in ad you're interested in.

THE DOGGONE SEARCH IS ON AT CPI FOR ELECTRONIC SPECIALISTS!

Computer Peripherals, a subsidiary of Control Data Corporation and specialists in developing peripheral equipment for the computer market, is tracking top talent to keep up with our rapid expansion. We're ideally located in the City of Rochester, a pleasant suburban community nestled in the rolling hills of Southeastern Michigan. Join Us! You'll appreciate our stimulating professional environment and numerous opportunities for advancement.

ELECTRICAL ENGINEERS
To design power supplies - both linear and switching solenoid drivers, analog and digital circuits, AC power and servo-mechanisms. Requires BSEE, plus general knowledge of micro-processors and 3 years experience in circuit design.

ELECTRONIC ENGINEERS
Responsible for the design, development and implementation of automated test and test systems for printer products, printed circuit boards and printer sub assembly. Requires 3-6 years experience, plus BSEE and fluency in INTEL 8080 micro-processor hardware, assembly language and PLM80. Senior position requires 4 years experience in designing digital and linear electronic circuits for product test wear or equivalent.

We offer competitive salaries and comprehensive benefits. For prompt and confidential consideration, please forward resume and salary history to:

George Coddington
COMPUTER PERIPHERALS INC.
a subsidiary of
CONTROL DATA CORPORATION
1480 N. Rochester Road
Rochester, MI 48063

Affirmative Action Employer

311R

**Instant, Toll-Free,
Around-The-Clock, 7-Days-A-Week,
Response To Your Inquiries**

The little 800 telephone symbol (similar to the larger version above) inserted in some of the advertisements in this classified section, is a toll-free inquiry service to our readers.

To find out information about any ad you're interested in, just call 800-257-7850 (in New Jersey 1-800-322-8650) and give the operator the numbers underneath the phone symbol.

That's all you have to do to take advantage of this instant, toll-free, seven-days-a-week, around-the-clock service.

Electronics

Post Office Box 900
New York, NY 10020

ICAO Seeks Aviation Specialists

THE CHALLENGE

Over the next six months we will be hiring more than 170 aviation specialists for short and medium-term assignments in Africa, Asia, Latin America and the Middle East.

We are looking for very expert, very experienced technical specialists who have good academic degrees or equivalent high professional qualifications, together with a minimum of ten years practical aviation experience, at least half of it in the specific area of specialization. Obviously with this experience requirement we don't expect applicants to be much below the age of 35. There is no upper limit as long as you are young in spirit and in good health.

THE ORGANIZATION

We are the International Civil Aviation Organization (ICAO), and we administer a technical assistance operation funded in main part by the United Nations Development Programme. Our expenditures this year will be close to (U.S.) $50 million, and we shall be helping more than 75 developing countries.

THE JOBS

We are looking particularly for *electronics engineers* and *electronics technicians* (technical officers) who are highly qualified in one or more of the following fields:

—Aeronautical Communications
—Aeronautical Radar
—Aeronautical Navigation Aids

THE TERMS

We pay good salaries, ranging from (U.S.) $28,000 to $44,000 before taxes, depending upon the job. The cost-of-living allowance depends on the duty station. For example, currently for an expert with dependents: $12,940 to $17,730 in Jordan and Venezuela; $7,470 to $10,240 in Nigeria; $6,370 to $8,740 in Malaysia. Plus: Installation grants, travel for dependents, education grants, and six weeks leave per year with home leave after two years.

If you have the necessary experience and ability, and if you or your employer would like to help a country develop its citizens and resources—while you accumulate valuable international experience—send your resume to:

Technical Assistance Recruitment
International Civil
Aviation Organization
1000 Sherbrooke Street West
Montreal, Quebec, Canada H3A 2R2

ICAO · OACI · ИКАО

Rubber/Plastics Industry Oriented

Supervise Development of Computer-Based Data Acquisition and Process Control Systems

You will be working at the General Tire Research Center where we're involved in much more than tire technology. General has many non-tire products – vinyl wallcoverings, seating materials, polyurethane foams, tennis balls, automotive body and suspension components, closed cell extrusions, etc. – literally thousands of products. This diversity offers exciting opportunities in materials and process research.

You will direct an interdisciplinary professional team in developing specific methodology, applicable hardware, software, data acquisition, instrumentation and control systems for mini-computer/microprocessor control of rubber and plastics process operations.

For this position, you will need an M.S. or Ph.D. in Engineering, a knowledge of the rubber and plastics industry and at least 5 years experience in real-time computer applications. Experience and accomplishments are desired in design and application of digital systems for process control and data acquisition. Digital electronics experience should include the interfacing of mini-computers and microprocessors with sensors and other instrumentation to monitor experiments with the purpose of developing a model of the process.

This is a challenging position involving Section Head responsibilities and the opportunity to use creative talents developing systems from the ground up. Naturally, the total compensation plan is good, including generous benefits and significant continuing growth possibilities.

If your background, goals, and ambitions seem to match our needs, send your resume and salary requirements in total confidence to:

Dr. Jon S. Gerhardt, Manager
Technical Staff Development
THE GENERAL TIRE & RUBBER COMPANY
Research Division
2990 Gilchrist Road
Akron, Ohio 44305

GENERAL TIRE

An Equal Opportunity Employer M F

Call toll-free 800-257-7850. In N.J. 1-800-322-8650.
Ask for number under phone symbol in ad you're interested in.

ATTENTION CREATIVE
ELECTRONIC ENGINEERS, MICROCOMPUTER PROGRAMMERS AND TECHNICIANS

SIMON SAYS:

Travel to the Northeast to Western New England to scenic East Longmeadow, MA. nestled in the foothills of the Berkshires and a whole new world of electronic opportunity awaits you.

The Milton Bradley Company has propelled itself into the electronic game and toy arena in a most dramatic and successful fashion in the last two years. This momentum is continuing in a most encouraging way. Consequently, we are seeking additional talented electronic personnel with both hardware and/or software experience and knowledge to expand our inhouse electronic product development capability. We have immediate openings for the following types of personnel:

Senior Electronic Product Engineers

Qualified candidates will have a minimum of ten years electronic consumer product experience with a BSEE degree or the equivalent thereof.

Electronic Product Engineers

This position requires a minimum of 5 years electronic consumer goods experience and a BSEE or equivalency.

Software Engineers/ Microcomputer Programmers

3 to 5 years experience in microcomputer programming and knowledge of microcomputer assembly languages is required.

Electronic Technicians

1 to 3 years experience as a technician in an electronic consumer goods environment is preferred. An AS degree in electronics would be an asset.

In addition to scenic beauty in the immediate locale we offer proximity to skiing, sailing, surfing and several other quality factors of life.

The successful candidates will enjoy an attractive compensation package which includes a complete fringe benefit program.

Please send resume and salary requirements in confidence to:

MB MILTON BRADLEY

Director of Corporate Personnel Administration
Milton Bradley Company
P.O. Box 3400 – Springfield, MA. 01101

An Equal Opportunity Employer M/F

Call toll-free 800-257-7850. In N.J. 1-800-322-8650.
Ask for number under phone symbol in ad you're interested in.

Engineers

Our Hunt Valley complex, located in the northern suburb of Baltimore, has immediate openings in the following areas:

Software

Applicants should have BSEE and major specialization in computers or with BS in computer science and a knowledge of digital and analog circuit design and at least 2 years experience in one or more of the following areas:

- Design and generation of analog/digital test application software
- Design and generation of ATE executive and support software

ATE Systems Design

Engineers with hardware and software background to develop state-of-the-art ATE from the systems aspect. Experience in digital/analog circuit design, microprocessors, distributed process, and programming is desired. BSEE or computer science with four years of applicable experience is required.

Digital Hardware Design

Responsibilities include systems specifications and design utilizing advanced microprocessors and microcomputers as applied to sophisticated electronic test problems. Minimum of 2 years experience and BSEE degree.

Electronic Design

Requires capability in solid state electronic design. Should have at least 2 years experience in analog and digital testing of military avionics subassemblies. BSEE required.

IF or RF Electronic Design

At least 2 years design experience involving very stable oscillators and other RF circuitry operating at X-band. BSEE degree.

Also, professionals with electronics background are needed in the following areas:

Field Engineering
Engineering Writing
Industrial Engineering
Product Evaluation
Electromagnetic Compatability
Environmental Test Engineering
Quality Assurance
Manufacturing Processes
Packaging Engineering
Reliability
Instructors
Programming

U.S. citizenship is required for all positions.

Please send resume, stating present salary, to:

R.A. Richmond, Dept 595
Westinghouse
P.O. Box 1693
Baltimore, MD 21203

An Equal Opportunity Employer

Westinghouse

Engineer

If you're a talented engineer seeking an environment that emphasizes personal growth through teamwork, consider a career with Hewlett-Packard. Our Corvallis Division is responsible for the development and manufacture of advanced personal computing products and we currently have a challenging opportunity in the following area:

MOS ENGINEER

Working in our product R&D Lab, you will have total responsibility for MOS Design from logic through debug. To qualify, you must have a basic understanding of MOS, logic and analog circuits. We would prefer an EE who has been responsible for at least one LSI design.

At Hewlett-Packard, you'll enjoy such benefits as promotional opportunity, cash profit sharing, company-paid retirement, educational assistance, flexible working hours, stock purchase plan and medical, dental and life insurance.

Please send your resume in confidence to: Diane Pugh, 1000 N.E. Circle Boulevard, Corvallis, OR 97330. We are an equal opportunity employer dedicated to affirmative action.

H-P and You in Oregon

HEWLETT hp PACKARD

Tennessee Eastman Company's Research Laboratories in Kingsport, Tennessee, needs an experienced electronics engineer for a broad range of "hands-on" and developmental engineering. The work is related to the performance, reliability, and improvement of electronic instrumentation used for chemical and physical analyses and for the processing of materials. Duties include servicing scientific instrumentation, designing instrument-computer interfaces, and developing micro computer applications for automation.

Candidates should have a B.S. degree in Electrical Engineering and "hands-on" experience with instrumentation and computers. The ideal candidate will enjoy the challenges of analyzing instrument failures and restoring optimum performance as well as developing electronic systems for automation. Please send resume to: **Mr. M.F. Lowe, P.O. Box 511, Tennessee Eastman Company, Kingsport, TN 37662.**

An Equal Opportunity Employer

POSITIONS WANTED

Would You Hire an Aussie? Electronic engineer with bachelor degree and 3 years basic experience in Australia wants career in dev. electronic products or components in area of Concord, N.H. Permanent resident July, 79. Resume and references available. P. Dickerson, RFD #2, Box 215, Lubec, ME 04652.

Hardware/Firmware, Software, Product and Application Engineers

OUR GROWTH CAN BE YOUR GROWTH

At Allen-Bradley Systems Division, we apply "state-of-the-art" computer and microprocessor technology to industrial systems. This Division has grown four-fold since 1975 and is still growing... strong! As an important part of an international corporation, employing over 13,000 people, we emphasize stability and a sophisticated professional environment, which promotes your growth and ours.

Opportunities exist for engineering professionals in the following areas.

HARDWARE/FIRMWARE DESIGN ENGINEERS

We have a variety of challenging assignments for engineers able to take responsibility to design and develop programmable controllers and numerical control systems employing digital and analog design techniques. Your background should include a B.S.E.E., scientific or advanced degree with 2 + years of related experience. Involvement with computer and microprocessor design is highly desirable.

SOFTWARE ENGINEERS

Since receiving your engineering or scientific degree (E.E., Comp. Eng., Comp. Science, Math, or Physics), you have two or more years experience establishing a strong engineering orientation and an assembly language background, preferably with minicomputers. You are ready to assume project responsibility for software specifications, including design, test and documentation. Projects can include numerical control, communications and machine dependent software.

PRODUCT/MARKETING ENGINEERS

Draw upon your experience to identify market possibilities for new products. Duties include participation in research, exploration, identification and recommendations for product opportunities based on anticipated industry-wide requirements. Background should include B.S.E.E. with 2 or more years experience and understanding of microprocessor technology and applications.

APPLICATIONS ENGINEERS

Use your engineering skills to define customer control system requirements, determine design strategy and prepare proposals. Also implement control systems, participate in customer/sales training programs and be involved in new product planning and development. You presently have an engineering degree or equivalent experience in industrial control systems. Exposure to microprocessors and/or programming helpful.

If your experience and career goals match these professionally rewarding positions, you owe it to yourself to contact us. The total compensation plan is good, including generous benefits and the career growth possibilities are exceptional! Act NOW! Send your resume and salary history/requirements to:

Duane C. Smith, Salaried Employment Supervisor

A-B QUALITY

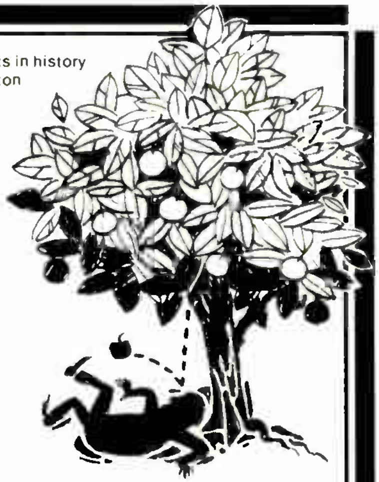
ALLEN-BRADLEY CO.
Systems Division Dept. EM
747 Alpha Drive • Highland Heights, Ohio 44143
Quality in the best tradition.

306R

An Equal Opportunity Employer M/F

Call toll-free 800-257-7850. In N.J. 1-800-322-8650. Ask for number under phone symbol in ad you're interested in.

Great moments in history
Sir Isaac Newton



The problem: Knowing one when you see it.

The solution: The right environment.

You can find out just how at the upcoming National Computer Conference (NCC) in New York June 4-7. There you'll be able to meet with representatives of the company that's making the power and advantages of computerization accessible to more and more people in more and more places.

Call us COLLECT today to schedule an interview with us: (213) 882-0623.

As computer technology advances, PCC's Peripherals Division is a stride ahead, bringing it all together in products and services for original equipment manufacturers and computer systems end-users. Our capabilities extend throughout North America to international locales, and encompass peripheral equipment, subscriber maintenance, micro-computer and data entry systems...and more. The careers:

Principal Engineer - Mechanical

Responsible for the mechanical design and sustaining of flexible disk drive products. Requires BSME and a minimum of 5 years experience on the design of flexible disk drives and/or other related commercial peripherals.

Sr. Manufacturing Engineer

Requires BS degree or equivalent and a minimum of 5 years related experience in baseline cost definition and control, master scheduling, value analysis, plant layouts, etc.

Sr. Test Equipment Engineer

Requires BSEE and 8-10 years experience in digital and analog design. Prefer some test equipment design experience and/or computer peripheral design experience.

Principal Engineer - Electrical

Requires BSEE, MSEE desirable and at least 8 years experience with computer disk and/or tape peripheral digital circuit design.

Sr. Mechanical Engineer

Requires BSME and a minimum of 5 years experience in the development of disk drives including thermal analysis, precision mechanisms and electronic packaging.

Production Managers

Assume responsibility for product schedules, labor efficiency, material usage, as well as cost center budget development. We prefer a Bachelor's Degree and require at least 5-10 years of related supervisory experience within an electro-mechanical manufacturing environment.

Buyers (Mechanical)

Minimum requirements include at least 2-3 years experience as a fabrication or mechanical buyer. We are looking for top-notch negotiators who preferably have the ability to read blueprints and are knowledgeable of machine or sheetmetal environments.

Visit us at the NCC and you'll also find out about the many rewards you can expect in a PCC career. Our exceptional benefits program includes paid life, health and dental insurance, long-term disability, savings/retirement plan, stock purchase plan, educational assistance, up to 25½ paid days off during the year, an employee referral award program, and liberal relocation assistance. Plus, our location is a reward in itself - in the heart of sunny Southern California.

PCC...we're reaching out for top computer people.

PCC PERTEC COMPUTER CORPORATION
PERIPHERALS DIVISION
9610 DeSoto Avenue, Chatsworth, CA 91311
An Equal Opportunity Employer M/F

Call toll-free 800-257-7850. In N.J. 1-800-322-8650.
Ask for number under phone symbol in ad you're interested in.

Would you hire an engineer who couldn't understand this magazine?

Of course not. ELECTRONICS is the technical publication for technical people. If they can't understand it, they can't receive it. That's why, when you're looking for qualified engineers, you should consider our Classified Section.

For only $65.00 per inch your recruitment advertising will reach over 90,000 pre-screened engineers as they're reading to combat job obsolescence, while they're thinking about their future and bettering themselves.

There's no charge for typesetting and free layout service is provided.

For more information call or write:

ELECTRONICS

**Post Office Box 900
New York, N.Y. 10020
Phone: 212/997-2556**

ENGINEERS/SCIENTISTS:

You'll like working at Lockheed in Sunnyvale on the San Francisco Peninsula

Lockheed Missiles & Space Company is a name worth remembering. Our Career opportunities have never been better for professionals eager for a challenging, responsible, meaningful environment. Your talents will expand with the diversification of programs we have to offer, and your lifestyle will be pushed to its limit, with nearby beaches, ocean fishing, boating, wine country, fine schools, theaters, sporting events, and our year 'round sunny, fresh air atmosphere.

Investigate the following opportunities available at Lockheed:

- **Guidance & Control Systems**
- **Advanced Communications Systems**
- **RF Antenna Engineering**
- **Scientific Programming and Analysis**
- **Electro-Optical System Design and Analysis**
- **Test Equipment Design**
- **Reliability Engineering**
- **Radar Systems**
- **Applications Programming**
- **Software Systems Development**
- **Signal Processing Systems**
- **Digital Circuit Design**
- **Microelectronics**

Most of these positions require an appropriate degree. Several positions offer opportunities at all levels. Interested?

For immediate consideration, please forward your resume to Professional Employment, Dept. Elec-67, P.O. Box 504, Sunnvale, California 94086, or call weekdays collect at (408) 743-2200. We are an equal opportunity affirmative action employer.

309R

LOCKHEED
MISSILES & SPACE COMPANY

Call toll-free 800-257-7850. In N.J. 1-800-322-8650.
Ask for number under phone symbol in ad you're interested in.

Classified and employment advertising

F. J. Eberle, Manager 212-997-2557

■ For more information of complete product line see advertisement in the latest Electronics Buyers Guide
• Advertisers in Electronics International
‡ Advertisers in Electronics domestic edition

Advertising Sales Staff

Advertising sales manager: Paul W. Reiss
1221 Avenue of the Americas, New York, N.Y. 10020
[212] 997-4371
Atlanta, Ga. 30309: Michael Charlton
100 Colony Square, 1175 Peachtree St., N.E.
[404] 892-2868
Boston, Mass. 02116: Frank Mitchell
607 Boylston St.
[617] 262-1160
Chicago, Ill. 60611
645 North Michigan Avenue
Jack Anderson [312] 751-3739
Robert M. Denmead [312] 751-3738
Cleveland, Ohio 44113: William J. Boyle
[716] 248-5620
Costa Mesa, Calif. 92626: Robert E. Boedicker
3001 Red Hill Ave. Bldg. #1 Suite 222
[714] 557-6292
Dallas, Texas 75201: John J. Uphues
2001 Bryan Tower, Suite 1070
[214] 742-1747
Denver, Colo. 80203: Harry B. Doyle, Jr.
123 Speer Blvd. #400
[303] 837-1010
Detroit, Michigan 48202: Jack Anderson
1400 Fisher Bldg.
[313] 873-7410
Fort Lauderdale, Fla. 33306: Michael Charlton
3000 N.E. 30th Place, Suite #400
[305] 563-9111
Houston, Texas 77002: John J. Uphues
601 Jefferson Street, Dresser Tower
[713] 659-8381
Los Angeles, Calif. 90010: Robert J. Rielly
3200 Wilshire Blvd., South Tower
[213] 487-1160
Minneapolis, Minn. 55435: Robert M. Denmead
4015 W. 65th St.
[312] 751-3738
New York, N.Y. 10020
1221 Avenue of the Americas
John Gallie [212] 997-3616
Matthew T. Reseska [212] 997-3617
Philadelphia, Pa. 19102: Matthew T. Reseska
Three Parkway
[212] 997-3617
Pittsburgh, Pa. 15222: Matthew T. Reseska
4 Gateway Center
[212] 997-3617
Rochester, N.Y. 14534: William J. Boyle
Powder Mill Office Park, 1163 Pittsford-Mendon Rd., Pittsford, N.Y. 14534
[716] 248-5620
San Francisco, Calif. 94111: Don Farris
Dean Genge, 425 Battery Street,
[415] 362-4600
Paris: Patrick Mouillard
17 Rue-Georges Bizet, 75116 Paris, France
Tel: 720-73-01
United Kingdom & Scandinavia: Simon Smith
34 Dover Street, London W1
Tel: 01-493-1451
Scandinavia: Andrew Karnig and Assoc.
Kungsholmsgatan 10
112 27 Stockholm, Sweden
Tel: 08 51 68 70 Telex: 179 51
Milan: Ferruccio Silvera
1 via Baracchini, Italy
Phone 86-90-656
Brussels:
23 Chaussee de Wavre
Brussels 1040, Belgium
Tel: 513-73-95
Frankfurt / Main: Fritz Krusebecker
Liebigstrasse 27c, Germany
Phone 72 01 81
Tokyo: Akio Saijo, McGraw-Hill Publications Overseas Corporation, Kasumigaseki Building 2-5, 3-chome, Kasumigaseki, Chiyoda-Ku, Tokyo, Japan
[581] 9811

Business Department

Thomas M. Egan
Production Director
[212] 997-3140
Carol Gallagher
Production Manager International
[212] 997-2045
Betty Preis
Production Manager Domestic
[212] 997-2908
Thomas Kazich
Production Manager Related Products
[212] 997-2044
Marieanne Meissner, Production Assistant
(212) 997-2843
Frances Vallone
Reader Service Manager
[212] 997-6057

Electronics Buyers' Guide

H.T. Howland, General Manager
[212] 997-6642
Regina Hera, Directory Manager
[212] 997-2544
Thomas Kazich, Production Manager
[212] 997-2044
Marieanne Meissner, Production Assistant
[212] 997-2843
Frances Vallone, Reader Service Manager
[212] 997-6057

Classified and Employment Advertising

Frank Eberle, Manager
[212] 997-2557
Mary Ellen Kearns, Sales Manager (212) 997-3306

SOME OF OUR CITY'S BEST ADVANTAGES CAN'T BE COMPUTED.

Virginia Beach has a data bank of advantages that quickly add up to success for electronics operations. We're midpoint on the East Coast. Our 1,000-acre Oceana West Industrial Park is minutes from the Port of Hampton Roads and Norfolk International Airport. By rail or truck we're within a day's reach of one-third of the U.S. population. We're convenient to major military bases and Washington D.C. Our ample labor force includes active and retired military personnel, many with advanced electronics skills. Our wage scale and tax structure are surprisingly low. But not everything that's good about Virginia Beach will show up on a computer printout. Our clean windswept skies, mild climate, sandy beaches and friendly people can have an incalculably good effect on your personal and business future. Some of our best advantages have to be sensed. For full facts, contact A. James DeBellis, Director of Economic Development, 18 Municipal Center, Virginia Beach, Va. 23456. Telephone (804) 427-4541.

Come to your senses

VIRGINIA BEACH

Circle 266 on reader service card

An invaluable, time-saving library of design facts and figures...

Circuits for Electronics Engineers

From *Electronics'* highly respected "Designer's Casebook," *346 circuits from all over the world—arranged by 51 of the most useful functions designers use to implement their systems,* including...• Amplifiers • Analog to digital & digital to analog converters • Counters • Detectors • Discriminators • Display circuits • Function generators • Integrators • Logic circuits • Memory circuits • Operational amplifier circuits • Power supplies • Protection circuits • Switching circuits • Temperature control • Timing circuits • Voltage regulating circuits... and many more. 396 pages, $15.95.

Design Techniques for Electronics Engineers

The best of *Electronics'* popular "Engineer's Notebook," a host of *proven design problem solutions to assist you at every point in the development of an engineering project*—when you're making measurements... interpreting data... making calculations... choosing materials... controlling environment... laying out and purchasing components, and interconnecting them swiftly and accurately. The professional edge you can use to solve design problems fast, avoid tedious manual calculations, cut bench and development time. 370 pages, $15.95.

Order today! And don't forget the other valuable Electronics Magazine Books on the coupon below.

Electronics Magazine Books P.O. Box 669, Hightstown, NJ 08520

I must be fully satisfied or you will refund full payment if the book is returned after ten-day trial examination. Send me:

_____ copies of *Microprocessors* @ $8.95
_____ copies of *Applying Microprocessors* @ $9.95
_____ copies of *Large Scale Integration* @ $9.95
_____ copies of *Basics of Data Communications* @ $12.95
_____ copies of *Circuits for Electronics Engineers* @ $15.95
_____ copies of *Design Techniques for Electronics Engineers* @ $15.95
_____ copies of *Memory Design: Microcomputers to Mainframes* @ $12.95
_____ copies of *Personal Computing: Hardware and Software Basics* @ $11.95

Discounts of 40% on orders of 10 or more of each book.

☐ Payment enclosed ☐ Bill firm ☐ Bill me

Charge to my credit card:
☐ American Express ☐ Diners Club
☐ Visa ☐ Master Charge

Acct. No. _____ Date Exp. _____

On Master Charge only, first numbers above name _____

Name _____ Title _____

Company _____

Street _____

City _____ State _____ Zip _____

Signature _____

Electronics

Reader Service

For additional information on products advertised, new products or new literature, use these business reply cards.

Complete entire card.

Please print or type.

Circle the number on the Reader Service postcard that corresponds to the number at the bottom of the advertisement, new product item, or new literature in which you are interested.

To aid the manufacturer in filling your request, please answer the three questions.

All inquiries from outside the U.S. that cannot reach Electronics before the expiration date noted on the Reader Service postcard must be mailed directly to the manufacturer. The manufacturer assumes all responsibilities for responding to inquiries.

Subscriptions & Renewals

Fill in the subscription card adjoining this card. Electronics will bill you at the address indicated on the card.

Electronics June 7, 1979 This reader service card expires September 7, 1979

NAME ______ TITLE ______

PHONE (______) ______ COMPANY ______

STREET ADDRESS (Company ☐ or home ☐ check one) ______

CITY ______ STATE ______ ZIP ______

Was This Magazine Personally Addressed to You? ☐ Yes ☐ No

Industry classification (check one):

a ☐ Computer & Related Equipment
b ☐ Communications Equipment & Systems
c ☐ Navigation, Guidance or Control Systems
d ☐ Aerospace, Underseas Ground Support
e ☐ Test & Measuring Equipment
f ☐ Consumer Products
g ☐ Industrial Controls & Equipment
h ☐ Components & Subassemblies
j ☐ Independent R&D Organizations
k ☐ Government

Your design function (check each letter that applies):
x ☐ I do electronic design or development engineering work.
y ☐ I supervise electronic design or development engineering work.
z ☐ I set standards for, or evaluate electronic components, systems and materials.

Your principal job responsibility (check one)
t ☐ Management
v ☐ Engineering

Estimate number of employees (at this location): **1.** ☐ under 20 **2.** ☐ 20-99 **3.** ☐ 100-999 **4.** ☐ over 1000

1 16 31 46	61 76 91 106	121 136 151 166	181 196 211 226	241 256 271 348	363 378 393 408	423 438 453 468	483 498 703 718
2 17 32 47	62 77 92 107	122 137 152 167	182 197 212 227	242 257 272 349	364 379 394 409	424 439 454 469	484 499 704 719
3 18 33 48	63 78 93 108	123 138 153 168	183 198 213 228	243 258 273 350	365 380 395 410	425 440 455 470	485 500 705 720
4 19 34 49	64 79 94 109	124 139 154 169	184 199 214 229	244 259 274 351	366 381 396 411	426 441 456 471	486 501 706 900
5 20 35 50	65 80 95 110	125 140 155 170	185 200 215 230	245 260 275 352	367 382 397 412	427 442 457 472	487 502 707 901
6 21 36 51	66 81 96 111	126 141 156 171	186 201 216 231	246 261 338 353	368 383 398 413	428 443 458 473	488 503 708 902
7 22 37 52	67 82 97 112	127 142 157 172	187 202 217 232	247 262 339 354	369 384 399 414	429 444 459 474	489 504 709 951
8 23 38 53	68 83 98 113	128 143 158 173	188 203 218 233	248 263 340 355	370 385 400 415	430 445 460 475	490 505 710 952
9 24 39 54	69 84 99 114	129 144 159 174	189 204 219 234	249 264 341 356	371 386 401 416	431 446 461 476	491 506 711 953
10 25 40 55	70 85 100 115	130 145 160 175	190 205 220 235	250 265 342 357	372 387 402 417	432 447 462 477	492 507 712 954
11 26 41 56	71 86 101 116	131 146 161 176	191 206 221 236	251 266 343 358	373 388 403 418	433 448 463 478	493 508 713 956
12 27 42 57	72 87 102 117	132 147 162 177	192 207 222 237	252 267 344 359	374 389 404 419	434 449 464 479	494 509 714 957
13 28 43 58	73 88 103 118	133 148 163 178	193 208 223 238	253 268 345 360	375 390 405 420	435 450 465 480	495 510 715 958
14 29 44 59	74 89 104 119	134 149 164 179	194 209 224 239	254 269 346 361	376 391 406 421	436 451 466 481	496 701 716 959
15 30 45 60	75 90 105 120	135 150 165 180	195 210 225 240	255 270 347 362	377 392 407 422	437 452 467 482	497 702 717 960

Electronics June 7, 1979 This reader service card expires September 7, 1979

NAME ______ TITLE ______

PHONE (______) ______ COMPANY ______

STREET ADDRESS (Company ☐ or home ☐ check one) ______

CITY ______ STATE ______ ZIP ______

Was This Magazine Personally Addressed to You? ☐ Yes ☐ No

Industry classification (check one):

a ☐ Computer & Related Equipment
b ☐ Communications Equipment & Systems
c ☐ Navigation, Guidance or Control Systems
d ☐ Aerospace, Underseas Ground Support
e ☐ Test & Measuring Equipment
f ☐ Consumer Products
g ☐ Industrial Controls & Equipment
h ☐ Components & Subassemblies
j ☐ Independent R&D Organizations
k ☐ Government

Your design function (check each letter that applies):
x ☐ I do electronic design or development engineering work.
y ☐ I supervise electronic design or development engineering work.
z ☐ I set standards for, or evaluate electronic components, systems and materials.

Your principal job responsibility (check one)
t ☐ Management
v ☐ Engineering

Estimate number of employees (at this location): **1.** ☐ under 20 **2.** ☐ 20-99 **3.** ☐ 100-999 **4.** ☐ over 1000

1 16 31 46	61 76 91 106	121 136 151 166	181 196 211 226	241 256 271 348	363 378 393 408	423 438 453 468	483 498 703 718
2 17 32 47	62 77 92 107	122 137 152 167	182 197 212 227	242 257 272 349	364 379 394 409	424 439 454 469	484 499 704 719
3 18 33 48	63 78 93 108	123 138 153 168	183 198 213 228	243 258 273 350	365 380 395 410	425 440 455 470	485 500 705 720
4 19 34 49	64 79 94 109	124 139 154 169	184 199 214 229	244 259 274 351	366 381 396 411	426 441 456 471	486 501 706 900
5 20 35 50	65 80 95 110	125 140 155 170	185 200 215 230	245 260 275 352	367 382 397 412	427 442 457 472	487 502 707 901
6 21 36 51	66 81 96 111	126 141 156 171	186 201 216 231	246 261 338 353	368 383 398 413	428 443 458 473	488 503 708 902
7 22 37 52	67 82 97 112	127 142 157 172	187 202 217 232	247 262 339 354	369 384 399 414	429 444 459 474	489 504 709 951
8 23 38 53	68 83 98 113	128 143 158 173	188 203 218 233	248 263 340 355	370 385 400 415	430 445 460 475	490 505 710 952
9 24 39 54	69 84 99 114	129 144 159 174	189 204 219 234	249 264 341 356	371 386 401 416	431 446 461 476	491 506 711 953
10 25 40 55	70 85 100 115	130 145 160 175	190 205 220 235	250 265 342 357	372 387 402 417	432 447 462 477	492 507 712 954
11 26 41 56	71 86 101 116	131 146 161 176	191 206 221 236	251 266 343 358	373 388 403 418	433 448 463 478	493 508 713 956
12 27 42 57	72 87 102 117	132 147 162 177	192 207 222 237	252 267 344 359	374 389 404 419	434 449 464 479	494 509 714 957
13 28 43 58	73 88 103 118	133 148 163 178	193 208 223 238	253 268 345 360	375 390 405 420	435 450 465 480	495 510 715 958
14 29 44 59	74 89 104 119	134 149 164 179	194 209 224 239	254 269 346 361	376 391 406 421	436 451 466 481	496 701 716 959
15 30 45 60	75 90 105 120	135 150 165 180	195 210 225 240	255 270 347 362	377 392 407 422	437 452 467 482	497 702 717 960

Electronics
Reader Service

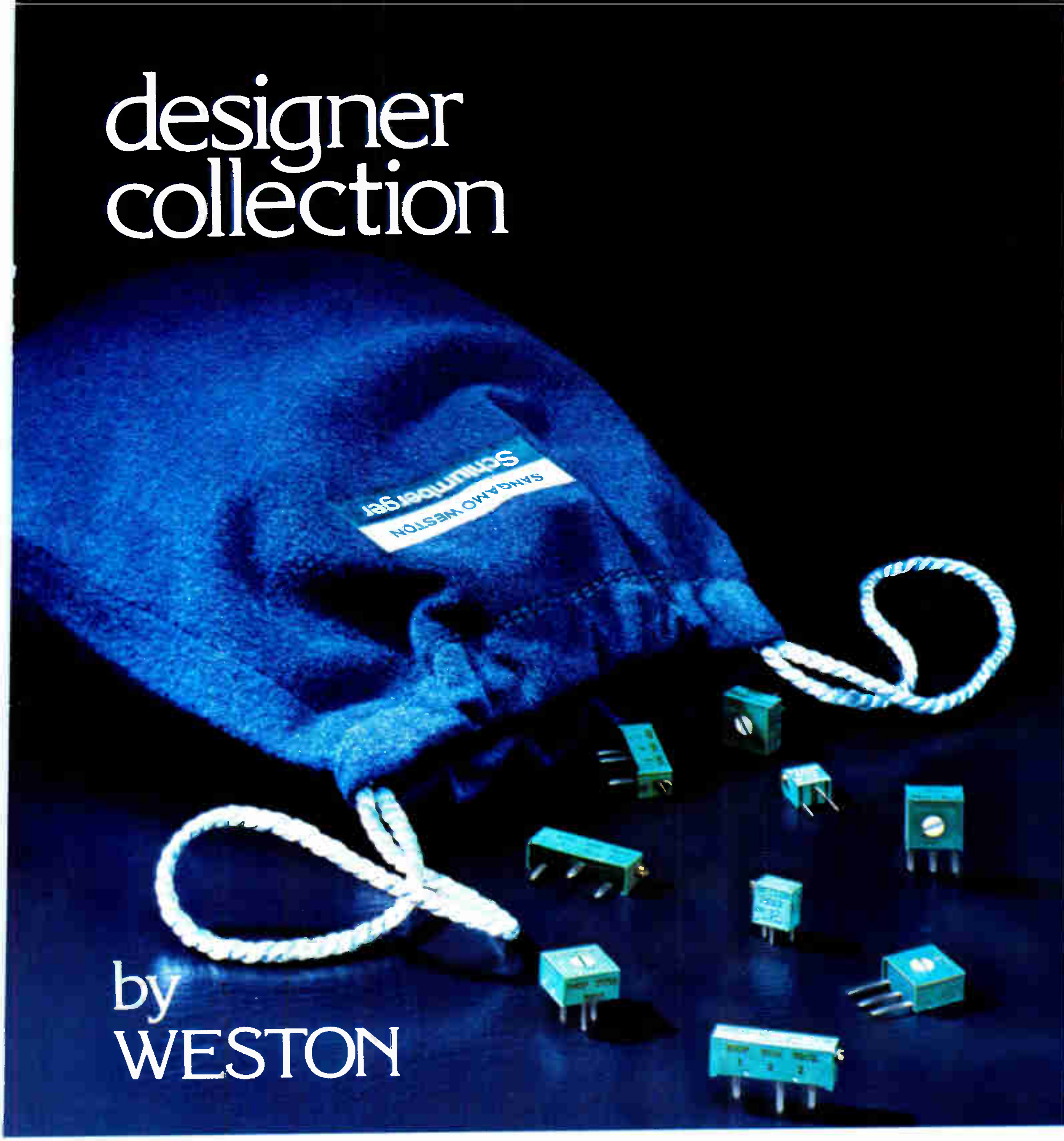
If the cards below have already been used,
you may obtain the needed information
by writing directly to the manufacturer,
or by sending your name and address,
plus the Reader Service number and issue date,
to Electronics Reader Service Department,
P.O. Box No. 2530, Clinton, Iowa 52734.

Affix
Postage
Here

Electronics
P.O. Box No. 2530
Clinton, Iowa 52735

Affix
Postage
Here

Electronics
P.O. Box No. 2530
Clinton, Iowa 52735



It's the designer collection of finest-quality cermet trimmers from Weston. It's everything you would expect in a designer collection from expert styling and superior craftsmanship to long-term durability and reliable performance **at competitive prices!** Choose from the 830 (¾" rect. multiturn), 840 (⅜" sq. single turn), 850 (⅜" sq. multiturn) or the 860 (¼" sq. multiturn).

You'll find just the right form, fit and function trimmer for all your demanding applications. Write today for complete specifications, evaluation samples and pricing.

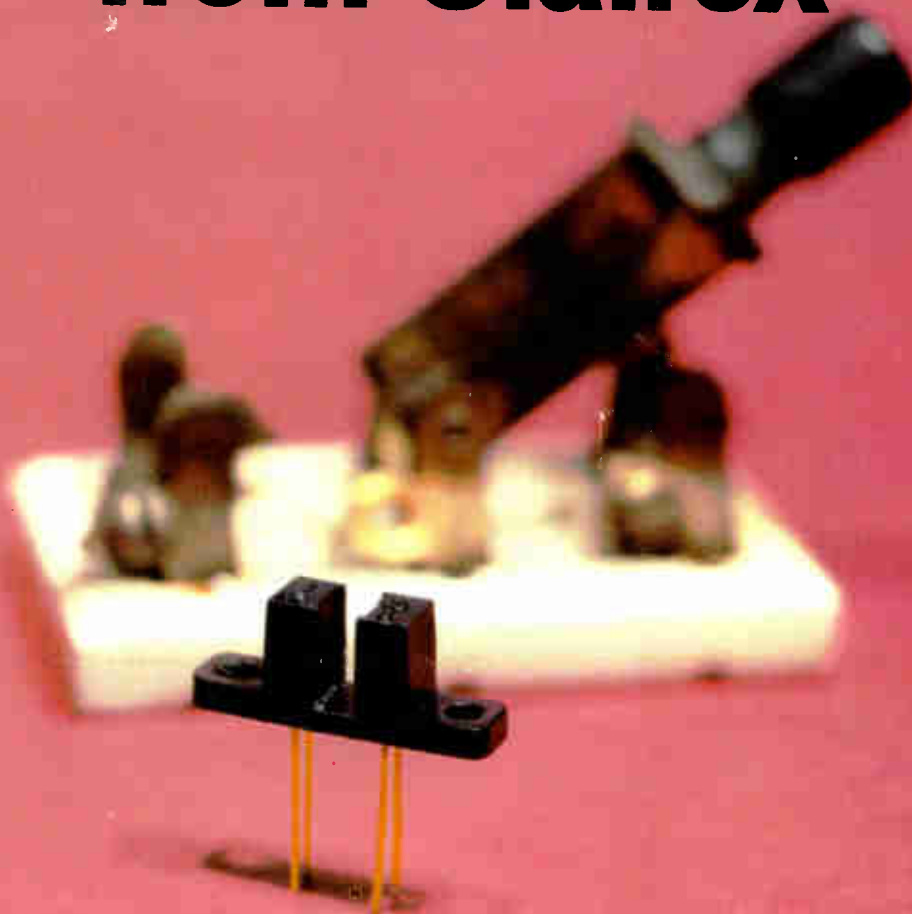
SANGAMO WESTON
Schlumberger

WESTON COMPONENTS & CONTROLS
A Division of Sangamo Weston, Inc.
Archbald, Pa. 18403
Tel. (717) 876-1500
TWX 510-656-2902
Telex 83-1873

Circle 901 on reader service card

Switch from the old to the new!

Low-cost OPTICAL SWITCHES from Clairex



Switch from slow switching, moving parts and arcing problems to fast switching, solid-state, low-cost optical switches from Clairex.

Seventeen optical switches in the CLI 800 series lets you choose from: a wide range of sensor currents; phototransistor and photodarlington outputs; and two voltage ranges, 30 and 55 volts. Each series features a model with a ten-mil slit over the sensor for applications necessitating stringent target resolution.

Clairex also offers the CLI 200 and CLI 300 series that are designed for harsh environmental applications.

For details on the full line of Clairex Optical Switches, call (914) 664-6602 or write Clairex,® 560 South Third Avenue, Mount Vernon, New York 10550.

CLAIREX ELECTRONICS

A Division of Clairex Corporation

Circle 902 on reader service card