SOLID SUPPORT FOR COMPUTER DESIGN

VIRTUAL MEMORY
LOGIC ARRAYS
SELF TESTING
Simply set and reset—right on the button!

Just push the PLUS or MINUS buttons for the precise setting you want. It's that simple. The newly designed Model 3680 Series of Digital Pushbutton Potentiometers let you set and reset with absolute accuracy.

Fast data entry and information readout on large easy-to-read digital displays.

A modular potentiometer "system," the Model 3680 Series consists of from one to five decades. Resolution is related to the number of decades used. Laser tailored, built-in cermet elements provide a wide choice of standard resistance values from 10 ohms to 1 Megohm.

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Number of Decades</th>
<th>Resolution</th>
<th>Standard Resistances (Ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3681</td>
<td>1</td>
<td>10%</td>
<td>10 - 100K</td>
</tr>
<tr>
<td>3682</td>
<td>2</td>
<td>1%</td>
<td>100 - 1 Meg</td>
</tr>
<tr>
<td>3683</td>
<td>3</td>
<td>.1%</td>
<td>1K - 1 Meg</td>
</tr>
<tr>
<td>3684</td>
<td>4</td>
<td>.01%</td>
<td>10K - 1 Meg</td>
</tr>
<tr>
<td>3685</td>
<td>5</td>
<td>.001%</td>
<td>100K - 1 Meg</td>
</tr>
</tbody>
</table>

Installation is a snap. Convenient snap-in mounting reduces installation time and eliminates the need for mounting hardware. An integral bezel covers irregular panel cutouts and minor panel edge blemishes. Rear dual-purpose terminals can be soldered or connected to standard interconnections.

All flame retardant material is used for fabrication. Glass-filled thermoplastic is UL listed 94V-0 (pushbutton material is UL listed 94V-1). Specifications include 100 PPM/°C tempco, 2 watts power rating, and -25°C to +85°C operating temperature range. Typical cost is $11.28* in 1,000 quantities (three decade Model 3683) — comparable to the cost of separate precision potentiometers and dials.

Simple, fast and accurate Pushbutton Pots from Bourns. A concept that's right on the button with your design needs. Send today for Model 3680 catalog.

TRIMPOT PRODUCTS DIVISION, BOURNS, INC., 1200 Columbia Avenue, Riverside, CA 92507. Phone: 714 781-5122. TWX: 910 332-1252.

*Domestic U.S.A. price only.
In RF diodes HP gives you a universe to choose from.

HP Schottky diodes for low noise mixing, high sensitivity detecting and general purpose switching feature high breakdown voltages (to 70V) to handle high level signals, pico-second switching speeds for low distortion, and low turn-on voltage for low power consumption.

HP PIN diodes for attenuation, AGC and modulation are noted for their low distortion products, large dynamic range, and tight resistance matching.

A wide selection means there is a diode that is right for your circuit needs, including MIL spec. Low volume prices meet your design and production requirements. Stringent test procedures assure the reliability you need for your universe, whether it is satellite communications, CB radio, computer switching, ECM or anything in between.

Best of all, one phone call to your local HP distributor can solve just about any diode problem you may have. HP's universe of diodes are in stock now—in the quantities you need.

In the U.S. contact Hall-Mark, Hamilton/Aven, Pioneer Standard, Schweber, Wilshire or the Wyle Distribution Group (Liberty/Elmar).

In Canada, call Hamilton/Aven or Zentronics, Ltd.
See what you've never seen before.

Now Tektronix proudly announces its new 1 GHz real-time scope, the 7104. Rise time: 350 ps. Plus a 10mV/div - 1V/div vertical sensitivity, and a 20 cm/ns writing rate so any signal, single-shot or repetitive, can be seen and photographed. A window into a world previously invisible.

As part of the Tektronix Plug-In family, the 7104 is compatible with 7000-Series plug-in units. Including several new ones that take the 7104 to the limits of its specifications. In addition, the 7104 opens a whole new world of technology, both in circuit design and crt operation.

Throughout the history of science, important discoveries have been made possible by similar advances in instrumentation. We believe the 7104 represents such an advance.

The Tektronix 7104 Plug-In Oscilloscope. See what you've never seen before.

See the 7104 at Electro-New York

For literature, call (800) 547-1512 toll free.
Electronics Review
COMPONENTS: Motorola, National prepare IC converters, 39
MILITARY: DOD will request proposals next month for VHSI, 41
PERIPHERALS: Data station offers OEMs flexibility, 41
INTEGRATED CIRCUITS: CDC says Soviets make good chips, 42
COMPUTERS: Plug-compatibles fight back, 44
PACKAGING & PRODUCTION: Electron-beam annealers readied, 46
NEWS BRIEFS: 46
CHARGE-COUPLED DEVICES: CCDs receive two-pronged boost, 53
AUTOMOTIVE: TI ships carburetor control parts to Delco, 54
MICROPROCESSORS: Italians to make Zilog 28000, 56

Electronics International
GREAT BRITAIN: BBC reduces composite TV signal to 34 Mb/s, 71
WEST GERMANY: MBB to equip China electronically, 72
JAPAN: Fixed-head VCR fills a (loop) hole, 72
WEST GERMANY: Magnetically soft alloys are strong, too, 76

Probing the News
MEMORIES: Alphas stylem static, 85
MICROCOMPUTERS: Chip, mini makers squaring off, 88
COMMUNICATIONS: Military acts in digital Drama, 90
TRADE: Japan’s markets less inscrutable, 94
COMPONENTS: Why Europeans are on edge, 96

Technical Articles
COMPUTERS: Supporting their design amid evolving technology, 101
System/38 shows how IBM aims to keep up with the times, 102
Customized metal layers vary standard gate-array chip, 105
Level-Sensitive Scan Design tests chips, boards, system, 108
Hash index helps manage large virtual memory, 111
SOFTWARE: Forte’s forte is tighter programming, 114
DESIGNER’S CASEBOOK: Detector recovers narrow pulses, 120
Optoisolator initializes signal-averaging circuit, 121
Timer generates sawtooth with switchable symmetry, 123
PACKAGING & PRODUCTION: Steel—the ideal substrate? 125
ENGINEER’S NOTEBOOK: Program finds 8-by-16-bit product fast, 129
Fractional-binary program creates pseudorandom integers, 129
Five-state LED display monitors paging system, 131

New Products
IN THE SPOTLIGHT: Desktop computer sells for $2,850, 137
Video system with dual processors unburdens host, 138
Bit-slice mini for multiple users boasts lower price, 141
POWER SUPPLIES: Power-One gets into switching supplies, 144
COMPUTERS & PERIPHERALS: Four-pen plotter sells for $16-k, 156
INSTRUMENTS: Hand-held meter reads true rms, 168
COMPONENTS: Volt converters are accurate, 180
MICROCOMPUTERS & SYSTEMS: System develops C-MOS parts, 192

Departments
Publisher’s letter, 4
Readers’ comments, 6
News update, 12
People, 14
Editorial, 24
Meetings, 26
Electronics newsletter, 33
Washington newsletter, 61
Washington commentary, 62
International newsletter, 87
Engineer’s newsletter, 132
Products newsletter, 211
New literature, 216

Services
Reprints available, 212
Employment opportunities, 222
Reader service card, 237

Highlights
Cover: IBM lays foundation for future design, 101
The recently introduced System/38 features on-chip testability and simplified
virtual memory management. A computer-guided electron beam defines interconnections
to customize a large-scale integrated gate-array chip.
Cover is by Art Director Fred Sklenar.

European oil jitters over unsold German TVs, 96
Oil shortage, unemployment, inflation add to component makers’ worries evident at
Paris show. But though consumer markets look poorly, military and data processing
business is looking up.

Language tightens microcomputer programs, 114
Third installment in microcomputer programming series examines Forth, a lan-
guage organized like a dictionary. The programmer can add his own definitions and intermix assembly instructions.

Porcelain-on-steel entices board designers, 125
The technology for producing porcelain-on-steel circuit boards is coming of age. Tool-
ing costs run high, but ruggedness and thermal properties are excellent.

... and in the next issue
A special report on data handling by satel-
lite ... new op amps that run on 1 volt or less ... a compact megabyte bubble-
memory module.

Electronics/March 15, 1979
Preparing the group of four articles on the IBM System/38 computer (p. 101) almost required a System/38 computer. Besides the introduction written by computer editor Tony Durniak, the project included three different articles prepared by six authors at two separate locations, coordinated from a third.

But the results are worth the effort, providing an early look inside the System/38, which was announced in October 1978 but will not be delivered until August 1979. More than describing a single computer system, the articles point to the directions in which IBM will go in future systems.

A review of the gate-array chips, by Jehoshua Pomerantz, Rolf Nijhuis, and Chet Vicary, came from IBM's Data Systems division in East Fishkill, N. Y. The system's unique built-in testing scheme was produced by Neil Berglund at the General Systems division (GSD) in Rochester, Minn. And the discussion of virtual address translation by Merle Houdek and Glenn Mitchell also came from Rochester. General Systems division headquarters in Atlanta, Ga., did the coordination.

An interesting sidelight on the System 38 project, which took about eight years from inception to product announcement, was the tilt of the design effort in that time from hardware to software. Brian Utey of GSD, project manager for the System/38 for five of those eight years, estimates that by the end of the program there were two and a half to three software people for each hardware designer.

"The real value of this class of product is the software, because that's the function the user sees and interfaces with," Utey comments.

It has been about a year since alpha radiation in dynamic random-access memories became an issue in the semiconductor industry. The questions at the time were: Is it serious, can users live with the soft errors caused by alpha particles, and will it be necessary to design around the problem?

Now, as the Probing the News story on page 85 points out, static RAMs heretofore believed to be impervious to alpha radiation have been invaded. The problem has appeared in those statics designed with polysilicon lead resistors. Again there is controversy about the seriousness of the problem and what the manufacturers must do about it.

Implicit in a discussion of solutions is the concern among producers that users may eventually demand a specification on soft error rates. If so, it will mean higher costs for increased testing, tighter processing techniques, and the use of premium-priced materials.

"The manufacturers are confident that soft errors in 4-K and 8-K static RAMs can be overcome by proper design," solid state editor Ray Capece observes, "yet many are concerned with alpha-particle radiation in the forthcoming high-speed 16-K statics. Until they actually build them, they will not be sure."
if you’re designing ATE systems you really ought to talk to our power supplies

... hundreds of models interface the IEEE 488 BUS through the KEPCO SN-488 programming system

Write Dept. BYF-14 for all the details

KEPCO

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

Only one of several

To the Editor: A major theme of a recent article in the People column, “West and Nichols count on servicing microprocessors” [Jan. 18, p. 14], was that Millennium Systems Inc. is the only company now making instruments designed exclusively for troubleshooting microprocessor-based products.

In fact, there are many products currently being offered that are alternatives to the Millennium µSA. Included in this category are instruments by Pro-Log, Mupro, Paratronics, and E-H International, as well as by AQ Systems, to name those that immediately come to mind.

We at AQ Systems have been manufacturing microprocessor analyzers since early 1976 and now offer two products in this category: the AQ6800 for 6800 and 6802 applications; and the AQ8080 for 8080, 8085, and Z80 system troubleshooting. Our instruments offer the unique feature of providing in-circuit emulation capabilities without removing the microprocessor chip from the system under test.

Isaac Klinger
AQ Systems Inc.
Yorktown Heights, N. Y.

Not so wonderful

To the Editor: The “wonderful discovery” discussed in the Jan. 18 Engineer’s Notebook, “Unspecified 8085 op codes enhance programming” [p. 144], is actually extremely dangerous from a programming standpoint.

Neither Intel nor any second-source vendor is obligated to have these unspecified operating codes function in future or even current 8085 microprocessors in the same way as described.

The result of using these op codes will, in all likelihood, be incorrect functioning when programs are moved from the development system to the application system. They therefore constitute traps to be sprung on unsuspecting persons using such software.

Furthermore, consumer confidence in microprocessor-based products will be damaged when myster-
Once again HP makes your money count.

A universal counter for $375.

The smart money's on HP's new 5314A Universal Counter because it does so much for so little. Now, in one low-cost counter, you can measure frequency up to 100 MHz, period down to 400 nanoseconds with 100 picosecond resolution, and time interval with 100 ns resolution. Add frequency ratio, ratio averaging, totalizing and a full complement of time interval measurement controls and you've got a package you'd expect to find at almost twice the 5314A's $375 price. Options: internal battery and charger, $95; TCXO time base, $100.

Time interval measurement capabilities are truly outstanding at the 5314A's price. Instead of limited single channel controls, or none at all, the 5314A gives you both input trigger level and slope controls for two input channels. So now you can measure pulse widths or time between pulses with stop and start commands from either one or two input control lines.

HP's frequency counters also save you time and money.

Using state-of-the-art components common to HP's most sophisticated counters, the HP5380 frequency counter series offers high accuracy, high input sensitivity, input attenuators and direct counting for rapid, convenient frequency measurement and adjustments.

To find out more about HP's low-cost laboratory grade counters and the entire family of sophisticated and versatile HP counters call your nearest HP field office. Or write for the 5314A and 5380 series data sheets and electronic counter brochure.

Prices domestic U.S.A. only

HEWLETT PACKARD

1507 Page Mill Road, Palo Alto, California 94304

For assistance call: Washington (301) 258-2000, Chicago (312) 265-9800, Atlanta (404) 965-1500, Los Angeles (213) 877-1282

Circle 7 on reader service card
New possibilities for your Printed Circuit Board

WIMA Miniature Capacitors

WIMA MKS 2 with a PCM of 5 mm

The new miniatures from WIMA help you to save space on your Printed Circuit Boards and can be utilised everywhere. They are the smallest plastic cased, metallised polyester Capacitors available.

Capacitance values 0.01 — 0.47 μF
(1 μF with 7.5 mm PCM.)

WIMA FKS 2 from 1000 pF.
All capacitors are resistant to moisture.

Please ask for our special catalogue.

WILH. WESTERMANN
Spezialvertrieb elektron. Bauelemente
P. O. Box 2345 · D-6800 Mannheim 1
Fed. Rep. of Germany

U.S. Sales Offices:
BOSL & ROUNDY · 3333, Detray Drive
Ft. Wayne · Indiana 46815
(219) 483-3378

THE INTER-TECHNICAL GROUP INC.
North Dearman Street · P. O. Box 23
Irvinton · New York 10533
(914) 591-8822

TAW ELECTRONICS CO.
4215 W. Burbank Blvd., Burbank
California 91505 · (213) 846-3911

Readers' comments

ious, possibly dangerous, effects result from the use of products containing 8085s employing these op codes.

L. Edward Reich
Arlington, Va.

Intel Corp. does indeed recommend that unspecified operating codes not be used, if for no other reason than that their inclusion (or function) in a particular chip issue is not guaranteed and they may in fact be removed as subsequent masks are made. The situation is roughly parallel to the use of "hidden features" in a particular calculator, where programmers also implement unspecified functions at their own risk.—ED.

Clarification

To the Editor: One point in my article, "Two chips, two processes combine in per-channel coder-decoder" [Feb. 1, p. 126], should be clarified. The final paragraph referred to Fig. 11, which was eliminated. Therefore the first sentence should be changed to read as follows:

"Since the codec's internal timing is independent of the data control clocks, the TP3000 can be readily used in a full-duplex single-channel application. That is, each of two codecs can transmit and receive data over a single interconnecting bus. The first codec would transmit PCM data to the second during the first half of the frame, and the converse during the last half of the frame."

The last sentence remains the same.

James W. Smith
National Semiconductor Corp.
Santa Clara, Calif.

Correction

In "ITT Semiconductors gears up for 64-K RAM production" (International Newsletter, Feb. 15, p. 64), the figure of 150,000 for 4-K and 16-K parts is per week, not per month.

1978 Index ready soon

The index of articles published in Electronics in 1978 will be available shortly. For a copy, circle 340 on the reader service card.
FORTRAN-80  The most widely used microcomputer FORTRAN in the world today is FORTRAN-80 from Microsoft. It's easy to see why. The FORTRAN-80 compiler supplies all of ANSI-66 FORTRAN (except the COMPLEX data type), plus many enhancements to the standard. FORTRAN-80 also provides a complete assembly language development system with relocating macro assembler and linking loader. The assembler supports a full, Intel-standard macro facility (including IRP, IRPC, REPEAT, local variables and EXITM), and it accepts Z80 or 8080 opcodes. FORTRAN-80 is available in versions that support the CP/M, TRS-80 TRSDOS, DTC and Altair operating systems, plus:

FORTRAN-80 FOR INTEL'S ISIS-II™  You can't buy a better FORTRAN for your ISIS-II operating system. Microsoft's FORTRAN-80 is the fastest and most compact FORTRAN available. Our code generation and optimized library routines keep run-time memory size low. The compiler resides in 24K and compiles 1200 lines per minute. The macro assembler resides in 16K and assembles 1000 lines per minute. Available on single or double density diskettes. Single copy: $500.


All software available at single-copy prices or OEM/Dealer agreement prices.

Only one company sets the pace with software for microprocessors.

THAT'S MICROSOFT.

Whether it's BASIC, FORTRAN, or COBOL, the largest-selling microcomputer systems use software by Microsoft:

Radio Shack. Tektronix. NCR.
Apple. TEI. Commodore.
Imsai. Ohio Scientific.
Ontel. Rockwell. and many others.

And at Microsoft, new things are happening all the time.

MICROSOFT
10800 NE Eighth, Suite 819
Bellevue, WA 98004
206-455-8080
Telex 328945

Circle 9 on reader service card
The Super Counters:

You're looking at the highest capability universal counters available today by far. With them you can make frequency, period and time-interval measurements that no other counters can do. Although they make ordinary measurement jobs easier, they also give you significant advances in accuracy, speed, performance, range and versatility.

**Advanced measurement techniques** give these counters far greater measurement resolution than other universal counters: up to 1000 times greater for frequency and up to 500 times greater for single-shot time interval.

The HP 5370A: ±20 ps single-shot resolution. 11 digits in 1 second. Statistical computation. Microprocessor control.

**A new combination of features** allows you to easily make measurements that less versatile counters cannot make—like accurate high speed dynamic measurements. These features include: unusually flexible architecture, triggered measurement capability, unmatched logic speed throughout and acceptance of any externally commanded gate time—instead of being limited to measurement times that are decade values of one second.

**For systems use**, both models offer HP-IB (Hewlett-Packard Interface Bus: IEEE-488-1975) for low cost systems interconnection.
Easily the highest capability counters available today.

The HP 5345A: Reciprocal counting to 500 MHz coupled with 2 ns single-shot resolution. 9 digits in 1 second. Expandable to 18 GHz.

Other unmatched features include:

**Model 5370A:** STATISTICS/microprocessor-computed mean, max, min and standard deviation of time intervals. TRIGGER LEVEL MEASUREMENTS/displayed to 10mV resolution with one keystroke. FAST CORRECTION/one keystroke compensates systematic errors such as unequal cable lengths.

**Model 5345A:** PLUG-IN VERSATILITY/ optional front panel plug-in accessories expand measurement range to 18 GHz, make automatic narrow-pulse RF measurements to 4 GHz, or add a third 500 MHz channel. HIGH-SPEED LOGIC THROUGHOUT/for higher speed in systems use... over 50,000 four-digit readings per second in HP's 5391A Frequency and Time Data Acquisition System, for example. The Super Counters offer many other features to help make your measurements much faster, simpler, more convenient and, of course, accurate. They're described in comprehensive data sheets that are yours for the asking. Prices: 5370A, $6500* including HP-IB, 5345A, $4400* plug-ins and HP-IB extra.

*Price domestic U.S.A.

**Your broadest choice of counters from the industry's most experienced source.**

The HP counter line is unmatched in breadth of choice from budget-conscious basic counters to the most sophisticated multi-purpose models available today. They're described in an Electronic Counter Selection Guide that we'll mail along with your 5370A and 5345A data sheets. Call or write today.

**HEWLETT-HP PACKARD**

1507 Page Mill Road, Palo Alto, California 94304

For assistance call: Washington (301) 948-6370; Chicago (312) 255-9800; Atlanta (404) 955-1500; Los Angeles (213) 877-1282

Electronics/March 15, 1979
News update

- It's beginning to look as if Grumman Aerospace Corp.'s championing of synthetic-aperture radar (SAR) for tactical purposes will pay off. The Navy is allotting $8.9 million for a flight demonstration of the Grumman-Norden Systems Radar-Guided Warning System. The system adds to the radar a new angle measurement technique that has been designed to overcome previous shortcomings of SAR [Electronics, March 31, 1977 p. 31].

Other defense agencies are also interested in the RGWS concept, which combines target acquisition and weapon guidance. Grumman, in Bethpage, N.Y., now has a $15 million contract from the Air Force to develop just such an airborne system to work with ground-based weaponry. Hughes Aircraft Co. has a similar Air Force contract.

Grumman has been promoting RGWS for several years as a way of adding a long-distance, all-weather attack system to the Navy's A-6E. By providing more precise target information at greater distances, a radar with RGWS capability would enable a plane's pilot to launch weapons before entering the range of surface-to-air missiles.

Only 3 feet in diameter, the SAR antenna operates as though its aperture were several hundred feet wide. Essentially, it processes returning signal information often missed by conventional radars and provides an image of much higher quality. In fact, Grumman expects a 1,500-fold improvement in image detail.

SAR provides a target map, but does not locate area precisely in relation to aircraft. Grumman's solution—developed in conjunction with Norden Systems Inc., Norwalk, Conn., a subsidiary of United Technologies Corp.—is called a relative angle processor. It analyzes angles of arrival at the right and left antenna halves of signals from the target, using them to compute altitude and azimuth data.

A previous Navy contract involved ground processing of the data. Now the companies are working on airborne processing equipment for 1981 flight tests. Ben Mason
Expanding the parameters of press-fit technology

Bellows contact now available in economical press-fit backpanels.

Through a dramatic new production technique, the familiar bellows-type contact pin is now available in press-fit. You get all the benefits of the bellows spring design — but with the advantages of press-fit... such as up to eight planes of circuitry without external wiring.

The true spring action of the bellows contact gives you much lower insertion force requirements — but equal retention. That means less gold wear on the contact.

As with all press-fit contacts, the bellows contact is removable and replaceable on the board. However, with the bellows press-fit contact, the insulator housing need not be removed.

The bellows press-fit contact can be selectively plated to get the gold exactly where it’s needed — and nowhere else. Offers lower cost for greater value.

Make your own backpanels. We’ll help you do it.

If your volume of usage justifies it, we’ll set up a program to furnish you the equipment and supplies to produce your own bellows contact backpanels. We opened the door to industry application of press-fit, and we’re making it more usable all the time. Write or call for additional information.

ELFAB
The Leader in Press-fit Technology
P. O. Box 34555 • Dallas, Texas 75234 • 214-233-3033
People

Walker hopes to soothe Tektronix' growing pains

Every company has growing pains, even one so long established and well known as Tektronix Inc., the instrumentation manufacturer. When its business surged last year by 32%, there were signs that restructuring of responsibilities was in order, and William D. Walker was elevated to the new post of executive vice president.

"We've grown faster than anticipated, and the old organization could not keep up," says Walker, whose job is to share the load on Tektronix president Earl Wantland's shoulders. The company ended its 1978 fiscal year at nearly $399 million. But another set of figures was an early warning—unfilled orders jumped from $128 million to $179 million.

Prior to the surge, Tektronix had embarked on an aggressive program of increasing its work force and work area. But new money, people, and facilities all require special attention from management, Walker points out. In his new job, he assumes responsibilities for manufacturing operations, marketing and sales, and research and development formerly carried by Wantland, who can now concentrate on long-term strategies and finances.

If anyone knows his way around Tektronix, Walker does. He's a 20-year Tek veteran familiar with its products, people, and goals. He has also had managerial experience in almost every area of the company, including engineering, product planning, and manufacturing. Most recently, he was group vice president of test and measurement products.

No surprises. Walker's plans—those he will reveal, at any rate—contain no surprises. Tektronix will continue fighting to keep its lead in oscilloscopes and low- to medium-resolution computer graphics terminals featuring proprietary storage cathode-ray tubes.

In addition, "we intend to remain in the high-end device test area but prefer not to scale down, for example, to the level of Sentinel," says Walker, alluding to Fairchild's recently introduced medium-sized system for testing large-scale integrated circuits [Electronics, Jan. 4, 1979, p. 161]. "We prefer to stay at the high-end line where the degree of capital commitment tends to keep competition down," he continues. Tektronix will continue to support its logic development systems area, Walker says, and he hints that it will probably broaden its logic analysis and digital test products.

Foster wants Interstate to be the plasma display source

Plasma displays are making little headway replacing cathode-ray tubes for lack of a steady supply of flat glass panels and because of sky-high prices—almost $1,000 for the panel alone, with drive and control electronics pushing it to $4,000 and up. But recent moves by Interstate Electronics have whipped the first problem, and the second is under attack, according to Richard A. Foster, new president of the A-T-O Inc. subsidiary.

"We're making a serious commitment to the future of plasma display," says the 43-year-old Foster, who moves up after four years as vice president of operations and 20 years of total service. What he terms "our first true commercial display product" (compared to military versions) will be ready in mid-to-late 1979. It will have a simplified, more compact electronics package that can be located remotely. This is

NEW TEXT TOOL
ECONO ZIP PRODUCTION
SOCKETS

New TEXT TOOL inexpensive ECONO ZIP socket series features easy, safe zero insertion and extraction pressure for "end-user" production requirements.

TEXT TOOL's new low cost ECONO ZIP series of production sockets are especially designed for those applications where initial loading and field replacement of expensive IC's are a necessity and socketry is an absolute requirement.

ECONO ZIP sockets are available in 16, 24 and 40 pin models. They are designed for mounting on standard 100° centers on either axis.

The ECONO ZIP socket is designed for the most simple mechanical action. A device can literally be dropped into the socket. Rotation of the cam to a built-in stop firmly retains the device with exceptionally good electrical contact. Counter rotation of the cam releases the device, thus providing zero pressure during both insertion and extraction.

These economical (U.L. approved plastic) production sockets offer additional device protection features including wide entry holes to accept bent or distorted leads that don't have to be reform prior to insertion, a screw driver operated plastic cam for easy operation and prevention of accidental unloading, and extremely long life (hundreds of actuations).

Detailed technical information on new low cost ECONO ZIP production sockets is available from your nearest TEXT TOOL sales representative or the factory direct.

TEXT TOOL
PRODUCTS, INC.
1410 W. Pioneer Drive • Irving, Texas 75061
214/259-2676
A Mux in Linear Wonderland

PMI Takes the Nonsense Out of Analog Multiplexers

Alice's nonsensical Wonderland was full of strange names, like Gryphon, and the famous Jabberwock. And slithy toves and borogoves.

In Linear Wonderland designers have a similar situation—like the MUX for instance. There are lots of analog multiplexers—and they're as confusing as Alice's Wonderland when engineers try to compare PMI's BIFET MUXes with other standard BIFET and CMOS versions. But they know that only from PMI "OFF" isolation, crosstalk, overvoltage protection and low cost are available in one component.

They know also that CMOS is known for static blowout and latch up, but PMI's BIFET technology has protection right in the chip, without expensive dielectric isolation, external or internal series resistors—or special handling. No other manufacturer of CMOS or BIFET MUXes offers that.

If you're tired of nonsense, challenge us. See if a PMI MUX really gives you BIFET reliability and low cost with break-before-make action. Just send in the coupon for your free "NO NONSENSE" MUX design information.

Lewis Carroll could get away with nonsense with his readers, but ours won't put up with it. They know the difference between slithy toves and borogoves. Here's the speed-power tradeoff table and prices.

If someone beats you to the coupon, write to us for your no nonsense MUX literature or circle #200.

**Precision Monolithics, Incorporated**

1500 Space Park Drive
Santa Clara, California 95050
(408) 246-9222 TWX: 910-338-0528 Cable: MONO

---

Mail to:
Precision Monolithics, Inc., 1500 Space Park Drive
Santa Clara, CA 95050

Send me some no nonsense MUX data sheets and application notes.

My name__________________________

Title______________________________

Company__________________________

Dept______________________________

Address____________________________

City________________State________Zip_____

Phone______________________________
Can’t see the difference? Small wonder. Film capacitors are film capacitors, are film capacitors. Ours do what theirs do, theirs do what ours do. Why, then, should you buy ours? Well, they’re priced right. And we do the very best job we can in every way: best materials, careful manufacture, complete QC. We try for 100% reliability in product and delivery and we come at least as close as anyone else and closer than many.

We make film capacitors: metallized polyester, polycarbonate, polypylene, polyester, polystyrene film and foil capacitors. Very good ones.

We’re not a giant and capacitors are all we make. No widgets, swidgets or other components. Just capacitors. So we can’t afford anything but top quality and reliability. But, since everyone claims these things, we have to be very price competitive as well. We are.

And, we care. About quality. And price. And delivery. We have to care. So that you will think Seacor and buy our capacitors. We have a catalog describing the capacitors we make in some detail. It’s free of course. Please write or phone for it. We can arrange samples, too. Of ours, not theirs.

SEACOR INC., 123 Woodland Ave., Westwood, N.J. 07675
Tel. (201) 666-5600 □ Telex 135354
Circle 16 on reader service card

Everything in Film Capacitors
Now we've put Teledyne technology in this popular SSR package

If you have been designing around this solid state relay package simply because of multi-source availability, this is important news. You don't have to settle for less than the best anymore. Now you, too, can reap the benefits of Teledyne SSR technology.

For instance, the Teledyne 615 features a 40% reduction in component count. We don't need to spell out the cost and reliability advantages that gives you.

No black magic. We do it by using ICs to replace a significant part of the discrete circuitry. We designed the ICs ourselves. We build them ourselves. That gives us an exceptional degree of quality control. And it gives you reliability and performance you can really count on.

The Teledyne 615 Series is available in 10, 25 and 40 amp versions. Contact us for full technical details or see your local Teledyne distributor for off-the-shelf delivery.
Is automatic testing a panacea? With today's PC volume and complexity, it's not so much a panacea as it is a necessity. But to implement a test solution requires a thorough understanding of the available test systems and your production environment.

**When to test?**
That's as important as how. The cost of fault identification increases dramatically with each production step. Thus, you want to catch faults as early in the production process as possible, but it doesn't necessarily follow that extensive incoming parts inspection is the answer. Your real goal is high turn-on rates in final test. That demands high-yield PC boards. And as the diagram below shows, several factors including good parts go into high-yield PC boards.

A PC board assembly process will produce anywhere from 20% to 80% good boards. A typical number is 60%. Of the faulty boards, a fault spectrum might look like this:

With a good board yield of 60% and no PC board testing, even a simple product with five boards would over-load final test. Nine out of ten units would fail. This makes board level a good place for thorough testing. For this is the first opportunity to locate faults across the entire fault spectrum. But which tester is for you?

**Choosing a circuit board tester.**
There are no simple answers to selecting an automatic circuit test system. But, from our experience, we know that these are some of the factors involved: Production yield, test yield, fault spectrum, PC volume, board type, and anticipated new products.

Will the system test for the spectrum of faults that you will encounter? Will it generate component level diagnostic information? Will it test present and future board types and do it fast? Is it easy to expand and adapt to changing requirements?

What are the true costs? How much time and effort is involved in programming, debugging, fixtureing and training? And will you get prompt, competent service if you need it? HP can help you answer these key questions.

**Over two million boards worth of experience.**
HP's new Automatic Circuit Test Systems are the result of our extensive in-house experience with automatic circuit testing.
result in large improvements in product yield, as shown below. For example, in a ten PC board product, increasing board yield by only 8% (from 90% to 98%) will leverage product turn-on rate from about 35% to 80%. That’s a large payoff, and an excellent reason to consider HP’s 3060A.

The standard 3060A has a full set of analog and digital functional testing tools for testing most analog, digital or combined boards including at-speed testing of microprocessor-based boards using signature analysis techniques.

Some boards, such as large complex logic boards, will benefit from the use of HP’s DTS-70 Digital PC Board Test System ($90,350* for standard operational system). This simulator-based tester tells you how effective your test programs are and identifies the portion of the circuit not completely tested. This is important feed-back permitting better program development. A useful tool in R&D, the DTS-70 can model your designs and help you produce better products. Your test engineer will appreciate its ability to model feed-back loops, find open traces and identify intermittent faults.

Just as important, the DTS-70’s power and flexibility comes from its controller, the HP 1000 Computer System. Using a Real-Time Executive operating system, you can simultaneously test PC boards and develop new programs. As your testing needs expand, two more test stations and several programming terminals can be added without the expense of additional computer power. The operating system is compatible with data-base management software to keep track of your test data and help you better manage your production. The DTS-70 will easily fit into your long range computer network plans providing distributed processing and communication to your data processing center.

The bottom line. Can automated PC board test equipment save you money? Again, there are no simple answers. But it has saved us money and chances are it will save you money, too, if any of these conditions exist in your plant: high PC volume, complex boards, production testing backlog, low turn-on rates of complete systems, high in-process inventory costs and high warranty costs.

Your production operation is unique, but we can help you characterize it by comparing the cost of testing, or not testing, at each level to arrive at your best test resource allocation. Let us help you answer these key test questions. Call your HP field engineer today.

* Domestic U.S.A. price only.

HP Circuit Testers—The Right Decision

HEWLETT PACKARD

P.O. Box 60001, Loveland, Colorado 80537

For assistance call: Washington (202) 944-5400, Chicago (312) 255-9800, Atlanta (404) 955-1500, Los Angeles (213) 877-1262

Circle 19 on reader service card
VAX 32-bit software. It lets you write your programs in record time.
Compared with every other 32-bit OEM computer on the market, Digital's VAX-11/780 doesn't only run faster. It programs faster too. And the reason is simple. The software.

The VAX-11/780 comes with the most comprehensive, most powerful set of 32-bit development tools ever offered to the OEM. Compilers. Linkers. An on-line HELP command. A symbolic de-bugger that can print out in familiar decimal notation, as well as binary. Editors that create new files while keeping prior versions available.

In addition, the VAX/VMS operating system is designed to do many of the things that would have to be written into the application program on other machines. It gives you features like a real-time scheduler. Automatic or user-controlled memory management. Built-in network protocols. And a file system that can access data any way you like. Since the operating system can do more, you do less—and deliver to your customer sooner.

With over 800 man-years of development behind it, VAX software is also incredibly reliable and fully mature.

The VAX-11/780. It programs like it runs.
How Fairchild Takes the Thorns out of LSI Testing.

Choosing the right LSI test system is tough. There are many things to consider, and one of the most important is customer support. Here's how Fairchild makes the difference. Whether you buy our Sentry general purpose LSI tester or our Xincom memory test system, we'll back you with the largest and most professional service and support team in the industry.
Applications Engineering. Our team of applications specialists will program our systems to give you all the information you need about how to test your device. Whether you buy a system or not. If you do buy, all that information and programming are yours.

A world of training. Even the best system is only as good as the people who run it. To make sure your people know everything they have to about LSI testing, we've built the largest and most comprehensive training center in the world. With every Sentry or Xincorn system, you're covered with course credits. Even before your system is installed, your people will learn operation and maintenance, basic programming and assembly language. They can also take special courses in programming and advanced LSI testing techniques. And they'll get all the hands-on training they'll need in our test lab.

On-site preparation. While your people are training at one of our centers in the U.S., Europe or Asia, our engineers are at your plant helping you get ready for delivery. Our product specialists help you find the best locations for your system. They make sure all your device programs have been checked out. And they make sure your system gets up and running fast.

Service is our specialty. No matter where you are, we've got you covered. More than 100 field engineers around the world assure fast response whenever you need help. You can choose from a variety of service contracts. One gives you complete calibration and servicing, free parts replacement and a guarantee to be there within 24 hours. Another provides a spare parts kit that offers even faster turnaround. And if your operation needs it, we can provide a resident service or applications engineer.

We won't let you forget. If you need additional or special training, we can help. Our programmed learning center offers video tapes, audio cassettes and special workbooks. On-site courses can also be arranged. Nearly a hundred application notes are available to help you solve almost any LSI testing problem. There's even a User's Club, which gives you a chance to exchange programs and experiences with others in your field.

There's more. Whether you choose Sentry or Xincorn, we'll make sure you don't get stuck. We'll help get rid of the thorns all along the way. Before, during and after your system arrives.

Find out more about Fairchild's total support program. Mail the coupon today.
Or contact: Fairchild Systems Technology, 1725 Technology Drive, San Jose, CA 95110 (408) 998-0123

---

Fairchild: First in LSI testing

[Check box options: Please have a representative call. Send your Total Support brochure.
My test needs include ____________]

Name ______________________
Tel ______________________
Company ______________________
Address ______________________
City/State/Zip ______________________
Area Code (  ) Phone ______________________

Circle 23 on reader service card
Editorial

Are ‘they’ in trouble?

The language may be different, but the theme surely is familiar. Japanese newspapers recently were enlivened with large advertisements decrying the move to open phone company purchases to international bidding. Sponsored by two trade groups of equipment makers serving the Nippon Telegraph and Telephone Public Corp., the ads were headlined “We are in trouble.”

“We,” it turns out, means not just NTT and its suppliers but every Japanese citizen. Should the government decide to open NTT equipment to general bidding [Electronics, March 1, 1979, p. 63], the results would be “devastating,” says the ad. “Service expected by the nation could not be maintained, and service cost itself would go up.” This is a rough partial translation of the ad, but to many observers of the telecommunications industry it must sound like a reprise.

Remember the Carterfone decision of the U.S. Supreme Court, which threw open American Telephone and Telegraph Co.’s lines to competitive equipment? That decision was preceded by manifesto after manifesto from AT&T arguing such equipment would degrade the U.S. telecommunications system. The dust has settled now, and to no one’s surprise (maybe not even Ma Bell’s), the American phone system is alive and well. It has accommodated itself to equipment from all over the world—even from Japan.

Implicit in the ad is the notion that NTT and its suppliers are sacrifices in the tense trade negotiations. By permitting open competition, the Japanese government will satisfy the U.S. negotiators’ demands for greater market access—so runs the undercurrent.

To put it politely, this attitude is completely unjustified. Telecommunications everywhere is a growth industry with rapid technological development the order of the day. NTT is no pawn in the trade debate; it is a major market in itself, one that can best be served by unfettered competition. The sooner that realization comes, the better—for the Japanese people, as well as for telecommunications suppliers around the world.

Finally, the specter of technological disaster needs to be exorcised once and for all. No one doubts that NTT operates a fine voice and data communications system, with rigorous demands on its equipment. But so does AT&T, and outside suppliers are living up to its requirements.

Fiber optics in the cold light of day

A market research firm not usually known for its bearish outlook has cast more doubt on the rapid acceptance of fiber optics. In “Fiber Optic Technology and Markets,” New York researcher Frost & Sullivan Inc. questions the idea that a major commercial boom in fiber is just around the corner. Think more in terms of 10 years, F&S advises. Indeed, the field is already overcrowded with competitors touting real or imagined products, as we pointed out in a special report on data links late last year [Electronics, Dec. 21, p. 89].

Not that fiber won’t grow. Frost & Sullivan estimates that military sales will be worth $20 million by 1987. Telephony will come to $22 million and telecommunications to $10 million by then. As for the fiber-optic—wired home, sales may not get much higher than $2 million by 1987.

Let’s face it, there are problems. One is the lack of long-lasting light sources and good connectors for easy systems hookup. Even standards of design are lacking for most applications.

Yes, fiber optics will take its place in the electronics industries. But it’s not going to be a panacea nor an overnight bonanza. Therefore, it is well that manufacturers and users avoid the hyperbole that blew millimeter waves and the wired-nation concept out of proportion.
PRO-LOG makes it easy to board the STD BUS.

Introducing the STD BUS, the simplest bused microprocessor system ever made. STD means Simple To Debug, Simple To Develop, Swift To Deliver.
The new STD BUS—8-bit microprocessor systems built around a standard bused motherboard which allows any card to work in any slot. Thus you can change the function of your system, the memory type, even the microprocessor type by simply exchanging one card for any other. The STD BUS is 56 lines wide and is compatible with Pro-Log's standard 4½-inch by 6½-inch edge-connected cards.

It's supported by both Pro-Log and MOSTEK and freely available to the industry.

A whole new card series available for use with the STD BUS.
Our new 7000 Series 8-bit systems were specifically designed for use with the STD BUS. We have cards in limited quantities now, in production quantities in January.

Buy 250 of any one card, and we give you free the plans for that card and non-exclusive manufacturing rights so you can build it yourself.

In addition to cards, we also make a ½ or ¼ rack card cage. It includes motherboard, card edge connectors and mounting brackets.

Every part in our systems is or soon will be a second-sourced industry standard which means that if you produce our systems yourself, you'll never have to worry about the availability of sole-sourced parts. Through cross licensing arrangements, MOSTEK will also be building most of our cards giving you yet another source of supply.

Learn about the STD BUS and our 7000 Series Systems.
Send for our Microprocessor User's Information Packet.
Pro-Log Corporation, 2411 Garden Road, Monterey, CA 93940. Phone (408) 372-4593.

Watch for announcements as new cards become available.

PRO-LOG CORPORATION
Microprocessors at your fingertips.

"Visit us at ELECTRO 79, Booth 1313 - 1315"

Electronics / March 15, 1979

Circle 25 on reader service card 25
Meetings


Seminar on Microprocessor Applications, Continuing Education Program, Pratt Institute (Brooklyn, N. Y.), Essex House Hotel, New York, April 6.

Interface '79—Seventh Annual Interface Data Communications Conference and Exposition, The Interface Group (Framingham, Mass.), McCormick Place, Chicago, April 9–12.


16th Annual Rocky Mountain Bioengineering Symposium, IEEE, Fitzsimons Army Medical Center, Denver, Colo., April 23–25.

27th Annual Relay Conference, National Association of Relay Manufacturers (Elkhart, Ind.), Oklahoma State University, Stillwater, Okla., April 23–25.


Newcom—The 1979 Electronic Distribution Show, Electronic Industry Show Corp. (Chicago), Las Vegas Convention Center and Las Vegas Hilton Hotel, Las Vegas, Nev., May 1–4.


Finally.
Compatibility.

With Mostek's
new 8K
static RAM.

compatible with ROMs and EPROMs. Compatible with microprocessors.
Mostek's new 8K static RAM offers total flexibility for your system. Organized as 1Kx8,
the 4118 is a next generation Micro Memory,™ available today.

It's a Micro Memory!
Designed for 8-bit and
16-bit systems, the 4118 interfaces directly with all present
and future generation microprocessors. A Chip Select control is provided for easy memory
expansion and decoding, and internal latches are available to latch the Address
and Chip Select inputs. If the Latch function is not needed, it can be easily bypassed. An
Output Enable control provides easy user control of the
bus in all bus configurations. System design is simplified with the MK4118.

It's more than common!
With a pinout common to
standard 24-pin ROMs,
PROMs, and EPROMs, the
4118 still has more. Access
time is a fast 120ns (max.) and
power dissipation a low 200
mW (typ.). The 4118 is the new-
est addition to our compatible

Micro Memory family which includes Mostek's 2716
EPROM.

It's immediately available!
For byte-wide, memory applications requiring density,
flexibility, and immediate availability, Mostek's 4118 is
the one to choose. For the location
of your nearest distributor, call 214/245-0266, Mostek
Corporation, 1215 West Crosby Road, Carrollton, Texas 75006.
In Europe contact Mostek Brus-
sels; phone (32) 02/660.25.68.
Mostek distributors.

Advent Electronics
CEDAR RAPIDS, IA
INDIANAPOLIS, IN *

Arrow Electronics
ANN ARBOR, MI *
ATLANTA, GA *
BALTIMORE, MD *
BLOOMINGTON, MN
CLEVELAND, OH
DAYTON, OH
FARMINGDALE, NY *
FT. LAUDERDALE, FL *
HAMDEN, CT
MELBOURNE, FL
MOORESTOWN, NJ *
OAK CREEK, WI
SADDLEBROOK, NJ

Bell Industries
ALBUQUERQUE, NM
CHICAGO, IL *
DENVER, CO *
SALT LAKE CITY, UT
SUNNYVALE, CA *

Cramer Electronics
DALLAS, TX *
EDINA, MN *
GAITHERSBURG, MD *
NEWTON, MA *
ROCHESTER, NY *
SOLON, OH *
SUNNYVALE, CA *
SYRACUSE, NY *

Diplomat Southland
TAMPA, FL

Ft. Wayne Electronics
FT. WAYNE, IN *

Graham Electronics
INDIANAPOLIS, IN

Hammond Electronics
GREENSBORO, NC
GREENVILLE, SC

Intermark Electronics
SAN DIEGO, CA
SANTA ANNA, CA
SUNNYVALE, CA

Kierulff Electronics
BILLERICA, MA *
CHICAGO, IL *
DENVER, CO *
LOS ANGELES, CA
PALO ALTO, CA *
PHOENIX, AZ *
RUTHERFORD, NJ *
ST. PETERSBURG, FL
SAN DIEGO, CA
SEATTLE, WA *

Lionex Corp.
BOSTON, MA
WOODBURY, NY

Olive Electronics
ST. LOUIS, MO

Preco Electronics
MONTREAL, CANADA *
OTTOWA, CANADA *
TORONTO, CANADA *

Quality Components
AUSTIN, TX *
DALLAS, TX *
HOUSTON, TX *

R.E. Industrial
VANCOUVER, CANADA

Schweber Electronics
ATLANTA, GA
BEACHWOOD, OH
BEDFORD, MA *
DANBURY, CT *
HORSHAM, PA *
HOUSTON, TX *
IRVINE, CA *
LIVONIA, MI *
ROCHESTER, NY *
SOMERSET, NJ
WESTBURY, NY *

Semiconductor Specialists
KANSAS CITY, MO

W.E.S. Ltd.
WINNIPEG, CANADA

*Demonstration Center
The quick step to Z80 power.

Get on the fast track to Z80 power with your local Mostek distributors. They have everything you need, including factory trained engineers and demonstration centers at many locations.

Start with our MK 3880 line of Z80 components, industry's most powerful 8-bit microcomputer family.

Or begin with our MD Series™ of OEM microcomputer boards. It features our MDX-line of STD-Z80 BUS compatible modules for building your system one function at a time. You buy only what you need, and reduce hardware design time.

Plus you only need one development system, Mostek's AID-80F™ to develop and debug software for all our microcomputer products. BASIC and FORTRAN are also available for use on the AID-80F.

For components, boards, or systems, take the quick step to your nearest Mostek distributor. Or contact us directly for more information at 1215 West Crosby Road, Carrollton, Texas 75006; phone 214/242-0444. In Europe, contact Mostek Brussels; phone (32)02/660.25.68.

MOSTEK®

Circle 29 on reader service card
In logic design, production or service,

If your product or service depends on logic, you should know about HP's constantly expanding family of logic-test equipment.

You'll find a wide choice of measurement solutions designed to make logic analysis, testing, troubleshooting and servicing easier, more efficient and more cost effective than ever before.

HP logic-test equipment offers capabilities ranging from hand-held troubleshooting tools to automated instrument systems... instruments for stimulus and instruments for monitoring... dedicated instruments and multipurpose in-
depend on HP for your testing and troubleshooting solutions.

Instruments. In fact, HP has logic-test equipment to support products in every phase of your operation, including design, production and service.

That's why you should have a free copy of our new Logic Brochure — complete with many useful product descriptions and selection guides. It can help you pick the right instruments for your organization's particular logic testing and troubleshooting needs.

In design, HP's logic family gives you the tools to speed the transition from concept to product. They put you on critical system buses as well as key circuit nodes for a real-time view of system operation. That can mean faster troubleshooting, shorter development time and greater design reliability.

In production, HP has a choice of instruments and systems for each of the three important levels of production test: incoming inspection, board test and system test. These logic testers are designed to help you verify performance and quickly isolate faulty components and assemblies. They’re your assurance of component quality, board test efficiency and system reliability. And they can help you maintain high product quality, meet delivery schedules and control production costs.

In service, HP offers an array of portable instruments to arm field service personnel, plus versatile bench instruments for plant and depot service facilities. Put these vital logic-testing and troubleshooting tools in the hands of your service engineers and technicians for easy detection and isolation of logic malfunctions. You'll speed installation, maintenance and repair in a wide variety of digital systems.

Find out more about HP's logic family by sending for our free Logic Brochure today. It includes product application descriptions plus selection guides so you can zero in on the required instrumentation for your organization.

Just fill out and return the reply coupon. Or, for immediate assistance, contact your local HP field engineer.

HP—When you depend on logic

Please send me a free copy of the HP Logic Brochure.

Name
Title
Company
Address
City/State/Zip

Mail to: Hewlett-Packard, 1507 Page Mill Road, Palo Alto, California 94304

Circle 31 on reader service card
When you're small you've got to be tough to last.

This rugged little $\frac{3}{8}$-watt fixed resistor (\.145 L x .062 D) is hard to beat in durability. It's the Type BB...part of a family that has passed nearly 800 million unit test hours without a single failure. It's small enough to be mounted on .300 by .100 hole centers, eight in the same space as one dual in-line package. It takes transient pulses that would knock out most any film resistor of similar dimensions. Performance is exceptionally consistent from one resistor to the next. We have the space-saving resistors you need. Our distributors have them when your need is now.

**Quality in the best tradition.**

ALLEN-BRADLEY
Milwaukee, Wisconsin 53204

Circle 32 on reader service card
With a crash program aimed at a silicon-gate redesign of its MC14-1000 microcomputer, Motorola is hoping to correct a severe backlog that has arisen from yield deficiencies with the company's metal-gate version of the 4-bit complementary-MOS machine. Limited samples of the silicon-gate redesign may be available late this month, says an official at the firm's Austin, Texas, integrated-circuit operation. In going to the denser silicon-gate technology, Motorola expects to be able to move the part quickly down the learning curve. That has not happened with the metal-gate version. The result has been supply problems for customers whose low-power applications can't use the n-MOS or p-MOS versions of the popular TMS1000 design supplied by other firms.

With memory device testing leading the way, the automatic test equipment market is living up to predictions that it will enjoy a healthy 1979. The latest evidence is the first crop of bubble memory testers, one of which is coming from the Xincom division of Fairchild Camera and Instrument Corp.'s Test System Group in Chatsworth, Calif. The new Xincom tester will be able to operate as a stand-alone unit or interface with the host computer of a large Xincom test system. Fairchild hopes to introduce it at the Semicon West show that is scheduled to be held in San Mateo, Calif., May 22-24.

Built around two microcomputer chips, GenRad Inc.'s new model 1731 linear integrated-circuit tester may be one of the most comprehensive systems on the market even though it fits on a benchtop and costs only $22,900. With a Z80 chip to control its test, calculation, display, and keyboard functions and a Rockwell 6502 to control its tape-drive functions, the Concord, Mass., firm's model 1731 checks out operational amplifiers, voltage comparators, voltage regulators, voltage followers, and current mirror op amps—perhaps more than 3,000 device types.

Software, stored on magnetic-tape cassettes, specifies program generation and entry plus system setup. The test software literally prompts operators through the correct sequence of tests; because it is so interactive, it could save much of the personnel component of testing costs. But the initial payoff will be a level of performance and features similar to those found on systems with six-figure price tags.

Texas Instruments Inc. says it will begin limited shipments during the second quarter of a 1-megabit magnetic-bubble memory board and associated controller board for purposes of evaluation, prototyping, and small production runs. Expected to find early use in industrial control systems and small data-processing applications, the bubble board will be the first to incorporate TI's 256-K bubble memory chip—the TIB0303—announced last August. With four TIB0303s on it, the 11-by-7½-inch board is designed to work with the controller board as a general-purpose operating subsystem—expandable to an 8-million-bit system—for use not only with the company's microcomputer and minicomputer lines, but with other manufacturers’ machines as well.
To protect the sensitive parts of computer and memory systems, Advanced Micro Devices Inc., Sunnyvale, Calif., plans to come out this summer with a power supply controller chip that features these programmable functions: delay and rise time for the power supply, ±5% or +10% over-voltage protection, current limit detection, delays for over-voltage and over-current shutdown circuits. Moreover, the bipolar AM6800, due to be shipped in sample numbers in May, also monitors the power supply and informs the computer of the status. The device is TTL-compatible and is housed in a 20-pin dual in-line package. It also boasts a 2.5-V reference characterized to within 0.25%.

Will it come down to a shootout in St. Louis? The CBS Broadcast Group will conduct technical tests of the rival British and French television text information services at its station there, KMOX-TV. Planned tests of the French system, Antiope, have been discussed [Electronics, Jan. 18, p. 33], but plans for the face off with the incompatible British Teletext system emerged only when CBS filed with the Federal Communications Commission for authority to conduct the over-the-air tests. Because special decoders are needed for the signals, sent on one line of the TV-field blanking interval, the tests will not interfere with home viewing. CBS Broadcast Group president Gene F. Jankowski says the tests are “an effort to determine which system will provide the best and most reliable teletext service.”

Now that Bell Canada has a full-feature fiber-optic system operating in 40 Toronto homes [Electronics, Jan. 4, p. 33], Manitoba telephone, which is independent of Bell, is going to wire 150 homes in the rural Manitoba town of Elie. The $6.1 million feasibility study—there is no similar project in the U.S.—will offer multichannel television and FM radio plus a variety of other services. ... Dictaphone Corp. of Rye, N.Y., is jumping into the market for pocket-size dictating machines with an 8-oz unit that offers such features as fast forward and fast erase. Using the minicassette developed by market leader NV Philips, the Dictamite costs $195. ... Solid State Scientific Inc. of Montgomeryville, Pa., has agreed to sell its Radio-Frequency Transistors division to DuMont Electronics Corp. of Clifton, N.J., a wholly owned subsidiary of Thomson-CSF of France. The division will be renamed the Solid-State RF and Microwave division and will sell French-made high-frequency devices in the U.S. ... As part of a $160 million demonstration program subsidized by the Department of Energy, New York City’s Consolidated Edison Co. has purchased 40 electric vehicles, modified AMC Pacers, from Electric Vehicle Associates of Cleveland, Ohio. The cars are powered by 20-horsepower, SCR-controlled dc motors and 20 lead-acid batteries rated at 145 ampere-hours. ... General Motors Corp. has agreed to purchase at least 7,000 commercial video-disk players from Universal Pioneer Corp., the joint venture of Pioneer Electronic Corp. of Japan and MCA Inc. of Universal City, Calif. ... Look for Texas Instruments Inc. to second-source Intel Corp.’s codec. Such a big-name alliance should go a long way toward breaking down the reluctance of telephone companies to switch to solid-state devices... Actually saying for the first time that it plans to market a home computer, Texas Instruments has asked the FCC to temporarily consider rf modulators and video sources as separate items.
It's the great Codec-based transformerless telephone subscriber channel unit.

Now, for the first time, a low-power, low-cost, space-efficient telephone Subscriber Channel Unit (SCU) without transformer or hybrid circuit is more than a vague hope for the future.

Motorola has developed a unique complement of three reliable monolithic LSI circuits and three specially-designed discretes. Our PCM Codec, PCM Filter, and Subscriber Loop Interface Circuit (SLIC) will produce the least-expensive, lowest-power, most-compact SCU for future Class 5 Central Office, PABX and carrier equipment designs.

Codec and discretes are available. Filter and SLIC sampling is firm for early 2nd Quarter, '79.

**SLIC banishes transformers**

It's the SLIC that displaces transformers, saving both money and space. In it, the MC3419 provides signal separation for 2- to 4-wire conversion plus suppression of longitudinal signals at the 2-wire input. Two specially-designed power Darlington's, MJE270/271, and the MDA220 transient suppressor complete the circuit. The SLIC provides hook-status outputs and operates at near-zero on-hook power. It's the only monolithic semi-conductor SLIC designed to fully meet Class 5 Central Office specs.

The MC14406 and MC14407 are full-duplex 8-bit companded PCM Codecs designed for 8K samples per second. The 24-pin MC14407 provides pin selection of A-law or Mu-law companding, and the 28-pin Mu-law MC14406 offers two-way LSB signaling. On-hook power drain is just 1 mW. Less than any other Codec.

Like the Codec, the MC14413 PCM Filter is manufactured with our time-proven standard metal-gate CMOS process. Both bandpass transmit and low-pass receive filters are on the chip. The MC14413 requires no external precision components. On-hook power use is only 1 mW.

Total on-hook power requirement of the entire card as illustrated is just 10 mW, max. Off-hook power also is superior. The SCU operates with the standard -48 V and a single 12 V supply.

For information, write Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, AZ 85036.

Long-term Motorola leadership in bipolar ICs, power, CMOS and NMOS is your assurance of our capability and product reliability. We are fully committed to providing the telecommunications industry with its requirements for innovative systems through silicon.

**Motorola semiconductors for digital switching systems**

**Subscriber Channel Unit**
Codec, Filter, SLIC

**EPROMs**
8K & 16K

**ROMs**
8K, 16K, 32K & 64K

**Discretes**
Switchmode power
Schottky rectifiers

**Processors**
M6800 Family
(6800, 6801, 6803, 6809)
MC2901A
MC10800

**Ram**
Dynamic RAMs
4K & 16K

Electronics / March 15, 1979
The easy installment plan.
An exploded view of our pre-assembled multidigit LED displays.

Installing LED's one at a time isn't a very bright idea.

Not when you consider that National's two and four digit displays can considerably lighten-up your workload. First of all, our circuits are all on PC boards designed for soldering, wiring or simply plugging into PC connectors. They have LED die already pre-matched for brightness. So you don't have to test brightness digit by digit.

All duals and quads are end-stackable. And come in sizes that fit most anything. 0.3", 0.5" and 0.7" digit character heights. And with common anode, common cathode, multiplex and direct drive configurations.

Put all these time and work saving features together and you have the bottom line to this easy installment plan. It'll save you money.

So ask about our dual and quad LED's. Unless you enjoy making work for yourself.

---

National Semiconductor
2900 Semiconductor Drive
Santa Clara, CA 95051

Gentlemen: Sure, I'd like to save myself some work and money. Please send me further information about National's LED's.

<table>
<thead>
<tr>
<th>Name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td></td>
</tr>
<tr>
<td>Company Name</td>
<td></td>
</tr>
<tr>
<td>Address</td>
<td></td>
</tr>
<tr>
<td>City</td>
<td>State</td>
</tr>
</tbody>
</table>

Electronics / March 15, 1979

National Semiconductor
"We'll give you old-fashioned personalized service."

The customer comes first at Samtec...and our growing OEM and distributor accounts really appreciate it. We believe that service follow-up, delivery and pricing promises are meant to be kept—and we work hard to see that they are.

Why not give us a try and see how trouble-free personalized service can be?

Get our New 32-page catalog today—complete with all specs and ordering data. See what a difference personalized service can make!

Samtec
810 PROGRESS BOULEVARD, NEW ALBANY, INDIANA 47150
PHONE (812) 944-6733

© 1978-Samtec, Inc.
IC makers ready converters for 8-bit processors

Motorola, National talk of one-chip devices that connect to data bus, simplifying system designers' chores

Data converter makers—most of them specialized houses whose hybrids hotly contest each other in the market—are facing intense new competition. A wave of integrated-circuit makers are joining Signetics Corp. [Electronics, July 21, 1977, p. 139] in bringing to market monolithic analog-to-digital and digital-to-analog converter chips that can be connected directly to microprocessor buses. All three main-line silicon technologies—complementary metal oxide semiconductor, standard bipolar, and integrated injection logic are being applied to make the parts.

Motorola Semiconductor Group's Integrated Circuit division will have three d-a converters by midsummer, including the 8-bit microprocessor-compatible MC6890, a universal bus-oriented bipolar model that needs no external parts to plug into any 8-bit microprocessor (see p. 40). Motorola is already selling in volume the first of its new breed of converters—a blazingly fast, d-a unit that converts at a speed in excess of 25 megahertz. However, this unit, the MC10318, which has been on the

Direct connection. National Semiconductor's Naked-8 (top) needs no interfacing logic to operate with 8-bit microprocessors like the 8080. Motorola's answer to a bus-compatible d-a converter is the MC6890 (bottom). It catches data on the fly, latches it, and converts it into varying analog signal.
National puts all logic on its a-d chip . . .

National calls its ADP0801 the first truly bus-compatible analog-to-digital converter because all the logic to interface with a microprocessor is on chip. At a price of $2.75 in 100-piece quantities, National believes the part meets a need for a low-cost a-d converter no one else has addressed, according to linear marketing manager David Whetstone. With a maximum error from \( \frac{1}{4} \) least significant bit down to \( \pm 1 \) LSB, it will replace 10-bit a-d approaches used to get equal accuracy and costing up to 10 times more, he says. This was achieved with a new design using a charge-balance comparator and on-board thin-film silicon-chrome resistive ladder, which in combination reduce the component count and active area size. The complete converter uses only 16 discrete resistors, 4 capacitor arrays, and 32 switches. National thinks the ADP0801, which it refers to as the Naked-8 because it needs no external components, will find volume applications in home computing, instrumentation, low-end process control, equipment monitoring, and other areas. National will put the part in production soon.

Other features include a 100-microsecond conversion time, an on-chip clock generator, a differential 0-to-5-V analog input range, a single 5-V supply, and compatibility with transistor-transistor logic. Moreover, the 0801 provides the digital output code in a true 2's complement format.

. . . while Motorola crams its d-a chip full, too

Motorola expects its universal bus-oriented MC6890 to be its best shot in the digital-to-analog converter market. According to the company, it will be loaded with features Motorola thinks will appeal to 90% to 95% of the 8-bit d-a market. Foremost is an on-board 2.5-volt precision voltage reference for the laser-trimmed thin-film resistors. This does away with the common external 10-V references and corresponding potentiometers, says design engineer Gregory Smith. The monolithic converter also has master-slave registers, or double-buffered latches, to make data glitches in the processor transparent to the converter. Setting time is 120 to 140 nanoseconds. Another feature is a reset pin that overrides stored data and forces it to 0.

Price of the MC6890 8-bit converter, on the market sometime in the third quarter, is expected to be in the $5 to $7 range, for quantities of 100 and up. That's as specific as Motorola can be for now.

market since January, is aimed at video applications, rather than microprocessor applications.

On the analog-to-digital end, National Semiconductor Corp. is providing samples of, and will soon have in production, the industry's first 8-bit monolithic a-d converter with on-chip microprocessor-interfacing logic. Called by National the Naked-8, the model ADP0801 C-MOS part (see above) contains the protocol, signal levels, and bus timing to interface directly with such popular 8-bitters as the 8080, 8085, and Z80 (see diagram). And, with an additional external logic gate, it can also hook up to a 6800.

In an approach typical of National to gain a share of the market, the price will be as low as $2.95 per 100 units in plastic packages. Other monolithic a-d and d-a units are slated to follow from the Santa Clara, Calif., chip maker, as well. Its goal, says National, is to have the high-volume end of the data-conversion market well covered. In advanced development is a 12-bit-plus-sign a-d chip that will potentially have better conversion and accuracy specifications than the 0801. A 10-bit is also likely, and the d-a end is not being overlooked either, according to the company.

As for Signetics, it is filling out its family of tr bus-compatible chips that began with the 2-microsecond settling time model NE5018 in July 1977. In its new 5019, the Sunnyvale, Calif., company is managing to reduce the maximum error of the d-a converter to 0.1% from 0.2%, making a \( \frac{1}{4} \)-least-significant-bit part out of the now-available chip.

Moreover, Analog Devices Inc., Wilmington, Mass., the leader in data-conversion products, which has in the last several years added semiconductor processing capabilities to its bag of design tricks, has its eyes on Signetics' 5018. It plans to offer a functionally comparable device by late fall. (For about a year, the company has offered the C-MOS microprocessor-compatible AD7524, which needs an external voltage reference.)

For designers of microprocessor-based systems, the new monolithic converters will simplify their jobs by incorporating all the logic that they need in order to interface with 8-bit microprocessors. In effect, the converters can be just plugged into the microprocessor bus.

Like National, Motorola is also ready to leap into the converter marketplace. "Last year we created a manufacturing base; this year we go for market share," says Henri Jarrat, 1C division vice president and director of bipolar operations, Mesa, Ariz. This plan, incidentally, applies across the board to all Motorola's linear products.

TV in view. Motorola's MC10318, which is aimed primarily at television broadcasting systems, is catching on fast, claims Michael Henry, design manager for linear interfaces. Especially useful is a complementary current output of 51 milliamperes. "This allows direct driving without using an operational amplifier," Henry says.

Critical to Motorola's growing significance in converters and other linear ICs is its newly established precision thin-film processing capability—put into operation during 1978—which is finding its way into many of its linear products, according to Jarrat.

Although Motorola calls itself a "dark horse" in converters, its d-a units of the early 1970s, especially the 8-bit 1508, still sell. But the present program is "a major thrust to get a leadership position in this market, which will amount to $70 billion by 1983," Jarrat says.
Military

DOD will request proposals next month for VHSIC project

The Pentagon is now ready to roll on its VHSIC program for very high-speed integrated circuits. In early April, it will publish its first request for proposals for nine-month definition studies to be awarded by late summer. Formerly known as VHSI, the triservice effort [Electronics, Sept. 14, 1978, p. 81] is expected to cost $198 million over six years and will get under way with up to $6 million this year.

Looking for partners. As the DOD moves to convert its VHSI concept into contract dollars, industry interest is intensifying: prime systems contractors are scrambling to team with semiconductor houses and universities having expertise in the field.

TRW, for example, is reportedly teamed with Motorola and is working on lining up both Control Data and Digital Equipment to handle systems architecture. It is also said to be negotiating with California Institute of Technology and Carnegie-Mellon University.

Hughes Aircraft is talking with both National Semiconductor and Signetics, according to program sources, whereas Fairchild is reported to have discussed working with such prime contractors as General Electric, Raytheon, and Westinghouse, as well as Stanford University. Rockwell International is also showing strong interest, but less is known about its plans.

Loners. A number of other large manufacturers are expected to go it alone. Included in that list are such corporate giants as IBM, Texas Instruments, and Western Electric, AT&T's manufacturing arm.

How many proposals does the DOD expect? "Less than 15, maybe 10," says Larry W. Sumney, VHSIC project manager in the office of Leonard Weisberg, director of electronics and physical sciences.

Perhaps the only major semiconductor house not expected to enter the VHSIC competition is Intel Corp., where vice chairman Robert Noyce (see p. 46) and others have expressed concern about the program's drain on the industry's already short supply of good integrated-circuit design talent.

Asked about such concerns, Sumney notes only that the issue has not been raised with the Pentagon by other manufacturers. He points out that annual semiconductor R&D by private industry now runs about $300 million, not counting outlays by IBM and AT&T. The DOD's proposed expenditures through fiscal 1980 for VHSIC "will total about $36 million—roughly 10% of what's spent by industry."

Plans. Each of the VHSIC program's three parts will get approximately equal budget shares, Sumney says, and run in parallel. VHSIC-I is expected to run for four to five years, with perhaps as many as six contractor teams striving for circuits with 1.25-micrometer minimum feature sizes (see "The payoff for VHSIC").

Between two to four contractors would then be selected to continue as finalists. VHSIC-II will push to extend the state of the art to submicrometer dimensions, nominally 0.5 to 0.8 µm. Both efforts, Sumney says, will be vertically integrated, combining circuit design, architecture, software and testing—referred to as DAST by the Pentagon—with fabrication, production and systems demonstrations in a single program.

VHSIC-III will support the technology developing in the other two program segments with shorter-term projects. Labeled the program's catchall area by some industry observers, VHSIC-III "is essential to provide flexibility and stimulate innovation, as well as attract the broadest possible group of performers," Sumney explains.

The payoff for VHSIC

The achievement of truly "smart" military systems and weapons will be one measure of the DOD's success with its VHSIC program. The second measure will be dollars saved in systems' life-cycle costs. "Besides savings as a result of reduced size, weight, and power consumption," says VHSIC program manager Larry Sumney, "reliability should significantly increase because of reduced parts counts and reduced interconnections in electronics systems. We must have VHSI circuits that are readily available in quantity, affordable because they are not custom-designed but broadly applicable." Sumney lists several future applications areas where VHSIC could pay off. They include:

- Ground radar that could distinguish between friendly and enemy aircraft by performing fine-grained intrapulse analysis of radar returns in real time.
- Airborne synthetic-aperture radar able to function during evasive maneuvers and still deliver a radar-guided missile accurately.
- Intelligence receivers able to handle over 1,000 signals and provide highly accurate direction location yet fit into a small truck.
- Satellites able to perform extensive on-board processing and reduce the bandwidth of signals relayed to the ground.
- Accurate positioning and tracking of all submarines in an ocean basin, and small, low-cost manpacks providing precise positioning and allowing selection and transmission of preset digital messages in a netted system.

Peripherals

Data station offers OEMs flexibility

Is it an intelligent terminal? Is it a desktop computer? It is almost impossible these days to tell by its hardware or its appearance just what a microcomputer-based system is
Electronic review

**Station master.** By supplying lots of software tools along with his model 3500 data station, Perkin-Elmer's James Folts hopes to tap many different applications.

**Electronic circuits**

**Integrated circuits**

**CDC says Soviets make good chips, seeks to sell them bigger computers**

With 11 integrated-circuit samples obtained from the Soviet Union, Control Data Corp. is trying to convince the Federal government that Soviet IC technology lags behind the U.S.'s by only about two years instead of five and is closing the gap fast. The computer maker wants to make the U.S. recognize Soviet technological advances and thus permit sale of more sophisticated computers to the USSR.

CDC executive vice president Robert D. Schmidt led a team of the Minneapolis-based company's executives to the Pentagon at the beginning of March to brief senior research and development officials there on the Russian circuits and turn the samples over for further analysis [Electronics, March 1, p. 58]. Long in favor of relaxing export controls on electronics sales to Warsaw Pact powers, Schmidt believes the Office of Export Administration's upper limit of 32 on a U.S. computer's processing data rate, or PDR, is unrealistic. This

**Customizing supply for original-equipment manufacturer**

...customizing supply for original-equipment manufacturer...
Caddock's Type TF
Low TC Ultra-Precision Film Resistors.

Utilizing Tetrinox™ film technology, the Model TF 050 N resistors combine TCs as low as 5 ppm/°C. values from 2 Megohms to 10 Megohms and tolerances to ±0.1% to surpass the performance of high-value wire-wound resistors.

Caddock's monolithic design and non-inductive resistance patterns eliminate fragile coiled-wire construction.

Laser production techniques keep these Type TF resistor prices below the basic material cost of fine resistance wire!

For Type TF data, circle Number 108.

Caddock's Type MS
Power Film Resistors.

Caddock's patented Non-Inductive Design in power ratings from 2 watts to 15 watts assures minimum voltage transients in all types of power switching circuits.

High stability Micronox® resistance films operate to +275°C and years-long load-life tests demonstrate extended-life stability better than 0.05% per 1000 hours.

For Type MS data, circle Number 103.

Caddock's Type 1776
Precision Decade Resistor Voltage Dividers.

When used as a 10 Megohm input voltage divider, the Type 1776 family can provide high accuracy voltage division in ratios of 10:1, 100:1, 1000:1 and 10,000:1.

The Type 1776 is available in 14 standard in-production models, and OEM quantity prices are low.

For Type 1776 data, circle Number 105.

Caddock's Type MG
High Voltage Resistors.

High voltage probes and control circuits make wide use of Type MG resistors for precision high voltage regulation and high voltage measurements.

Long-term stability — plus proven reliability — have also made these precision resistors first choice in communications satellite voltage control circuits.

For Type MG data, circle Number 106.
equals the power of a CDC 170 or 171 machine.

The Government computes PDR from factors such as processing speed, instruction lengths, and storage capacity. CDC estimates the Soviet's Ryad-2 computer models, the ECS-1060 and ECS-1065, have respective PDRs of 98 and 325.

Schmidt thinks the U.S. could easily raise its PDR upper limit to 75, opening up a Soviet market for sales of 100 CDC 172, 173, and 174 model computers worth $400 million to $500 million over five years. Additional sales for Honeywell, IBM, and Sperry Univac could raise total computer exports "to four to five times that amount."

Cocom, the international coordinating committee comprising the U.S., its partners in the North Atlantic Treaty Organization, and Japan, meets in April to consider raising the PDR to 45 for computers exportable to Eastern Europe.

Public display. The Soviet ICs, the first publicly displayed in the U.S., appear not to have altered the Pentagon's views, according to insiders there. Among the 11 circuits, some of them duplicates, is a 16-K dynamic random-access memory in a 16-pin side-brazed ceramic package somewhat larger than the Mostek 4116 model from which, CDC says, the Russian device was designed. This was the only chip CDC tested for electrical performance.

Among the ICs physically evaluated are a 4-bit microprocessor and a peripheral controller. They are complementary-metal-oxide-semiconductor devices and are housed in 42-pin top-brazed ceramic packages.

Other circuits are a 4-K dynamic RAM using n-channel silicon-gate technology packaged in a 22-pin side-brazed ceramic package and four emitter-coupled-logic circuits. CDC calls the latter similar to the 10-K series ECL devices.

Asked whether the Soviet circuits given to the company by the Ministry of Electronics in Moscow are production models or advanced prototypes, CDC's Lynn Gallup, manager of East-West technical strategy, said he was not certain, although he believes they are production models. Schmidt also conceded that the company does not know Soviet circuit yields or reliability.

Capable. As Gallup sees it, the fact that the Soviet Union "is capable of manufacturing complex integrated circuits" is more important than advanced production capability. "The Soviets obviously have developed the semiconductor process and know-how sufficient to make devices very close to the leading edge of technology."

CDC's inch-thick technical evaluation of the ICs notes significant differences between Russian and U.S. technology. The best Soviet device is the 16-K dynamic RAM, which U.S. companies, now moving on to 64-K parts, have made for about two years. The smallest dimension of the device is 5 micrometers versus 3 μm in the U.S., he says. And the Russian 4-bit microprocessor has no memory on chip, unlike U.S. 8- and 16-bit units.

Analysis and tests of the Russian 16-K memory against Mostek's 4116 by CDC's Microcircuits division also show "noticeable differences between the two circuits" in favor of the 4116. Mask alignments for the Soviet K56FY3 models A and B are inferior to those for the Mostek 4116P revisions 2 and 3, the report says. The transfer gate of the Soviet RAM, for example, "is shifted from one side of the bit line to the other and the contacts to metal are not as well centered as they could be."

Computers

Plug-compatibles fight back

If IBM's aggressive price/performance approach to the recently announced 4300 series mainframe computers was meant to intimidate its competitors [Electronics, Feb. 15, p. 85], it is apparently not succeeding. Major plug-compatible mainframe vendors have already begun a counteroffensive, its most recent manifestation the announcement earlier this month by Magnuson Systems Inc. of three new machines and price cuts on two existing ones. Before this came Itel Corp.'s new AS/3-5 machine, made by National Semiconductor Corp. and pitted directly against IBM's new 4341.

But an examination of the new offerings seems to confirm feelings of industry observers that the plug-compatible computer game is not as lucrative as it once was [Electronics, March 1, p. 81]. However, despite the apparent squeeze by IBM, executives of plug-compatible competitors Itel, Magnuson, and National Semiconductor still maintain they can compete with the 4300.

Magnuson's new units—the M80/32, M80/42, and M80/43—are said to range from 300% the performance of the IBM 4331 at a price of $185,000 to 30% over the 4341's performance at $315,000. These join the almost-year-old M80/3 and M80/4 machines that compete against the IBM 370/138 and 148 respectively.

Claims. Magnuson's president, Joseph L. Hitt, says the Santa Clara, Calif., company's new units offer users not only price/performance advantages but also easier expansion to more powerful computers than is available from IBM. But is he overly optimistic?

The M80/3 and 4 were originally priced about 30% below IBM's and offered 1.2 to 2 times the throughput, whereas the three new Magnuson units come in roughly comparable to IBM's. Magnuson says its middle M80/42, for example, has 10% more throughput than the 4341. But its price of $275,000 with two megabytes of memory and three channels is also 5% more than a similarly configured IBM unit.

L. James Beckman, Magnuson's marketing vice president, says his company can deliver sooner than IBM and by the time IBM begins volume deliveries of the 4300 next year, Magnuson will be able to drop its prices.

Also reflecting the narrowing of the competitive margins is Itel's new AS/3-5 built by National Semiconductor. Itel says the AS/3-5 offers
LSI-11/2 add-in.
Add the future to your memory.
Now.

Decode 18-bit address.
Recover 3K words of I/O page.

Motorola's MMS1102 add-in module covers your future LSI-11/2* memory management needs. It is address selectable on 4K boundaries in a 128-word address space (decodes a full 18-bit address), matching requirements of the future as well as today's 16-bit address.

Up to 3K words of I/O page can be selectively utilized as read/write memory. That unique feature is standard, switch selectable.

Extensive parity options.

Other features include optional on-board parity generation and checking logic, internally distributed refresh, plus total hardware and software compatibility with LSI-11/2 and LSI-11* systems. Low standby power complements the LSI-11 battery backup feature. The '1102 is built with industry standard MCM4116 dynamic RAMs, and with the high Motorola quality and reliability you expect.

Good for the budget.

Budget tight? Motorola's 32K x 18(16) MMS1102 is the inexpensive way to add the system storage you need now, with the future on board. Get off-the-shelf delivery for just $950 (1-5 quantity), and OEM discounts are available.

Call (512) 928-6776

For immediate price and delivery information, call Motorola Memory Systems, (512) 928-6776, or your local Motorola sales office. To get an MMS1102 data sheet, write Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, AZ 85036, or circle the reader service number.

The MMS1102 is only one of the broad line of Motorola add-in, add-on memories available now for new and expanding systems everywhere. And, leading-edge storage capability is but one of the many technologies in which Motorola is providing service to the designers of innovative systems through silicon.

*MOTOROLA INC.

Electronics / March 15, 1979
Packaging & production

E-beam annealers are being readied

Heat is a necessary evil in semiconductor making. Manufacturers use annealing ovens to repair crystal lattice damage caused by ion implantation, yet the 550° to 1,000°C temperatures of these ovens create problems of its own, notably wafer warpage.

Never a desirable byproduct, warpage will be anathema in the coming era of very large-scale integration. "High temperatures can ruin a VLSI wafer," notes Anton C. Greenwald, director of pulsed electron-beam processing at Spire Corp., Bedford, Mass. With present-day lithographic equipment, "you can kiss submicron geometry good-by if there’s wafer deformation."

Solution. What looks like the way out of this dilemma is a precisely controlled method that heats only the surface of the wafer, minimizing lattice deformation. Such a method, using pulsed electron beams, has been developed by Spire to the point where the company is ready to market equipment.

"Pulsed electron beams heat the

News briefs

High-speed Marisat service may be near

Prospects are brightening for 56-kilobit-per-second ship-to-shore satellite-based communications over the Marisat satellite system. Satellite tracking of shipboard antennas during rough seas proved to be no problem, so the present 2,400-bit/s service could be supplemented as soon as enough users sign up. Speaking at Intelecom 79, the international telecommunications conference in Dallas, David W. Lipke, maritime systems engineering director at Marisat’s owner, Comsat, says 56-kb/s tests in the turbulent North Sea show bit error rates better than 10^-6 attainable 95% of the time with ship rolls as great as 10° to 15°.

SBS to get high-speed facsimile prototypes

AM International Inc. will develop and build two prototype high-speed facsimile communications terminals for the Satellite Business System Inc.'s new domestic network. The helium-neon input laser built by subsidiary ECRM Inc. will scan two pages a second, while the store-and-forward minicomputer module, made by AM subsidiary Jacquard Systems, will transmit the compressed bit stream at 8 million bits per second. Los Angeles–based AM International says production versions will cost about $75,000 each. A less sophisticated version, for narrower-bandwidth telephone lines, will be offered in the more lucrative market for 4,800-baud systems.

New Burroughs architecture revamps mid-range

A building-block architecture, new transistor-transistor-logic chips, and 16,384-bit memories are features of two new Burroughs Corp. computers that boast two to five times the performance of the previous mid-range computers. The B 2930 and B 3950 central processing units consist of six modules dedicated through microcode to particular functions that operate concurrently and asynchronously. The Detroit firm says the new 3950 offers up to five times the performance of the B 2835, yet is priced between $230,000 and $399,640, only about 27% more.

NCR replaces its intermediate line

Also modernizing its intermediate line of mainframe computers is NCR Corp., with five new machines available in multiprocessor versions. The largest, the V-8555M, offers 65% more power than the previous V-8580, but at $375,000 is 20% less expensive. The units are all based on 10K emitter-coupled logic and use 16,384-bit random-access memories. Reflecting the memory price war shaping up in the computer industry, the Dayton, Ohio, firm prices its add-on increments at $20,000 a megabyte.

Top executives change titles at Intel

Founders Andrew Grove, Gordon Moore, and Robert Noyce have changed titles at Intel Corp. The move more closely reflects their duties at the growing Santa Clara, Calif., microcomputer systems company. In the new lineup, Grove, as chief operating officer, moves from executive vice president to president; Moore, as chief executive officer, becomes chairman instead of president; and Noyce, who represents the company to the financial and Government communities, moves from chairman to vice chairman.

Riding high, Motorola boosts production capacity

By year’s end, Motorola Semiconductor Group’s Integrated Circuits division will have more than doubled its manufacturing capacity, with growth of capacity in the key n-channel metal-oxide-semiconductor area "exceeding a factor of three," reports Alfred J. Stein, division vice president and general manager. Expansion took place at four sites, including Mesa, Ariz., where a high-density H-MOS facility starts turning out 68000 16-bit microcomputers and MOS memories in the second quarter of this year. Other new production will be in Austin, Texas, and East Kilbride, Scotland, for both n-MOS and complementary-MOS circuitry and in France for bipolar parts. Almost all Motorola ICs will be made on 4-inch wafers, says Stein.
We’ve sharpened the cost-effectiveness of our single chip microcomputers. Now you have a choice. Our new PIC 1655 with 20 I/O lines, or the PIC 1650 with 32 I/O lines. Fewer I/O lines mean lower chip cost without sacrificing performance or features. That’s right, the PIC 1655 has the same features that make the PIC 1650 so popular: the same basic architecture and instruction set, so it’s just as easy to program. The same programmable 512 x 12-bit ROM. The same 32 x 8-bit RAM registers. And an on-chip oscillator to handle timing. You get a lot of features, but you pay a lot less.

When you need a versatile, low cost, stand-alone single chip controller, it pays to take your PIC. GI’s PIC 1650 with 32 I/O lines in a 40-lead DIP or, to save more space and even more money (less than $3.00 each in quantities of 100,000), the PIC 1655 with 20 I/O lines in a 28-lead DIP.

Whatever your PIC, you can count on GI’s engineers to give you full software, hardware and applications support. They have cross-assembler simulator programs and the ROM-less PIC 1664 for plug-in circuit emulation using either PROM or RAM. So whatever your 8-bit single chip microcomputer needs, GI has the PICs to fit them perfectly. To take your PIC and to get a free copy of our new 1978 Product Guide, call or write General Instrument Microelectronics, 600 West John Street, Hicksville, New York 11802, Telephone: (516) 733-3107.

We help you compete.
MITEL's Spi-Pulse 6000 Prototype from Spire Corp. aims electron beam inside tube at semiconductor wafers for annealing. Unit is 3 ft in diameter, 15 ft long. Price: $170,000.

Operation of the two models is essentially the same. From a field-emission cathode, a pulsed 100-nanosecond beam covers the wafer (up to 3 inches in diameter with the 6000; up to 1½ in. with the 600). The goal is 300 wafers an hour, provided makers of wafer-handling equipment come up with holders.

Beam energy and fluence, the power per square centimeter, are adjustable to vary the depth of heat. This adds versatility, because it permits different operations on different materials.

Annealing ion-implantation damage promises to be the most immediate application for the pulsed electron-beam process. "With e-beam, you can melt the surface without puddling it," Greenwald says. "The regrowth [into a single-crystal structure] is exceedingly good, and final crystal quality is as good as the virgin material."

Other uses. Another use involves epitaxial growth of semiconductor films on bare silicon. Silicon films can be grown at much lower temperatures than the 1,100°C that is required in ovens. Another task will be to form metal welds between metal contacts and silicon. Tantalum, tungsten, or platinum and the silicon immediately below may be fused by heat from the beam.

At least one researcher sees an exciting application ahead. "The pulsed electron-beam process gives
“Cost overruns and rejects in my harnesses have got to come down. If you have a method that can do it—and still deliver high quality assemblies—I’d sure like to hear about it.”
Some facts worth knowing about AMP MTA Connectors

**Description:** A complete wire-to-post interconnection system for .100" or .156" centerlines, including headers and tooling.

<table>
<thead>
<tr>
<th></th>
<th>.100&quot;</th>
<th>.156&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sizes:</td>
<td>2-28 position</td>
<td>2-24 position</td>
</tr>
<tr>
<td>Wire Range:</td>
<td>8-22 AWG</td>
<td>18-26 AWG</td>
</tr>
<tr>
<td>Keying Capacity:</td>
<td>.025&quot; square or round</td>
<td>.045&quot; square or round</td>
</tr>
<tr>
<td>UL Current Rating:</td>
<td>5 ampere</td>
<td>7 ampere</td>
</tr>
<tr>
<td>UL Voltage Rating:</td>
<td>250 VAC</td>
<td>250 VAC</td>
</tr>
<tr>
<td>UL Temperature Rating:</td>
<td>−55°C to +105°C</td>
<td>−55°C to +105°C</td>
</tr>
</tbody>
</table>

**Where to telephone:** Call AMP MTA Information Desk (717) 564-0100. Ext. 8400.
**Where to write:** AMP Incorporated, Harrisburg, PA 17105
**Product Information:** Check Reader Service Number 101.
The AMP Mass Termination Assembly System is a complete wire-to-post interconnection system for .100" or .156" centerlines, including headers and an extensive line of cost effective tooling. It can deliver 20 wire-to-post connections as fast as you used to make one.

With the AMP Cable Assembly Machine, for instance, the MTA System has been able to mass terminate both discrete and ribbon wire at a total applied cost savings approaching 40%.

The reasons for this are simple. The pre-loaded connectors of MTA increase quality terminations, reduce labor and drastically reduce rejects. No wire stripping. No crimping. No damage to contacts. No worn out crimp tools to replace. The whole job is simplified. A one-step assembly instead of a multiple operation full of chances for handling errors and damage.

Once our field engineers help set up an AMP MTA System, there's little chance for wiring errors. It's the modern wire-to-post interconnection system for .025" and .045" posts. With a cost-effective story worth investigating.

Want to look into it? See the opposite page and the page overleaf for complete tooling details.

AMP has a better way.
...and with cost effective tooling.

A complete line of AMP MTA Tooling assures a cost-effective assembly, whatever your production needs.

AMP Harness Board Tooling delivers low applied cost and high volume production of complex harness assemblies. Even daisy chaining. All wires are mass terminated on the board so the assembly is completely finished when removed from the board. No post operations needed.

For high production needs, AMP Cable Assembly Machines pull in up to 20 wires simultaneously and mass terminate—all in one cycle. A single-ended version terminates one end in a connector, then cuts and strips the other. A double-ended version terminates both ends into connectors. Both feature variable wire length capability in the same harness.

Connectors are tape-fed to the AMP Electric Bench Machine for high volume mass termination of both ribbon and jacketed cable by foot pedal, in one cycle.

Air-operated and manually operated hand tools, as well as an Air Bench Tool, are available to terminate one wire at a time for low and intermediate volumes.

Need more details? Call MTA Information Desk at (717) 564-0100. Ext. 8400. Or write AMP Incorporated, Harrisburg, PA 17105.

AMP is a trademark of AMP Incorporated.
very uniform annealing for gallium-arsenide wafers,” says Piero A. Pianetta, a technical staff member at Hewlett-Packard’s solid-state laboratory in Palo Alto, Calif.

**Charge-coupled devices**

CCDs receive two-pronged boost

There’s a growing contention among some mainframe computer makers that the once-bright promise of charge-coupled-device technology is in danger of being ended by rampaging n-MOS random-access memories on one side and magnetic bubbles on the other. But CCD advocates believe two recent announcements will pump renewed vigor into the technology: Fairchild Camera and Instrument Corp. is designing a quarter-megabit device for early 1980 introduction, and at this month’s Compcon conference, NCR Corp. unveiled a novel concept for putting 64-K CCDs in packages having only four pins (see below).

Fairchild’s upcoming 256-K part represents a substantial upgrade from its current 64-K devices, using an interlaced-ripple, serial-parallel serial internal multiplexing scheme that it employs on the 64-K memories, according to Gilbert Amelio, division vice president and general manager of the MOS products group, San Jose, Calif. But unlike the 64-K devices, which require four external clocks, the new 256-K devices generate two transfer clocks on chip to free up the two address lines needed on the 16-pin package.

**Shrunken.** Fairchild, one of two remaining CCD vendors in the U.S. (Texas Instruments is the other), has also reduced the 64-K part’s design rules to 5 to 6 micrometers in some cases—close to the shrunken dimensions of 3 to 3.5 μm of n-channel metal oxide semiconductors, Amelio says. This gives the new part an area of 40,000 mil², not much larger than some 64-K RAMS, he adds. The architecture is organized as 64,096-by-1-bit blocks, the same size blocks as in the 64-K memory. The access time, too, remains the same, about 800 microseconds for the worst case, and 400 μs average to get to any bit in a 4,096-bit loop in the best of the 5-megahertz parts.

“People who say that CCDs are being squeezed out by n-MOS RAMS and magnetic bubbles don’t know what they’re talking about,” Amelio declares. “We had an early entry into the field in 1972, so we had an early understanding of the marketplace. There are some performance features offered by CCDs that can’t be touched by RAMS or bubbles.”

One of those features, according to Amelio, is access time for computer applications. “In such applications, where data is being transferred 12 to 18 pages at a time, it’s how fast NCR plans four-pin, 64-K CCD

Intended for bulk memory storage, NCR Corp.’s proposed 64-kilobit CCD would reside in a 4-pin single in-line package designed to increase board density, according to Don Lauffer, manager of NCR’s technology center in San Diego. Sixteen of these 4-pin CCDs could fit into the space occupied by two 16-pin devices, which means that on an 11-by-14-inch board designers could stuff 1,152 of the packages for over 9 megabytes. With 16-pin packages, only 144 would fit, for 1 megabyte of storage.

According to Lauffer, NCR’s concept makes 4 pins do the work of 16 by integrating some simple circuitry onto the chip to time-share the pins, eliminating twelve bonding pads and associated input drivers. Two of the four pins are for power and ground. Another, the “F” pin, is used for the address, read/write, and data in/out functions. The last pin, labeled “S,” handles the chip-select and clock functions.

Lauffer claims that by having 4 pins instead of 16, the chip’s performance is degraded by only slightly more than 0.1%.
United Systems’ Indicators Will:

- MEASURE voltage and current; ac, true rms or dc.
- CONVERT the output of any transducer/transmitter to display in engineering units.
- DISPLAY temperature (C or F) directly from thermocouple, RTD, or thermistor sensors.
- INTERFACE readily into your system by optional “single line enable” parallel BCD output.
- INDICATE when a predetermined limit is exceeded, through relay closure or logic level output from optional internal comparator alarm.

And with United Systems’ exclusive adaptors these indicators change, in the field, to perform any measurement listed above and more!

For additional information contact your United Systems Representative or call the factory (513) 254-6251.

United Systems Corp: Precision measurements to count on

54 Information only circle #54 Demonstration only circle #253

Electronics review

you get the data from one memory to another that is important.” The block-oriented nature of CCDs is more suited to this application, so it is faster than competitive devices.

Automotive

TI ships Delco carburetor control

Driven by tougher Federal emission and fuel economy standards, the market for semiconductor products in automotive engine-control systems is expected to spurt dramatically during the next few years. Disclosure of one large pact came late last month, when Texas Instruments Inc. revealed a major automotive deal with General Motors’ Delco Electronics division.

Neither company is talking dollar amounts. But at TI in Dallas, vice president Charles M. Clough is calling the deal “one of the most significant contracts for semiconductor parts that Texas Instruments has ever signed.” At least one knowledgeable industry observer notes that the contract could well boost TI into second place behind Motorola among leading suppliers of integrated circuits to Detroit.

Support. Delco is the prime contractor to supply the electronic control module, or on-board computer, in GM’s new C-4 (computer-controlled catalytic-converter) emission-control system. Its parts will serve as support circuitry for a microprocessor (most of which will come from Motorola) in the module.

The module adjusts the air-fuel mixture in the carburetor on the basis of signals received from an oxygen sensor in the exhaust manifold. The C-4 system, which includes the control module as only one of its components, is scheduled to be installed on about 400,000 of GM’s 1980 cars and on all of its expected 5 million to 6 million 1981 cars.

The TI devices contracted for include three bipolar programmable read-only memories, eight low-power Schottky logic parts, eight linear...
How to be 16 places at once, logically.

When's the last time you had a nice chat with an integrated circuit? All you need is something to translate what's happening in its simple little logical mind. Something like our popular Logic Monitors.

Clip one onto an IC—any DIP up to 16 pins—and the 16 LEDs atop our Logic Monitor flash to the rhythm of the state of each pin. You have, in effect, 16 tiny logic probes in one pocket-size circuit-powered instrument.

And, as everyone knows, 16 LEDs are better than one. Because with just a glance, you can see inputs affecting outputs, a whole IC at a time.

Psychologists call the principle Gestalt (in short, the whole is greater than the sum of its parts). You'll call it smart, a timesaver. We just think it's logical.

CSC for yourself!

LM-1 Logic Monitor $59.95*

Corporate Headquarters:
70 Fulton Terr, Box 1942, New Haven, CT 06509
351 California St, San Francisco, CA 94104
(415) 421-8872, TWX 910-372-7992
Canada: Len Finkler Ltd., Ontario

CONTINENTAL SPECIALTIES CORPORATION
800-243-6077
**Electronics review**

control ICs, eight power transistors, and 32 diodes. Signetics and National Semiconductor, said to be among other suppliers for the C-4, have declined to comment.

**Microprocessors**

**Italians to make Zilog Z8000**

Chalk up another one for Zilog—another second source, that is. SGS-ATES Componenti Elettronici SpA, Italy's largest semiconductor manufacturer, has agreed in principle to become a supplier of the 16-bit Z8000 microprocessor in Europe, which the Cupertino, Calif., firm began supplying in sample quantities March 1. The Milan company will also produce the older Z8 single-chip 8-bit microcomputer, as well as the peripheral circuits for the Z8000, which include a memory-management unit, buffer memories, serial and parallel input/output chips, and random-access memories. SGS-ATES obtained the rights four years ago to build Zilog's 8-bit Z80.

With Advanced Micro Devices Inc. already a second source for the Z8000, Zilog has two. That's as many as Intel Corp. has for its 16-bit 8086. Intel, in Santa Clara, Calif., has so far won second-source agreements with Mostek Corp., Carrollton, Texas, and Siemens AG of Munich. Both agreements spurred controversy—the one with Mostek because the company had earlier agreed to make Zilog's Z80 [Electronics, Nov. 23, 1978, p. 46], and the other because Siemens had previously formed a company called Advanced Micro Computers with AMD [Electronics, March 1, p. 48].

Texas Instruments has on its side American Microsystems Inc. for its 9900. Standard Microsystems Corp. also has rights to make TI's 9900, but so far has opted not to build any. Other 16-bit devices—the 9440 from Fairchild, the 68000 from Motorola, and a device coming from National Semiconductor—have no official second sources yet.
"We needed a software tool that would give us direct control of a highly interactive system."

"We build Remote Switched Access Systems which provide circuit testing for Bell and Independent telephone companies nationwide. Our SAS is a microprocessor-based interactive test system with sophisticated diagnostic capabilities. The operator uses the terminal to call and test any circuit in the network. The software we developed to run our SAS was originally written in assembly language. It took a very talented programmer six months, 80 hours a week to write. Plus six months additional staff time. It hadn't been out in the field very long before our customers started requesting special routines and tests, all sorts of modifications. We tried every assembly language trick we could, but we couldn't modify the program economically."

—Gambera

"We had a crisis on our hands."—Morris

"We looked at Basic, Fortran, Pascal. They were all too complex. Then we looked at FORTH's micro package. At first we were skeptical. But we were faced with an urgent need. We figured 'What do we have to lose? If FORTH can do what they say, we can make it'"

"Within two days we were writing routines in FORTH that would have taken two to three weeks to write in assembler."—Morris

"That's when we decided to use FORTH. We were impressed by how quick and easy it is to use. A good programmer should be up on it in two days. We had all kinds of fun. Inside a month we were really confident with it."

"In three months, two of our people completely rewrote the program with significant enhancements."—Gambera

"We couldn't have delivered on our commitment without FORTH. Everyone in our organization is now using it for all but the most trivial routines."

"It's amazing the impact programming speed has had on our ability to work with customers."—Gambera

"FORTH programming is fast. We can be much more responsive now. FORTH's programming speed more than offset the cost of rewriting our first program. Target-compiling and de-bugging are quicker too. We target-compiled FORTH in one day. It would have taken a week in assembler. And something that might take 30 hours to debug in another language takes two hours in FORTH. Editing is extremely simple."

"FORTH gives us the nuts-and-bolts control of assembler without all the tedious coding."—Morris

"FORTH gives us better control over run time. It's very close to the microprocessor in terms of definitions so you can configure as you like, right at the hardware level. That's especially important to us since we have a lot of interfaces, a lot of driver routines."

"My advice to others is: 'Try It.'"—Gambera

"You won't believe it until you do. We all know how stubborn people can be when it comes to trying something new. Engineers can't afford to be. If a tool works, you use it. FORTH works for us. We wouldn't consider going back to assembler or switching to some other high-level language. We're sold on FORTH. We only wish we'd tried it sooner."

"Engineers can't afford to be stubborn about trying new tools. If it works, you use it."

FORTH is a stand alone operating system and multi-level language for minis and micros. We also offer contract programming services. For full details or for information on a FORTH seminar in your area call (213) 372-8493 or send the coupon attached on your company's letterhead.

—Gambera

"Within two days we were writing routines in FORTH that would have taken two to three weeks to write in assembler."—Morris

"That's when we decided to use FORTH. We were impressed by how quick and easy it is to use. A good programmer should be up on it in two days. We had all kinds of fun. Inside a month we were really confident with it."

"In three months, two of our people completely rewrote the program with significant enhancements."—Gambera

"We couldn't have delivered on our commitment without FORTH. Everyone in our organization is now using it for all but the most trivial routines."

"It's amazing the impact programming speed has had on our ability to work with customers."—Gambera

"FORTH programming is fast. We can be much more responsive now. FORTH's programming speed more than offset the cost of rewriting our first program. Target-compiling and de-bugging are quicker too. We target-compiled FORTH in one day. It would have taken a week in assembler. And something that might take 30 hours to debug in another language takes two hours in FORTH. Editing is extremely simple."

"FORTH gives us the nuts-and-bolts control of assembler without all the tedious coding."—Morris

"FORTH gives us better control over run time. It's very close to the microprocessor in terms of definitions so you can configure as you like, right at the hardware level. That's especially important to us since we have a lot of interfaces, a lot of driver routines."

"My advice to others is: 'Try It.'"—Gambera

"You won't believe it until you do. We all know how stubborn people can be when it comes to trying something new. Engineers can't afford to be. If a tool works, you use it. FORTH works for us. We wouldn't consider going back to assembler or switching to some other high-level language. We're sold on FORTH. We only wish we'd tried it sooner."

"Engineers can't afford to be stubborn about trying new tools. If it works, you use it."

FORTH is a stand alone operating system and multi-level language for minis and micros. We also offer contract programming services. For full details or for information on a FORTH seminar in your area call (213) 372-8493 or send the coupon attached on your company's letterhead.

—Gambera

"Within two days we were writing routines in FORTH that would have taken two to three weeks to write in assembler."—Morris

"That's when we decided to use FORTH. We were impressed by how quick and easy it is to use. A good programmer should be up on it in two days. We had all kinds of fun. Inside a month we were really confident with it."

"In three months, two of our people completely rewrote the program with significant enhancements."—Gambera

"We couldn't have delivered on our commitment without FORTH. Everyone in our organization is now using it for all but the most trivial routines."

"It's amazing the impact programming speed has had on our ability to work with customers."—Gambera

"FORTH programming is fast. We can be much more responsive now. FORTH's programming speed more than offset the cost of rewriting our first program. Target-compiling and de-bugging are quicker too. We target-compiled FORTH in one day. It would have taken a week in assembler. And something that might take 30 hours to debug in another language takes two hours in FORTH. Editing is extremely simple."

"FORTH gives us the nuts-and-bolts control of assembler without all the tedious coding."—Morris

"FORTH gives us better control over run time. It's very close to the microprocessor in terms of definitions so you can configure as you like, right at the hardware level. That's especially important to us since we have a lot of interfaces, a lot of driver routines."

"My advice to others is: 'Try It.'"—Gambera

"You won't believe it until you do. We all know how stubborn people can be when it comes to trying something new. Engineers can't afford to be. If a tool works, you use it. FORTH works for us. We wouldn't consider going back to assembler or switching to some other high-level language. We're sold on FORTH. We only wish we'd tried it sooner."

"Engineers can't afford to be stubborn about trying new tools. If it works, you use it."

FORTH is a stand alone operating system and multi-level language for minis and micros. We also offer contract programming services. For full details or for information on a FORTH seminar in your area call (213) 372-8493 or send the coupon attached on your company's letterhead.

—Gambera

“We had a crisis on our hands.”—Morris

“We looked at Basic, Fortran, Pascal. They were all too complex. Then we looked at FORTH's micro package. At first we were skeptical. But we were faced with an urgent need. We figured ‘What do we have to lose? If FORTH can do what they say, we can make it’”

"FORTH programming is fast. We can be much more responsive now. FORTH's programming speed more than offset the cost of rewriting our first program. Target-compiling and de-bugging are quicker too. We target-compiled FORTH in one day. It would have taken a week in assembler. And something that might take 30 hours to debug in another language takes two hours in FORTH. Editing is extremely simple."

"FORTH gives us the nuts-and-bolts control of assembler without all the tedious coding.”—Morris

"FORTH gives us better control over run time. It's very close to the microprocessor in terms of definitions so you can configure as you like, right at the hardware level. That's especially important to us since we have a lot of interfaces, a lot of driver routines."

"My advice to others is: 'Try It.'"—Gambera

"You won't believe it until you do. We all know how stubborn people can be when it comes to trying something new. Engineers can't afford to be. If a tool works, you use it. FORTH works for us. We wouldn't consider going back to assembler or switching to some other high-level language. We're sold on FORTH. We only wish we'd tried it sooner."

"Engineers can't afford to be stubborn about trying new tools. If it works, you use it."

FORTH is a stand alone operating system and multi-level language for minis and micros. We also offer contract programming services. For full details or for information on a FORTH seminar in your area call (213) 372-8493 or send the coupon attached on your company's letterhead.

—Gambera

“We had a crisis on our hands.”—Morris

“We looked at Basic, Fortran, Pascal. They were all too complex. Then we looked at FORTH's micro package. At first we were skeptical. But we were faced with an urgent need. We figured ‘What do we have to lose? If FORTH can do what they say, we can make it’”
When to go custom. When a single custom circuit can replace hundreds of individual components, the benefits are obvious. But the cost of developing that single custom circuit is high, and only becomes practical if the volume you will actually use is significant. At Synertek, the first stage in custom circuit evaluation is a cost-versus-volume analysis.

Some applications, such as digital watches, would be impossible without a single custom circuit. In other cases, the performance and reliability advantages may outweigh the initial higher cost considerations. In any case, it’s a simple matter of economics. With fewer parts, lower assembly and inventory costs, smaller size, less weight, less heat to dissipate, greater reliability and a competitive edge to help build that crucial volume requirement, savings are enormous in a successful custom program.

Getting there on time. You can’t afford to wait the normal 26 weeks development time, and then find the end product doesn’t do the job. At Synertek, we have the development stages down to a science. We provide complete working level interface between your product development group and our custom circuit specialists. Every step of the way.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Concept Review</td>
<td>4-10 Weeks</td>
</tr>
<tr>
<td>B. System Definition</td>
<td>1-4 Weeks</td>
</tr>
<tr>
<td>C. MOS Logic Design</td>
<td>6 Weeks</td>
</tr>
<tr>
<td>D. Circuit Design</td>
<td>1-4 Weeks</td>
</tr>
<tr>
<td>E. Breadboard Design &amp; Documentation</td>
<td>1-4 Weeks</td>
</tr>
<tr>
<td>F. Breadboard Fabrication</td>
<td>1-4 Weeks</td>
</tr>
</tbody>
</table>

Our customers participate in design meetings and are urged to attend the periodic design reviews. A fully functional breadboard is built for each custom circuit. Where any possible doubt is felt about the original specifications, the customer is urged to work with the breadboard in his own systems for...
to know about circuits.

Hands-on review by his own product development and marketing people.

To date, we've produced over 200 custom circuits for advanced electronic products covering an incredible array of applications. Our record of delivering on time, in specification, is excellent. We will gladly provide customer references on request.

Which process to specify. Whichever does the job best, and most economically. Our standard product lines are implemented in N-Channel, P-Channel, CMOS, Ion Implanted Silicon Gate with or without Depletion Loads. All are available now for your custom circuit from Synertek.

It's your circuit, and your circuit alone. You need that confidence. And Synertek provides it. Our expertise is in MOS circuitry. We guarantee the proprietary nature of your Synertek custom circuit.

How we do it. We possess one of the outstanding custom circuit groups in the country, and one of the very few completely dedicated to custom work. Our custom group draws on resources and experience gained in producing a tremendous volume of standard MOS circuits and duplicates every facility and resource applied to our standard line. In spec. in production, at the right price.

Synertek, Inc.
3001 Stender Way
Santa Clara, California 95051
(408) 988-5600
Jerry Densky
Custom Product Marketing Manager

SALES
AL BARGOOG—EASTERN AREA MANAGER
400 Humphrey Street, Suite 2
Swampscott, MA 01907
617-545-1170
JOHN BASISTA—CENTRAL AREA MANAGER
4615 W. Streetsboro Road, Suite 204
Richfield, OH 44286
216-659-4195
CHUCK KEOUGH—MIDWEST AREA MANAGER
2865 Butterfield Road, Suite 150
Oakbrook, IL 60521
312-986-8989
SHEL SCHUMAKER—WESTERN AREA MANAGER
20863 Stevens Creek Blvd., Bldg. B3, Suite C
Cupertino, CA 95014
408-255-3941
JOHN FARLEY—NORTHWEST REGIONAL MANAGER
in Cupertino sales office listed above
ED HARMON—SOUTHWEST REGIONAL MANAGER
1900 Quail Valley, Suite 290
Newport Beach, CA 92660
714-752-5535
RON KASPER—MANAGING DIRECTOR,
EUROPEAN MARKETING
Honeywell House, Charles Square
Bracknell, Berkshire, England RG12 1EB
Direct Dial: 011-44-44-44-244-555
JOE PATRIDGE—EASTSALES MANAGER
3001 Stender Way, Santa Clara, CA 95051
Fiber Optics Measurement Lab... in your hand!

For Absolute Measurements of Light Sources, Photoreceivers, Fiber Cable Transmission, Connector and Splice Loss.

Nothing else even comes close...

AS PERFORMANCE — Only the 22XL has
measurement in dB over nine decades, with
readout in dBm (decibel milliwatt) or dBu
(decibel microvolt), and a selectable 1dB or .01 dB
resolution. DC response and unlimited AC response
are switch selectable.

Add to that a sensitivity down to 1 picowatt (—90.0
dBm), with the model 150 and 250 plug in silicon
sensor heads, and a power handling capability of
1 watt with the model 350 head. The 250 head is
spectrally flat from 500 nm to 950 nm. This
revolutionary performance comes in two matched
sensor heads simultaneously, which can be
switched to single mode (alone) for absolute light
source measurements, or dual mode (log ratio) for
comparison of sources or cable. Plus, the heads are
all socketed and interchangeable, and carry their
own calibration to the electronics. It is easy to
connect to these heads. Terminations for all the
major connector systems, as well as bare cable, are
available in thread mounted adaptors. A head
extension cable is also available.

A built-in 900 nm IR source simplifies photoreceiver
calibration and fiber cable dB loss measurements.
Your own photodiodes can be calibrated on the
22XL. Add to that a sample-hold mode, for splice
and interconnect loss measurements.

The 22XL is ideal for both lab and field work. The
rechargeable Ni-Cd battery is good for nine hours.
A 34 pin edge connector brings out digital and
analog signals for driving recorders, and with a
Photodyne Accessory Box, microprocessors. The
dual anodized aluminum case protects a
one-board circuit assembly on which all
components mount, including switches and display,
for easy calibration and repair. All major
components, including display, are socket
mounted for easy replacement.

IN PRICE — At $685, the price is revolutionary. A
model 150 sensor head, complete with computer
generated and NBS traceable calibration from 400
nm to 1150 nm, is available at $175. To get your hands
on one call (213) 889-8770 or 889-8817.

Revolutionary Performance — Revolutionary Price
Model 22XL Optical Multimeter
Air Force picks three to build Seek Talk models

Air Force contracts are going to E-Systems Inc.'s ECI division, St. Petersburg, Fla. ($4.1 million); General Electric Co., Fairfield, Conn. ($4 million); and Hazeltine Corp., Greenlawn, N. Y. ($5.4 million), to competitively design, build, and test advanced development models of Seek Talk, the jam-resistant voice system for tactical air-to-air and air-to-ground communications planned for 1983 production. Eliminated from the competition was Magnavox Corp., which participated in last year's design stage. Rome Air Development Center, N. Y., is overseeing the program.

FAA orders removal of LiSO2 batteries from all planes

Lithium–sulfur-dioxide batteries have become a literally explosive issue at the Federal Aviation Administration. A series of six explosions, plus spontaneous fires and corrosive leakage problems caused in the last six months by aging LiSO2 in aircraft emergency locator radio transmitters (ELT), has spurred the agency to order their removal by owners and pilots within 30 days from March 28. About one third of the 180,000 U. S.-registered planes (except scheduled airliners) that have been required since 1974 to carry automatic ELT units use LiSO2 batteries, the FAA estimates; the remainder have alkaline or magnesium batteries. The agency identified six ELT equipment makers, some of whose models used LiSO2 batteries. They are: Communications Components Corp., Cessna Aircraft Co., Dorne and Margolin Inc., Garrett Manufacturing Ltd., Leigh Systems, and Pointer Inc.

Pascal people make progress toward standard

In marked contrast to the stormy meeting of the American National Standards Institute's X3J9 committee held last December, the meeting on Feb. 20 in Costa Mesa, Calif., was a model of progress toward a candidate standard for the Pascal high-level language [Electronics, Feb. 15, p. 96]. One result was that two joint meetings of X3J9 and the Institute of Electrical and Electronics Engineers' P770 task group are now scheduled: one for April 26 and 27 in Boulder, Colo., and the other for June 6 and 7 in New York after the National Computer Conference. "If the trend continues, we'll have a candidate standard in June," Bruce Ravenel, chairman of P770, told a gathering at the IEEE Computer Conference in San Francisco. Ravenel says the standard most likely will be the same as that described by Niklaus Wirth and Kathleen Jensen in their 1974 "Pascal User Manual and Report."

Sanders, ITT teams developing jammer for Navy, Air Force

Two teams are ready to do battle in the final rounds for contracts for the joint Navy–Air Force Airborne Self Protection Jammer (ASPJ). Sanders Associates and Northrop Corp. as the first team and International Telephone and Telegraph Corp. and Westinghouse Electric Corp. as the second have received sustaining engineering contracts. Later this spring the Defense Systems Acquisition Review Council will look over the ASPJ program, and each team should receive a first-phase development contract of $10 million to $15 million. The final development contract will go out in 1980 to one of the two.

The ASPJ will provide on-board protection for fighters and attack aircraft against radar-guided weapons systems and will be viable from the mid-1980s through the year 2000. Industry observers place a price of $1 billion to $1.6 billion on the production award, scheduled for 1984.
VHSIC’s takeoff roll looks good

Six months ago the Department of Defense first announced its plans to advance the semiconductor art with a program to develop very high-speed integrated circuits [Electronics, Sept. 14, 1978, p. 81]. The question at that time was: will VHSIC fly? Now we have at least part of the answer: the program is about to take off (see p. 41).

How well, how far, and how fast VHSIC flies is still uncertain. That will depend as much on the performance of the program’s pilots in the Pentagon and the congressional support they receive as on industry’s ability to innovate.

Pentagon performance so far gets good marks from industry, where interest in VHSIC is running high. “I’m impressed with DOD adding a program-definition phase up front before charging ahead,” says one prospective bidder’s representative in Washington. “It shows that they are listening.” Another potential competitor observes, “The program people are hanging loose, encouraging comments. I just hope they can remain flexible.”

DOD’s management plan

Final DOD approval of VHSIC plans for source selection and business management is just about complete at this writing. That will be followed by establishment of a program structure to include appointments of three military representatives to a VHSIC source selection acquisition council, balanced in turn by a separate source selection evaluation board. The Air Force, Army, and Navy representatives have yet to be named, but DOD program manager Larry Sumney indicates they will have ranks equivalent to two- or three-star generals—a sign of the importance the Pentagon attaches to the effort.

The lead military commands responsible for implementing VHSIC within each service also have to be officially named, although these are likely to be the Air Force Avionics Laboratory (AFAL), the Army Research and Development Command (Aradcom), and either the Naval Air Systems Command (Navair) or the Naval Electronics Systems Command (Navlex), or both, depending on the nature of the weapons systems selected for VHSIC demonstrations. While the individual services will choose their own candidate systems for demonstrations, company recommendations on which systems could benefit most from VHSIC technology will have significant bearing on those choices.

Keeping options open is crucial to DOD’s success in developing VHSIC circuits. The task of reducing minimum features on a chip to less than a micrometer is enormous, of course; but to do that and then carry it forward to mass production of such circuits represents a staggering challenge that will not be overcome with money alone.

Leaders of the Pentagon program appear to have recognized that need when they established VHSIC-III as a parallel six-year effort to support the technology of parts I and II, the development of the circuits themselves. In contrast to those large, vertically integrated programs, VHSIC-III “will consist of many shorter programs with a more limited scope, concentrating on key technologies, equipment, or tools” that Sumney says will provide “alternative directions not specifically included” in the larger efforts at the start. If, for example, a university or corporate laboratory comes up with a new and unanticipated development, it could be funded under VHSIC-III to pursue that effort. Should further development prove successful, the technology could then be incorporated as appropriate into VHSIC-I or II. What’s more, says Sumney, an organization bidding as a team member on the larger circuit development segments would not be precluded from bidding separately for VHSIC-III funds.

An uncommon commendation

That DOD approach is to be commended. It seems to recognize that the semiconductor industry, perhaps the most innovative segment of electronics, is anything but static. By making VHSIC-III a separate parallel effort, the Pentagon is also accommodating those design specialists who find it difficult to function effectively within the constraints mandated by a large, coordinated multicompany team working toward a specific program goal.

All these points must be made to Congress when it comes to a vote on the VHSIC appropriation. If DOD can get away from costly, custom-designed circuits and advance the state of the American semiconductor art at the same time, both the nation and the industry will be better for it.

Ray Connolly
A new series of vacuum fluorescent display drivers that simplify the design of many applications, including . . . POS systems, cash registers, clocks, scales, automotive displays, appliances, and pinball machines.

These new integrated circuits contain either six or eight high-voltage output drivers and are compatible with most TTL, MOS, and CMOS logic systems. All are expressly designed to interface between low-level digital logic and vacuum fluorescent displays. They are capable of driving display digits and/or segments and permit all outputs to be activated simultaneously. Pulldown resistors are incorporated into each output and no external components are required in most applications.

For application engineering assistance on these or other interface circuits, standard or custom, write or call George Tully or Paul Emerald, Sprague Electric Company, Semiconductor Division, 115 Northeast Cutoff, Worcester, Mass. 01606. Telephone 617/853-5000.


For the name of your nearest Sprague Semiconductor Distributor, write or call Roger Lemere, Sprague Products Company, North Adams, Mass. 01247. Tel. 413/664-4481.

<table>
<thead>
<tr>
<th>Type No.</th>
<th>UDN-6116A</th>
<th>UDN-6126A</th>
<th>UDN-6118A</th>
<th>UDN-6128A</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Pins</td>
<td>16</td>
<td>16</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Sustaining Voltage</td>
<td>85V</td>
<td>85V</td>
<td>85V</td>
<td>85V</td>
</tr>
<tr>
<td>Source Current</td>
<td>40mA</td>
<td>40mA</td>
<td>40mA</td>
<td>40mA</td>
</tr>
<tr>
<td>No. of Drivers</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Input</td>
<td>5V</td>
<td>6-15V</td>
<td>5V</td>
<td>6-15V</td>
</tr>
<tr>
<td>Compatibility with:</td>
<td>TTL, Schottky, TTL, DTL, and CMOS</td>
<td>MOS (PMOS or CMOS)</td>
<td>TTL, Schottky, TTL, DTL, and CMOS</td>
<td>MOS (PMOS or CMOS)</td>
</tr>
</tbody>
</table>
Who do you think of for high-performance 16K RAMs?

Next time

Take your pick: our µPD416 standard family offers a whole range of performance choices—extending to 120 ns access time and 320 ns cycle time. In either plastic or ceramic packages.

Every characteristic of our µPD416 family meets or exceeds industry standards, which means our parts are suitable for any application you can name. And we’ve been shipping in volume since August, 1977, so you know we can deliver parts when you need them.

Of course, 16K RAMs are just part of our story. We also have a broad selection of other memory components, led by our industry standard

---

P/N | tRAC | tRC | tD1H | tD1Z
---|---|---|---|---
µPD416-5 | 120 ns | 320 ns | 35 mA | 1.5 mA
µPD416-3 | 150 ns | 375 ns | 35 mA | 1.5 mA
µPD416-2 | 200 ns | 375 ns | 35 mA | 1.5 mA
µPD416-1 | 250 ns | 430 ns | 35 mA | 1.5 mA
µPD416 | 300 ns | 510 ns | 35 mA | 1.5 mA

Ta = 0°C to +70°C

---

16K µPD416 Family

4K µPD411 Family

4K µPD416 Family

1K µPD2102AL, µPD2111AL, µPD2101AL Series
4K Dynamic RAM (μPD411), with access time down to 135 ns, and our highly successful high-speed 4K Static RAM (μPD410), with access times down to 70 ns. Plus CMOS RAMs, Bipolar PROMs, 1K and 4K Static RAMs, and mask programmable ROMs up to 64K bits.

At NEC, we've built a reputation for advanced technology and volume delivery. We're also known for remarkable product reliability—thanks to experienced designers and meticulous manufacturing techniques, backed by 100% burn-in and testing with MIL-STD-883 methods. The result is an overall rejection rate of under 0.5%.

What's more, we offer thorough customer support, including documentation, testing, and special selection. And our engineers are always available to help with specific applications problems.

Our new product catalog will give you a better idea of just how much we can do for you, not only in memories but also in 8-bit and 4-bit processors and peripherals.

To get your free copy, clip your business card or letterhead stationery to this page and send to:
NEC Microcomputers, Inc., 173 Worcester Street, Wellesley, MA 02181.

If you haven't thought of NEC before, you will.

Next time.

NEC Microcomputers, Inc.
SwitchMax protects you in the hot temperature zone.

Maximum effectiveness in the switching mode

SwitchMax. A new series of RCA transistors designed and built for high performance in off-line power supplies, converters, and pulse-width-modulated regulators. SwitchMax transistors are hot-temperature tested. To give you new predictability under operating conditions. New efficiency in heat sink design.

Verified by worst-case testing

Every SwitchMax transistor is tested at 100°C or 125°C against precise limits for all switching parameters. Including inductive turn-off time and saturation voltage. To give you switching characterization that lives up to RCA's reputation in second breakdown, safe operating area, and thermal cycling ratings.

Performance that starts with design

These RCA n-p-n transistors have a multiple-epitaxial, double-diffused structure, fine emitter geometry, and a trimetal system. Which make SwitchMax transistors rugged. And give them excellent high-current and fast switching characteristics, with improved second breakdown.

For protection in the high temperature zone, ask for more information

With the SwitchMax power transistor booklet and RCA Application Notes, you'll be armed with facts to insure your protection in the hot-temperature zone.

Switch Max Booklet 2M1217 gives you full details on how these new transistors are designed, made, tested and characterized. There's also a designer's guide chart suggesting optimum transistor types for typical switching power supply circuits.

Application Note AN-6741 describes the use of the RCA 2N6676 15-ampere SwitchMax power transistor as a driven pulse-width-modulated flyback converter stage, in a 20-kHz off-line power converter providing 340 watts output.

Application Note AN-6743 is a description and analysis of a 900-watt off-the-line half-bridge converter using two 15-ampere SwitchMax high-voltage power transistors. This Note, too, demonstrates the outstanding capabilities of SwitchMax in a typical switching application.

For all this information, contact your local RCA Solid State sales office or distributor. Or write RCA Solid State, Box 3200, Somerville, NJ 08876.

RCA Power experience is working for you.
SGS-ATES to Introduce nonvolatile 1-K RAM at Paris show . . .

The Italian semiconductor house SGS-ATES Componenti Elettronici SpA feels it has a winner in its M 120 nonvolatile 256-by-4-bit random-access memory for read-mostly applications. Set to bow at the early April Paris components show, the bit-alterable part is an outgrowth of electrically erasable programmable read-only-memory technology and can store data for an estimated 100 years. Yet to a microprocessor it looks like a regular static RAM with an access time of 450 ns. SGS-ATES managed this feat with double-polysilicon-gate technology and on-chip control circuits that accept write data at a normal bus speed of 300 ns and then float the input/output pins while the slower internal modify cycle is carried out.

. . . while Siemens will present three memories

Look for Siemens AG to come out at next month's Paris components show with three parts: two random-access memories using emitter-coupled logic and an electrically erasable programmable read-only memory for which the Munich-based company guarantees a storage time of more than 10 years. The two ECL RAMs, designated the GXB100473 and GXB100475, have a capacity of 256 bits and 4,096 bits, respectively. The former has a maximum access time of 8 ns and a power consumption of 2.7 mw per bit; the latter accesses in 25 ns and consumes only 0.2 mw/bit. The EE-PROM, called the SAB 2808, uses double-polysilicon-gate technology and can store 1,024 8-bit bytes. With a 450-ns access time, the device needs 12 v for read-in, 25 v for programming, and 33 v for erasing, which takes only 60 seconds.

Toshiba makes C-MOS logic family 10 times faster

Toshiba Corp. has jumped the speed of its complementary-MOS logic family, which it calls C²MOS, with the announcement of its new HS-C² series. The company, which will supply samples of 10 different parts starting in April, plans to fill out the line with a total of 50 parts by the end of this year, and more the next. The new series is an order of magnitude faster than the standard C-MOS logic family, with a typical gate propagation delay to 5 to 15 ns. A decrease in channel length to about 4 µm and simplification of circuits both contribute to increased speed. The devices are designed to operate from power supply voltages of 5 ± 3 v, with an absolute maximum of 10 v. Initially, Toshiba hopes to take business away from TTL, including Schottky, rather than from its standard C² MOS parts.

UK viewdata module gets character set for 28 different languages

Character sets for up to 28 different languages, complete with accents and other language-specific features, can now be displayed with the addition of just one extra chip to the teletext-viewdata decoder set developed by GEC Semiconductors. The new G2 international character set implementation has been developed by the Wembley, Middlesex, company to meet a growing international interest in teletext and viewdata systems. GEC has already made its first sale of the new implementation to Bell Northern Research Ltd. in Canada for a proposed viewdata trial displaying both English and French in a 32-character-per-row, 20-row format. GEC says decoder sales have now taken off: it has booked $800,000 worth of business, with the same amount again in view. The two-chip implementation works by storing English language characters in one read-only memory and language-specific characters and accents in a second. A shift instruction preceding the English language character causes the corresponding character in the second ROM to be selected.
A two-color, 2-minute analog facsimile system shown in prototype by Matsushita Graphic Communication Systems Inc. today should be on the market before the end of the year. The standard text in black, together with corrections, revisions, additions, or other information in red, is sensed at the transmitter and recorded at the receiver by separate black and red on-demand ink-jet printers. In addition to linking with other terminals of the same type, the new terminals will communicate in black only with other Matsushita terminals using four amplitude-modulation transmission modes and all terminals using the 3-minute CCITT T3 recommendation for group 2 fax unit transmission, which employs a signal with vestigial-sideband phase-modulation—amplitude-modulation characteristics. The new terminal will cost less than $10,000.

RTC—La Radiotechnique-Compélec has in mind a rapid expansion this year for its 100-K family of emitter-coupled logic, notable for its gate propagation time of 0.75 ns and a power-delay product of 28 pJ. The Paris firm, the major French components producer for the Philips group, expects to have a total of nine parts by year-end, plus samples of compatible gate arrays and matrices of 24 or 36 basic cells whose functions can be defined by metalization. Also to come are two ECL 1,024-bit random-access memories, one with an access time of 10 ns, the other with 13-ns access time but lower power consumption.

A pocket liquid-crystal-display oscilloscope with a storage scope capability, a 500-mW power consumption, and a 2.5-MHz bandwidth—possibly extensible to 50-MHz—that's the long-term goal of a research program at Britain's Royal Signals and Radar Establishment, Malvern. The basis for the project is a novel technique for addressing twisted nematic liquid crystals that allows the display matrix to be driven continuously over its entire area, thus eliminating the flicker associated with multiplexed displays. In a prototype, the 5-kHz 100-by-100-element matrix is driven directly by 15-V complementary-MOS logic circuits, but RSRE researchers say that the technique can be readily extended to 512 by 512 elements and ultimately to 1,000 by 1,000 elements. A RAM provides storage.

A French telecommunications satellite will go on the air in mid-1983 unless there's a hitch in the government's Telecom 1 project. In a bid to get a piece of a market for satellite telephone circuits that it estimates will run some $230 million annually during the 1980s, the government will spend roughly $350 million to put up a pair of satellites—one of them a backup—into a geostationary orbit. Each satellite will have 12 transponders, half working in the 12-to-14-GHz band for high-speed digital transmission between points in France and half working in the 4-to-6-GHz band for transmission between France and its overseas territories.

International Business Machines Corp. announced its 4300 series computers in Japan on March 1. Price of the basic 4331 is ¥14.9 million, and of the basic 4341 ¥56 million. At the current exchange rate of ¥202.5 to the dollar, these amount to about $73,000 and $273,000, respectively—13% higher than the U. S. prices.
We can get Microprocessor Development Systems from Zilog, Intel or Tektronix on their way to you in minutes.

Whether your requirement is for a week, a month, a year or longer, there's one way to get the latest in microprocessor development systems from Zilog, Intel or Tektronix without waiting. Rent it from Leasametric.

Instantly, AUTEX, our nationwide 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 development system will be in your hands in less than 24 hours.

Need more than one system? 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 development systems. We stock the latest terminals, acoustic couplers, modems, communications and general-purpose 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.

Leasametric/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

A Trans Union Company
1164 Triton Drive, Foster City, CA 94404
**Sub-Miniature High Voltage Low Current Multi-Junction Fast Recovery METOXILITE Silicon Rectifiers**

**Down-To-Earth Prices!**

Increased Ministic production capabilities, and automated handling procedures, have enabled us to keep costs down for commercial and industrial applications and maintain the high quality proven in aerospace and MIL programs.

Our Silicon chips are "home grown" to guarantee quality, delivery and lowest price. The stacks are terminated with tungsten pins, high temperature bonded to the silicon, providing matched thermal expansion. All Ministics are hermetically sealed in "super tough" Metoxilite, manufactured with new techniques to reduce cost, improve insulation and uniformity.

And of course, Ministics are non-cavity rectifiers with solid silver leads.

**A Ministic for every application!**

Our increased product range makes it virtually impossible to find a Ministic that won't fit your application.

In addition to various types of discrete rectifiers, we can provide encapsulated higher voltage rectifiers and other configurations such as center taps, doublers, and full-wave bridges for use in high voltage power supplies and voltage multipliers.

PIV: 3,000 to 30,000 Volts
Average Rectified Current: 5 to 350 mA (depending on temperature & environment)
Recovery Time: 150 or 300 nanoseconds
Case Size:.300" to 2.00" L x .120" to .25" D

**Manufactured in the U.S.A.**

Contact the sales office nearest you to discuss your individual application with our sales engineer.

**Call Today!**

**SEMTECH CORPORATION**

652 Mitchell Road, Newbury Park, California 91320
(805) 490-2111 • (213) 628-5392 • TWX 910-336-1264

CHICAGO: (312) 352-3223 • DALLAS: (214) 641-2317

FLORIDA: (305) 644-5404 • MARYLAND: (301) 937-0070

NEW YORK / NEW JERSEY: (201) 964-3035

SAN FRANCISCO: (415) 494-0183 • SEATTLE: (206) 455-4807

CANADIAN SALES: Apextronics, Ltd (416) 493-9711
EUROPEAN SALES: Bourns AG, Zug, Switzerland (412) 232-242

70 Circle 70 on reader service card
BBC codes composite color TV signal to achieve 34-Mb/s rate

Researchers prepare for all-digital television environment using standard telephone lines

Because high-quality digital television transmission using conventional pulse-code modulation consumes a colossal 100 megabits per second—which could not be handled by the conventional telephone lines—research teams in Europe and Japan have been trying to reduce the data rate and still maintain acceptable broadcast quality. Now, the British Broadcasting Corp. claims to have succeeded.

BBC researchers have recently demonstrated a method of differentially pulse-coding a composite phase-automation-line (PAL) TV signal that cuts the bit rate by two thirds to 34 Mb/s [Electronics, Feb. 15, 1979, p. 64].

This fits neatly into European telephony data-rate standards of 8, 34, and 140 Mb/s and is in fact the rate the European Broadcasting Union is considering as a standard for exchanging international broadcasts accommodating the video signal and all its ancillary services. It could therefore lead to major economies in the use of standard PCM telephone links to distribute studio broadcasts to the BBC transmitter network, in the opinion of Paul A. Ratliffe, who heads the digital program at the BBC’s Kingswood Warren, Surrey laboratories.

The big technical advantage of a move to digital transmission, says Ratliffe, is that “the video quality is determined at the coding end in the studio and will be unaltered throughout the distribution network.” But there are also long-term strategic reasons. For one, as European countries move steadily toward an all-digital telephone network, high-quality video links that accept the full bit rate will become both scarcer and less economical.

For another, there is a strong move to go digital in the TV studio because editing is easier with digital video recordings [Electronics, Feb. 5, 1976, p. 94]. It thus makes technical and economic sense to move to digital transmission as well.

Different. The BBC has taken a different route than other groups by processing the composite PAL signal directly. Others have concentrated on coding the separate color components, with the exception of Britain’s Independent Broadcasting Authority, which uses composite PAL coding in its digital video recorder system [Electronics, Oct. 12, 1978, p. 63].

Apart from immediately cutting the data rate because only one signal is being coded, composite coding has the additional advantage that such systems can interface directly with analog PAL systems without the impairment associated with transcoding separate components.

Three more ways. Further bit-rate savings come from three separate sources. First, as in all digital coding schemes, removal of the blanking interval reduces the bit rate by about 24%. In practice, though, about 1% or 2% of this savings may be sacrificed in order to transmit blanking format and control information.

Second, the researchers cut the bit rate by sampling below the minimum required Nyquist frequency. However, doing so introduces spurious, or aliasing, frequencies, which are then removed by comb filters.

Savings also result from another common practice, reducing the number of bits per sample allocated to the signal. In linear PCM, 8 bits, or quantizing levels, are usually consid-
ered adequate for broadcast standards, but by employing differential PCM, the number of quantizing levels can be cut.

**Prediction and comparison.** In operation, a prediction is made of the input signal level, which is compared with the input signal itself (see figure). The error between the predicted and real signals is then quantized and transmitted. By transmitting the error signal, the number of quantization levels can be reduced. The better the prediction, the smaller the error and hence the smaller the number of bits that it is necessary to transmit.

But since quantization is nonlinear, small differences are transmitted with full accuracy and larger differences with progressively less accuracy. In this way, much of the picture information will be conveyed with no appreciable loss at a modest reduction in bit rate.

Ratliff says that with sufficient work the BBC technique could be applied to the U.S.'s National Television System Committee (NTSC) standards. He adds that it could also be applied in digital video tape recording to save tape.

---

**West Germany**

**MBB agrees to provide China with electronics gear and know-how**

The People's Republic of China's new open-door policy continues to generate business—or at least the prospects for it—for Western electronics firms. One of the latest deals is between various technical institutions in China and West German aerospace and electronics firm Messerschmitt-Bölkow-Blohm GmbH. A series of preliminary agreements, signed in Peking last month, involves television satellites, medical apparatus, and aircraft support equipment.

The most spectacular of the three agreements promises to be one between Munich-based MBB and the Chinese Academy for Space Engineering that aims at the joint development and construction of one or more TV satellites intended for live transmissions. Details have not yet been worked out, but the accord could entail as many as 20 satellites, each expected to cost from $40 million to $50 million.

The satellites, MBB says, would be developed in phases, with the goal of each phase jointly defined. Either party could terminate the agreement at the end of any phase.

Coming home. Initially, the academy will send groups of specialists to MBB's facilities in Munich for study, training, and participation in developing and building the first satellites. In later phases, the Chinese will transfer production, with diminishing West German assistance, to their own country.

The first satellite is to be ready by 1983 for launching by the Ariane rocket currently being developed by France with support from other European countries. From a geostationary orbit, this and subsequent satellites would broadcast mostly educational programs, presumably to ease the shortage of teachers brought on by China's Cultural Revolution a few years ago.

**Medical gear.** The second agreement is in the medical sector. Made with the Chinese Association for Medical Equipment, which employs some 70,000 people and is responsible for all equipment installed in Chinese hospitals, it entails cooperation in producing and applying medical gear. This deal, too, also provides for training Chinese specialists at the Munich facilities.

Part of the accord involves the delivery of a number of MBB's medical lasers, called "Medillas." These lasers, developed a few years ago and now being marketed by the Medical Equipment division of Siemens AG, are used in the treatment of various diseases and in stopping internal bleeding. They also perform various tasks in neurosurgery, dermatology, urology, and other fields.

**Aviation.** The third preliminary agreement involves aviation engineering. According to its terms, MBB will support the Chinese Association for Aircraft Construction and Equipment in designing rigs for fatigue tests and instrumentation for flight trials. It will also provide helicopter technology by transferring know-how, awarding licenses, and training Chinese personnel.

MBB says that both parties term the three agreements "extremely successful and trend-setting." They are the first results of a technology exchange pact negotiated in October of last year between China and West Germany's Ministry for Research and Technology. Close contacts between the Chinese and MBB were subsequently established during the visit of Fang Yi, deputy minister-president of China's Council of State and chairman of the National Commission for Science and Technology.

---

**Japan**

**Fixed-head VCR fills a (loop)hole**

A cassette with a continuous loop of tape that feeds into the cavity in the center of its hub is the key to an experimental fixed-head video cassette recorder developed at Toshiba Corp.'s Consumer Products Engineering Laboratory, Kawasaki. Toshiba's design enables the tape to move at 6 meters per second, the speed required to record the 3.9-to-5.4-megahertz band of the video luminance signal.

It thus eliminates the need for the complicated mechanical helical-scan arrangements used in other video recorders to obtain the necessary relative speed between tape and video heads [Electronics, Feb. 15, 1979, p. 64; Nov. 24, 1977, p. 106]. These designs both are difficult to manufacture and create a number of problems in operation.

For one, the new design eliminates...
Ultratech counts on Culligan ultrapure R/O water for precision manufacturing

Water purity is an absolute must for Ultratech of Santa Clara, California. Their only business is the manufacturing of photo masks for integrated circuit production. Even the smallest impurity in the emulsion can cause rejection of the end product.

So Ultratech relies on a Culligan-designed system to prevent any impurities from endangering this precise manufacturing process. Included is filtration, softening, deionization, reverse osmosis, ultraviolet light sterilization and submicron filtration.

The importance of this system is pointed out by Ultratech's emulsion production manager, David Lee. "Any serious problem with the quality of our water could possibly cause us to lose a valuable customer, not just a few rejects."

Culligan even installed conductivity monitors to make sure quality water standards are maintained. And a Culligan dealer is always nearby to handle emergencies at once.

Culligan Offers 2 Types of "State of the Art" Reverse Osmosis Membranes — cellulose acetate and hollow fiber.

- **Culligan's patented COR-FLO™ module** solves previous size limitations for spiral wound cellulose acetate membranes—produces more high quality water in the available space. Removes up to 95% of total dissolved solids, organics, even most bacteria.

- **The DuPont PERMASEP™ hollow fiber modules**, for large applications produce quality water with up to 95% of the total dissolved solids, and most organics and bacteria removed. Proven design simplicity.

Your Inquiry is Welcome — To find out how Culligan can add precision to your manufacturing process, call your local authorized Culligan dealer. Or contact Greg Montgomery at Culligan USA. Phone 312/498-2000. Or mail the coupon.

---

<table>
<thead>
<tr>
<th>Culligan Aqua-Clear® M Series</th>
<th>The DuPont PERMASEP™ hollow fiber modules, for large applications produce quality water with up to 95% of the total dissolved solids, and most organics and bacteria removed. Proven design simplicity.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culligan Aqua-Clear® S Series</td>
<td>Quality water—high bacteria and organic rejection, at 500 to 6000 gallons daily.</td>
</tr>
<tr>
<td>Culligan Aqua-Clear® KD Series</td>
<td>For high volume applications requiring ultra-filtration at 8000 to 140,000 gallons a day.</td>
</tr>
</tbody>
</table>

---

Greg Montgomery, Culligan USA
Northbrook, Illinois 60062

I would like to know more about Culligan water treatment.

- [ ] Have representative call
- [ ] Send literature

<table>
<thead>
<tr>
<th>NAME</th>
<th>TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPANY</td>
<td>PHONE</td>
</tr>
<tr>
<td>ADDRESS</td>
<td></td>
</tr>
<tr>
<td>CITY, STATE, ZIP</td>
<td></td>
</tr>
</tbody>
</table>

Water Treatment Application

[Circle 73 on reader service card]
the switching transients that occur between TV fields in the helical-scan units. Thus, it is suitable for recording other types of high-frequency signals in addition to video.

For another, changes in tape speed do not present the tape-tracking difficulties associated with the other designs. Thus variable speeds, as in audio recorders, are possible for other applications.

The 100-meter loop of tape has a continuous recording track that yields a long playing time—about one hour—despite the high tape speed. In operation, the tape is pulled through a slit in the stationary reel into the central cavity by the capstan and the roller (see figure). After gliding past the head and between the capstan and the roller, the tape loops over the reel and winds onto its outside.

Gentle. A mere 30 grams of tension—slightly more than 1 ounce—is sufficient to pull the graphite-lubricated tape from the reel, making it possible to use a pressure-sensitive tape splice in the experimental units. Because the pull is straight, no distortion of the tape occurs, which is possible with the schemes used in continuous-loop audio systems. Also, since there is almost no tension at the take-up point, no damage occurs there either.

Further, the head is flanked by two guides that have ridges to fix the height of the tape, and the shortness of the distances between these elements reduces any tendency of the tape to vibrate—a common problem of helical-scan units. Therefore, the complex stabilizing mechanisms of the latter are unnecessary.

Head up. Elevating the head by means of a stepping motor results in a recording track that winds around the tape 220 times with a total width of 50 micrometers. Since the tape width is 12.7 millimeters (½ inch), an ample margin is left at the two edges. Each turn of the track has a playing time of 16¾ seconds.

The track is parallel to the edge of the tape except for a portion that curves during the 20 milliseconds that is required to change the head elevation at the end of each turn. This curve occurs at the splice, which is detected by an optical sensor (not shown).

The head can be shifted vertically, and a complete traverse of the width of the tape takes 4.4 seconds. This permits material at any point on the tape to be accessed in a maximum of 21 seconds. In contrast, rewinding or fast winding of a helical-scan cartridge averages about 3 minutes.

The recording format is conventional except for the audio track. This track is recorded as an audio signal along the edge of the tape in other video tape recorders, but that is clearly not possible with this unit.

Instead, the audio signal is recorded as an fm signal with a carrier frequency of 1.5 megahertz and a deviation of ±100 kilohertz and is multiplexed with the luminance signal, which is an fm signal in the 3.9- to 5.4-MHz range. The chroma signal is translated down to a 688-kHz carrier—which is common in VCRs.

The track width of 40 µm is somewhat wider than the approximately 29 µm of long-playing VHS and Betamax units, but it seems good for an early prototype. On the other hand, the 10-µm guard band—in contrast to the lack of guard bands in the latest two-headed helical-scan units—is inevitable because azimuth shift is not possible with a single head. Still, the 1.27-m² area of tape per hour of playing time is very close to that of extended-play consumer units and in fact is better than that of the regular-play ones.

Longer. Although playing time of the prototype is only 61.1 minutes, Toshiba engineers say that they have successfully loaded 200 meters of tape into a standard cassette for 2 hours of playing time.

Elimination of the helical-scan mechanism has enabled Toshiba engineers to reduce the weight and size of the unit to about half those of consumer recorders. The area of the cassette is about midway between those of Betamax and VHS cassettes,
Hybrid Systems
Precision Resistors: Less Cost, Less Space, Less Hassle

Chips . . .
a million in stock right now.
Single value center tapped. Standard absolute tolerances to 1% (custom to 0.1%). Typical ±2ppm/°C tracking. Standard RETMA values from 10K to 301KΩ. Also standard and custom networks . . . 10, 20, 30 or more resistors per chip . . . combined resistance 2, 3, 4 MΩ or more. Processed to MIL-STD-883 or commercial.
Circle 74

Packaged Networks . . . to your specs . . .
or from our library of over 500 mask sets.
Standard R/2R networks or custom arrays. Computer laser trimming, absolute values to 0.1%, ratios to 0.01%, ±2ppm/°C tracking. Hermetic TOs, DIPs, and flat packs. MIL-STD-883 or commercial processing.
Circle 75

The largest producer of thin-film resistors in the world, Hybrid Systems can deliver 100,000 center tapped chips or 25,000 network chips per customer per week. More than a decade of experience and state-of-the-art thin-film processing technology keep us on top.

Whatever the challenge, on land, sea, or in the air — in commercial/industrial and military applications — Hybrid Systems meets the highest standards for reliability and performance. The quality control begins on the drafting board, continues through every step of the manufacturing process — and never quits.

For fast results, call or write. Or circle the number(s) on the reader service card.

When the chips are down . . .

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 4109390 HYSTRY 0)

In the United Kingdom:
Hybrid (Component) Systems U.K. Ltd.
12A Park Street, Camberley, Surrey
Tel. (0276) 28128
(TELEX 858720 HYBRID G)
Magnetically soft alloys are strong, too

Magnetic softness and high mechanical strength, both desirable properties for the materials used in everything from transformers to relays, are seldom found together in metals with a crystalline structure. A metals producer in Hanau, West Germany, has therefore found a way to make them with an amorphous structure.

The Vitrovac group of amorphous metals was developed by Vacuumschmelze GmbH, a subsidiary of Siemens AG. Their magnetic softness means that the materials can be easily magnetized even at high frequencies; and their mechanical strength translates into good dimensional stability, high elastic limits, and high resistance to wear and abrasion. In contrast, conventional magnetic materials are either soft magnetically and mechanically not very strong or magnetically hard with good mechanical properties.

Soft. Magnetically, the Vitrovac materials have not only a high maximum permeability, with values of better than 500,000 easily obtainable, but also a low coercive force of less than 10 milliampers per centimeter and high saturation induction values ranging from 0.6 to 1.2 tesla. Further, the magnetic hysteresis losses are lower than those of comparable magnetic materials such as Permalloy and silicon iron.

Mechanically, the Vitrovac group has a tensile strength better than 3,000 newtons per square millimeter—comparable to that of high-quality steel. In addition, the materials have high elastic limits and are insensitive to rough handling, even to sharp bending.

As for electrical characteristics, the temperature coefficient of the materials' resistivity can be set at between —100 parts per million per Kelvin and +500 ppm/K simply by changing the composition of the materials. The resistivity is from two to three times higher than that of crystalline magnetic materials.

Handy. These properties will come in handy in many applications, says Hans Warlimont, the project manager for Vitrovac. The materials' high saturation induction, he points out, will make it possible to design smaller inductive components. The high resistance to wear suits them for use in magnetic pickup heads for, say, tape recorders, while their low magnetic losses should benefit transformer cores.

Furthermore, their dimensional stability and elasticity should make them popular for magnetic shielding devices, because, unlike conventional high-permeability materials, they do not lose shielding properties in response to the bending forces common in this application.

The new materials are alloys of iron, nickel, and cobalt in varying proportions, plus nonferromagnetic metals like chromium and molybdenum. Additives such as boron, silicon, phosphorus, carbon, or aluminum help impede crystallization.

Chilling. To obtain an amorphous structure, the mixture is melted and then cooled at a rate of about 1,000,000 K per second. To cool it that rapidly, Vacuumschmelze uses a melt-spin process, which squirts the melt through a tiny nozzle onto a fast-spinning drum (see photo). Upon contact with the drum, the thin stream solidifies so suddenly that crystallization cannot take place and the desired amorphous structure is obtained instead.

Because the drum rotates, the melt solidifies in the form of thin strips, typically from 20 to 50 micrometers thick, depending on the drum's rotational speed and the melt's flow rate. These strips, which are from 1 to 25 mm wide, may then be mechanically compressed into small blocks.

Generally, amorphous metals can be made only in strips not much thicker than 50 μm. Any thicker, Warlimont explains, and the heat transfer from the strip's interior to its surface during cooling would take too long, resulting in a crystalline structure. In addition, the material's amorphous state is maintained only up to a certain crystallization temperature, which may be anywhere between 300° and 600°C, depending on the composition of the material.

The result of a three-year development effort at Vacuumschmelze, the two or three kinds of Vitrovac materials will be offered in small amounts beginning in April, Warlimont says. As production increases, larger quantities and more types will become available.

It is too early to talk about prices, Warlimont says, but the cost should be low. This, he points out, will result from large-scale production of strips directly from the melt in just one fairly simple and fast step. Also contributing is the relatively low cost of most of the raw materials.
**ELEC-TROL**

**DIP REED RELAYS**

DIP RELAYS THAT CAN TAKE A DIPPING...
FROM THE ORIGINATORS OF THE DIP

In 1968 when Elec-Trol introduced the first DIP Reed Relay to the industry—we had two purposes in mind. One was to provide a quality line of reed relays suited for insertion into standard 14-pin DIP sockets or directly onto printed circuit boards; and the other was to provide the customer with a rugged, miniature, low-cost reed relay that could withstand total immersion and board washing.

Today, Elec-Trol offers DIP Reed Relays in both .225"H and .275"H packages. They are available with Form A, B, and C dry-reed switch contacts up to 10 watts, and 50-watt Form A mercury-wetted reed switch contacts. In addition to providing total protection in hazardous environments, the DIP relays also feature high shock and vibration immunity and reed switch contacts that are hermetically sealed for low contact resistance. They can be driven directly by DTL/TTL logic, and they are available in 8-pin or 14-pin terminals with or without clamping diodes. Options include electrostatic shielding and contact run-in.

For more information, use the reader service card, or contact your local distributor, representative, or the factory direct.


**ELEC-TROL**

**DIP RELAYS**

140 STANDARD MODELS

Elec-Trol now offers one of the broadest lines of DIP Reed Relays available, 140 different standard models. You can select 1A, 2A, 1B, and 1C dry-reed contacts with either 3-watt or 10-watt ratings, or 1A mercury-wetted with 50-watt rating. All of them are available with or without clamping diodes and with a choice of 5, 6, 12, or 24 VDC cuts. For off-theshelf delivery or to ask about samples, contact your Elec-Trol distributor.

AUTHORIZED DISTRIBUTORS

**CALIFORNIA**

140 MODELS AVAILABLE.

**COLORADO**

A broader line of component distributors.

**FLORIDA**

Over 140 models available.

**ILLINOIS**

Over 140 models available.

**INDIANA**

A broader line of component distributors.

**LOUISIANA**

A broader line of component distributors.

**MASSACHUSETTS**

A broader line of component distributors.

**NEW JERSEY**

A broader line of component distributors.

**NEW YORK**

A broader line of component distributors.

**OHIO**

A broader line of component distributors.

**TEXAS**

A broader line of component distributors.

**VERMONT**

A broader line of component distributors.

For more information, use the reader service card, or contact your local distributor, representative, or the factory direct.

Can your sales engineer be here?
When it’s TRW, the answer is yes.

When you consider that TRW has over 250 people in more than 50 sales offices nationwide, with factory engineering and marketing staffs to help them, you can understand how we can make that statement.

TRW recognizes that service, before and after the sale, is as important as consistent quality and competitive prices. When you need help, or an answer in a hurry, we’ll get it to you.

When you want “yes” for an answer, call your nearest TRW/ECD sales office.


TRW Capacitors
TRW Cinch Connectors
TRW Cinch-Graphik
TRW Cinch-Monadnock
TRW Electronic Functions
TRW Globe Motors
TRW Holyoke Wire & Cable

TRW Inductive Products
TRW IRC Networks
TRW IRC Resistors
TRW LSI Products
TRW Power Semiconductors
TRW RF Semiconductors

TRW Electronic Components
Divisions of TRW Inc.

Circle 79 on reader service card
FOR RENT

Intel's amazing new generation Intellec Series II Microcomputer Development Systems... everything you'll ever need to develop a microcomputer-based product.

Model 230 is the most powerful member of the Intellec Series II family, providing you two double-density floppy diskettes with over 1 million bytes of on-line data storage, 64K bytes of RAM and an integral CRT.

The compact Model 230 also gives you a detachable, typewriter-style keyboard with upper and lower case characters and cursor controls. Its powerful SHS-II Diskette Operating System has relocatable and linkable software and allows the use of two high-level programming languages, PL/M-80 and FORTRAN 80, plus the microcomputer industry's most comprehensive line of macro assemblers. The system has over 1 million bytes of online diskette storage and will support up to 2 million total bytes. The System Monitor, a ROM routine provides a Self-test system diagnostic, and interfaces for a printer, paper tape reader/punch, and universal PROM programmer. Also provided. Model 230 gives you access to all the tools needed for your development work, including software editors, assemblers, compilers, debuggers, plus Intel's famous In-Circuit Emulators—ICE-80, ICE-85, and ICE-48.
For medium-scale system development, you can rent the Model 220. Now.

The Intellec Model 220 is also a complete packaged development system. It has an interactive, 2,000-character CRT with typewriter-style keyboard and a multi-speed, 295K byte floppy diskette drive and 2Kbit MULTIBUS card read/write diskette unit. Model 220 gives you 256K bytes of RAM memory and 4K bytes of ROM. The IBM/PC Diskette Operating System has a relocating 8080/8085 assembler and the user system interfaces directly to the ICE In-Circuit Emulators.

The Intellec Model 210 rents for the lowest price of any packaged, full support development system available—anywhere.

Model 210 gives you the minimum system required for the rapid, efficient development of microcomputer software. It has a ROM-based editor/assembler combination which allows the development of small 800-8000 program capability in ROM memory, which minimizes rewrites of paper tape. Plus, you can also write a ROM assembler/monitor for Intel's family of MCS-48 single-chip microcomputers. The compact Model 210 has 8K bytes of RAM, 32K bytes of ROM and its own microprocessor. Skill-set development capability is included. And it's easy to get started. All you have to do is interface the Intellec 210 to your terminal.

You can extend the powerful resources of an Intellec Series II system into your own prototype for fast and efficient software debugging in your product's final hardware environment. Just put your product on ICE-80, ICE-65, or ICE-18, all off-the-shelf at REI.

In complete your own CPU or your entire prototype system in real time or single-step emulation, simply select the appropriate in-Circuit Emulator model to match your system's microprocessors. And you can begin software development on your prototype with a precision pocket pocket size structure.

Computer-enhancing peripherals are available for short-term rental, too.

You can add to the already extensive capabilities of the Intellec Series II system with a variety of immediately available peripherals. These include two Intellec Printers, two dedicated joysticks for joystick-driven simulations, the other floating memory with 1 million bytes of storage. You can also choose a high-speed paper tape reader and a universal PROM programmer... all of which are far beyond today's HD.

Rental Electronics, Inc.
Another of the American companies

More than 12,871 state-of-the-art instruments... off-the-shelf throughout North America.

I want to know more about the Intellec Series II now!
Tell me more about: ☐ Model 230 ☐ Model 220 ☐ Model 210
Call me at ___________________________

☐ Send me a copy of your free illustrated Rental Catalog.
☐ I might be interested in buying—on a money-back guarantee—some of your late-model, well-maintained “previously owned” equipment. Send me your just-published Equipment Sales Catalog.
☐ Also, I have a pressing need right now for the following:

Please phone me immediately at
NAME ___________________________
COMPANY ___________________________
ADDRESS ___________________________
CITY ___________________________ STATE ______ ZIP ______
PHONE NUMBER ___________________________ EXTENSION ______

Complete this coupon and return it today to REI, 19347 Londelius St., Northridge, CA 91324. GSA #GS-04S-21963 Neg
UNIQUE R-N SINGLE CONTACT DESIGN PROVES SUPERIOR

They deliver 4 times greater holding force on your IC leads.

In a tough, 50 G shock test of 25 ICL sockets—none a single IC package came loose from the socket! More convincing proof that vibration problems are ended with R-N’s new low profile ICL sockets. Socket density in multi-layer board can now be increased without sacrificing reliability.

...and this FULL LINE of low-profile R-N ICL sockets is priced very, very competitively.

Beryllium copper for 36% greater contact strength than other commonly used contact alloys.

Self-lock leads hold socket firmly during high-speed wave soldering. Also, this “bump” restricts solder flow and prevents solder wicking.

“Side wipe” design meets flat, smooth side of IC lead for perfect contact.
“...TWO contacts are not more reliable than ONE!”

Surprisingly, a low profile (.150" high) DIP socket is a different breed of cat when it comes to engineering in contact reliability. Most standard DIP sockets have dual contacts. (R-N’s dual “side-wipe” contacts are among the most reliable in the industry.) But, when you shorten the contact length to achieve the “low profile” you lose a great deal of contact force and IC retention strength. So, to achieve effective low profile socket reliability you must redesign the contacts and make them out of the strongest contact material available.

Low .150" profile of ICL socket reduces board density by 26%.

Fat-Skinny TESTS PROVE* that R-N "back fold side-wipe” SINGLE CONTACT design for low profile sockets provides –

**4 TIMES BETTER IC RETENTION FORCE**
than competitive low profile dual-leaf sockets

Minimum withdrawal forces:

- R-N SOCKET
- SOCKET "A" 8 oz.
- SOCKET "S" 7 oz.
- SOCKET "T" 3 oz.

* In “Fat-Skinny test,” withdrawal forces are measured using the smallest size (.008") lead after insertion of largest size (.012") lead.

Representative NORMAL FORCE Test Scores for 10 R-N ICL low profile sockets

<table>
<thead>
<tr>
<th>TEST SOCKET</th>
<th>NORMAL FORCE *</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>410 grams</td>
</tr>
<tr>
<td>2</td>
<td>465 grams</td>
</tr>
<tr>
<td>3</td>
<td>490 grams</td>
</tr>
<tr>
<td>4</td>
<td>465 grams</td>
</tr>
<tr>
<td>5</td>
<td>395 grams</td>
</tr>
<tr>
<td>6</td>
<td>425 grams</td>
</tr>
<tr>
<td>7</td>
<td>465 grams</td>
</tr>
<tr>
<td>8</td>
<td>395 grams</td>
</tr>
<tr>
<td>9</td>
<td>410 grams</td>
</tr>
<tr>
<td>10</td>
<td>425 grams</td>
</tr>
</tbody>
</table>

AVERAGE – 430 grams

This force is 4 to 5 times greater than average dual contact socket NORMAL FORCE

* NORMAL FORCE means force perpendicular or at right angles to IC lead. The single ICL contact exerts this kind of force against the IC lead when inserted into the socket.

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.

ROBINSON NUGENT, INC.
800 East Eighth Street, New Albany, Indiana 47150 • Phone: (812) 945-0211 — TWX: 810-540-4082

Circle 83 on reader service card
Converting a color television signal into a screen full of "The Muppets" is only slightly less complicated than unscrambling an egg. The rf signal appearing at the receiver front end is a jumble of modulated subcarriers and synchronizing signals, all of which must be delicately picked off and converted into information the picture tube can handle.

The toughest unscrambling job of all falls to the chroma demodulator, whose synchronous detectors must pull the color information out of a phase-modulated subcarrier and combine it with brightness information to create the proper mixtures of primary colors at the video output stage.

To test the chroma demodulator (in today's TV sets, integrated circuits), it is necessary to apply a modulated test signal at the appropriate subcarrier frequency and then accurately measure a number of phase-sensitive output voltages at the device output.

In practice, most of today's chroma demodulators are tested on Teradyne J273 Linear IC Test Systems equipped with a "chroma generator" specially designed to develop the convoluted waveforms that are required. The output of the chroma generator's output consists of 16 segments, each of which is programmable in time, dc level, and subcarrier level. In addition, three separate "event" outputs can be programmed to provide keying pulses wherever they are needed. Finally, a gated voltmeter can be programmed to measure, in any given segment, dc voltage, ac voltage, or phase (corresponding to brightness, color saturation, and color information, respectively). Since color information is actually transmitted in the form of phase angles, phase measurement is especially critical in chroma testing.

The chroma voltmeter is more than equal to the task. First it measures the average values of the in-phase and quadrature components of the signal; then, from the ratio of the two values thus measured the voltmeter derives phase angle (\(\phi = \text{arc tan of the ratio of the two average voltages}\)).

By writing a one-line software instruction for each of the 16 segments, the user can develop a periodic waveform that will simulate the desired range of chroma input signals. Also under software control are a number of other variables, including voltmeter operating modes, subcarrier frequency and amplitude, and scale factor and attenuation of the video waveform. Test procedures differ for the American and European systems (NTSC and PAL), and this choice is also made in software.

Thanks to the J273 and its chroma generator, today's chroma demodulator can be rigorously tested on the production line in well under a second. The story doesn't end there, of course, for device designers are now busy adding more circuits to the same chip, while Teradyne's linear-test engineers are just as busy developing new automatic test techniques. After all, once you have unscrambled an egg, why not build a hen?
Alphas stymie statics

Research in soft-error phenomena reveals new alpha particle mechanisms and indicates certain static designs may be susceptible

by Raymond P. Capece, Solid State Editor

One semiconductor giant has assigned it top priority. Another has built a special memory-test system for it. And a third brought in 20 tons of lead to research it. "It" is the soft error effect in memories caused by alpha particle radiation.

Bad enough that the problem was uncovered in dynamic random-access memories and charge-coupled devices [Electronics, June 8, 1978, p. 42]; now evidence shows that those gremlins can also attack static memories. To complicate the situation, memory makers cannot agree on the importance of the problem.

At a conference last year, a question from the audience about alpha particle errors in statics brought a roar of laughter. But when Richard D. Pashley, head of static memory design at Intel Corp.'s Aloha, Ore., Memory Products division, mentioned the effects of alpha particles on his company's forthcoming high-speed 16-K static, he was deadly serious: "We haven't compiled any figures yet," he said at the International Solid State Circuits Conference in Philadelphia last month, "but alpha-particle hits have affected data in our 16-K RAM."

Pashley's revelation had to do with the fact that the 16-K part was Intel's first production static designed with polysilicon load resistors. The memory cells of most statics are flip-flops, which can be built with either six or four transistors and a pair of load resistors; alpha particles bother only the polysilicon-load designs. The tiny current normally flowing through the load can be overpowered by the charge flow that occurs when an alpha particle hits and the result is that the flip-flop gets flipped.

Consequences. Several memory makers have switched to the polysilicon resistor in the past few years to reduce chip size and power dissipation over six-transistor designs. The polysilicon loads can cut power dramatically, but if that resistor is too large, the RAM falls prey to alpha radiation.

The developer of polysilicon loads, EMM Semi Inc., Phoenix, Ariz., which has five years of experience with the resistors, smells a red herring: "We found the problem years ago and licked it," claims John Hartman, product development manager at EMM Semi. "By bringing it up, Pashley may be making trouble for the whole static-memory industry," he charges.

Hartman says that EMM Semi makes its parts alpha-immune by limiting resistor values. "We hold loads in the lowest power parts to 50 megohms and in the highest speed parts to 1 megohm," he explains.

To many memory makers, low-power parts have been a particular problem. To reduce power, some chip makers resorted to undoped polysilicon resistors that squeeze current down to a few picoamperes. Mostek Corp., Carrollton, Texas, had problems with its 4104, the lowest-power 4-K static on the market—it seems the difficulty was with the part's 2-gigohm load resistors—

Alpha blues. Research on alpha errors in dynamic RAMs reveals problems beyond those in (a), where 1s flip to 0s. Bit-sense lines are also vulnerable, and alphas can even attack static RAMs. Good news: RAMs using an epitaxial process (b) may reduce soft errors by 100 times.
Probing the news

and, says Darrell Rinerson, senior product engineer, Mostek has since had no alpha-radiation problems with other 4-K parts; nor have any cropped up with the company's 4118 8-K statics. "But it has not yet been determined whether soft errors will be a problem with 16-K statics," he warns.

High-speed trap. To date Texas Instruments Inc. makes only moderate-speed 4-K statics with poly loads. According to Dick Gossen, manager of MOS memory development, alpha particle problems do not yet exist, though he expects some changes: "We haven't seen soft errors yet, but I'm sure we will."

Gossen worries that the high-speed designs of future statics will be susceptible to radiation. "One way to boost speed is to reduce the voltage swings of the flip-flop; with the states of each half of the circuit separated by only a volt or two, the margins will get uncomfortably close." This may in part be why Intel's 16-K part, which aims at a 55-nanosecond access time, encountered difficulty.

Coincidentally, the same mechanism by which alpha particles affect statics has produced previously unexplained errors in dynamic devices. At first it was believed that the main cause of soft errors in dynamic RAMs was alpha particles coming to rest near charge-storage wells. The alphas crash through the silicon, producing numerous electron-hole pairs—a million or so—that are swept by the electric field to fill potential empty wells. This action changes 1s to 0s.

New evidence, however, indicates that alphas stopping near bit-sense lines are really the major culprits. (Static, too, have bit-sense lines that can be susceptible to alphas.) "If only wells were involved, the errors would show as 1s becoming 0s," explains Intel physicist Timothy C. May. "But we see a significant number of 0s becoming 1s."

The discovery led Intel to try to find new solutions, mostly through the use of "cooler" (more radiation-free) packaging material. "Even with package material that's one tenth as radioactive as today's," cautions May, "a 64-K dynamic RAM built simply as an extension of 16-K rules will have significant soft-error problems."

Intel's newest approach involves timing on the bit-sense lines. According to physicist May, the charge would have to be collected on the sense line during the brief period—about 10 to 40 nanoseconds—when the line is essentially floating or in a high-impedance state, making the source of error dependent on the chip's cycle time. Intel's tests on 16-K dynamic RAMs have indeed confirmed that soft errors increase with increased cycles.

Use the dependency. Thus, says May, designers should take advantage of that cyclic dependency in the sense lines. "Shortening the time the sense lines are floating, as well as making changes in the layout of the lines, will significantly decrease the error rate," he declares.

Of course, it's all a percentage game, and coupling May's design techniques with others should stave off radiation. "If you include error-correcting memory system designs, then the alpha particle problem will definitely be under control into the next generation of dynamic RAMs—the 256-K chip," Mostek's Rinerson maintains.

To muddle the situation further, however, some new data on alphas has been compiled by Bell Laboratories. At a meeting before ISSCC last month, D. S. Yaney and J. T. Nelson of Bell Labs, Murray Hill, N.J., revealed that the troublemaking electron-hole pairs produced by the particles, which travel 50 micrometers or more through silicon, recombine within as short a distance as 1 μm in a heavily doped region. That news alerted Bell, since it builds its dynamic memories with an epitaxial process that uses a thin (4-μm) p-layer on top of a p+ substrate. Bell's findings: a soft error rate one-hundredth that of industry-standard RAMs.

The news also excited T.J. Rodgers, manager of the memory department at American Microsystems Inc., who developed AMI's V-groove MOS—which also uses an epitaxial process. "V-MOS just might be inherently less susceptible to alpha particles, but I've got a bit of experimenting to do before I'll be able to find out for sure," Rodgers says.

Packaging materials still play the most important role in securing minimal-error devices. "At the very high end of the radiation range of packaging materials we're getting a probability of two alphas per refresh cycle per cell and the likelihood of very high error rates," Intel's May explains.

Ceramic materials are an Intel target. "Even though they may be cooler than other materials in the package, most of the die area is exposed to the ceramic," he explains. Intel's May claims that Japanese ceramics are running cooler than those from the U.S.

Many manufacturers and users believe the alpha particle problem is inflated. "There are many other sources of soft errors," says one MOS marketing manager, "like power-supply fluctuations and all kinds of system noise; alpha radiation is just one small part." A failure is a failure, however, and memory makers are finding their image at stake. Customers might even begin to specify a maximum allowable soft-error rate on the chips they buy. The gravity of the problem is indicated, though, by the papers to be given at the International Reliability Physics Symposium in San Francisco on April 24-26: at least a half dozen will focus on alphas.

Changing needs. Therefore, MOS memory makers now realize that new test and measurement equipment as well as new techniques will be needed to sell RAMs. Chip manufacturers must be able, for example, to measure radioactivity down to flux values lower than 0.1 alpha particle per square centimeter per hour to isolate the coolest packaging material.

At first, Intel was counting alpha particles directly with various scintillation counter schemes, finally settling on one that was 75% to 80% efficient and had resolution of 0.01 alpha per square centimeter per hour. May says now that better resolution can be achieved by counting gamma radiation from high-energy sources and then by extrapolating back to obtain a picture of the alpha radioactivity.
What we put in makes ours better.

That's why leading manufacturers, worldwide, are switching to General Instrument's rectifiers and bridges.

You shouldn't have to worry about rectifier failures - during assembly or after your products are in use. That's our job. But we don't like to worry either, so we build them better from the start.

SUPERECIli®
The world's best rectifier. Metallurgically bonded by brazing (at greater than 600°C) at both leads and junction to eliminate component failures caused by stresses from automatic insertion and wave soldering. Glass passivated, providing extra reliability exceeding military and environmental requirements. And finally, encapsulated with our UL listed flame retardant epoxy, for uniform size, clear marking, and easy handling. And all this at a low, low price.

Plus a complete selection of plastic and glass axial leaded rectifiers rated up to 6 amps, and 5000 volts, including fast recovery and controlled avalanche types.

BRIDGES:
For those applications requiring bridge circuits, General Instrument's complete line of silicon bridges offers most configurations from 0.5 amp to 35 amp - including center taps and doublers. For additional information, call or write for our complete catalog.

GENERAL INSTRUMENT CORPORATION
DISCRETE SEMICONDUCTOR DIVISION
600 West John Street, Hicksville, New York 11802 (516) 733-3333

Circle 87 on reader service card
Probing the news

Microcomputers

Chip, mini makers squaring off

While computer companies are slicing silicon, semiconductor houses are boxing systems and selling software

by John G. Posa, Microsystems & Software Editor

Digital Equipment Corp., in effect, puts its PDP-11/34 central processing unit onto a single board. Data General Corp. announces a new microNova chip as well as two new computer families that triple the performance of previous microNova products in less than a third the space [Electronics, March 1, p. 182]. And semiconductor houses like Intel Corp., are bullish on 16-bit devices and related software.

What's behind these role reversals in the world of microcomputers? Some competitors say they are not significant—that markets are and will continue to be clearly segmented into well-defined slots for the minicomputer companies and the chip makers. Others, however, contend that a real battle over markets is in store.

These markets have been traditionally separated for a variety of reasons. For one, the chip makers have just recently begun to move their devices and board products into the 16-bit minicomputer arena. But other factors, including type of user, software support, peripheral products plus service and distribution channels, not to mention expertise in large-scale integrated circuitry, have also kept the two sides apart.

With the advent of 16-bit devices, these distinctions are blurring. Silicon houses are getting more aggressive with chip and board performance and software support. Indeed, at least one promised part, the M68000 from Motorola Microcomputer Group in Austin, Texas, will sport numerous 32-bit attributes. Soon after the devices are introduced, they are incorporated onto board computers by the chip makers themselves.

The iSBC 86/12, a 16-bit CPU board from Intel Corp., Santa Clara, Calif., is nothing for the mini makers to scoff at. It features a dual-port RAM and an architecture well suited for master-slave configurations. Meanwhile, in the past year, Zilog, an Exxon affiliate, Cupertino, Calif., announced Cobol, Fortran, and Basic for its Z80 processor; later this year, it will also support Pascal. This is quite an arsenal of applications languages for a semiconductor company.

Switching. On the other hand, the integrated circuits being produced by some of the minicomputer manufacturers in their own fabrication plants are both sophisticated and competitively priced. Data General of Westboro, Mass., has microNova chips that execute the 16-bit Nova instruction set and have hardware multiply and divide. DEC of Maynard, Mass., is also toying with selling its new chip set, created with n-channel polysilicon-gate depletion-load MOS technology—not unlike that used by Intel, for example, to make its 8086.

"Minicomputer manufacturers have backed down on some of their policies," comments Ed Zander, marketing manager for microproducts at Data General. "We are making chips. But the chip makers are doing things differently now too—they're designing a lot of software and they're licensing it."

Clearly the minicomputer manufacturers are not going to scale down to 8 bits. That is a high-volume, second-source business that they want no part of. The competition, if

Down and over. The LSI-11/23 16-bit microcomputer can execute programs two to four times as fast as earlier LSI-11s and is 90% as fast as the PDP-11/34.
Inside the LSI-11/23

With DEC's LSI-11/23 comes a number of product announcements [Electronics, March 1, p. 34]. The heart of the system is a 16-bit central processing unit called the KDF11-AA. But also involved are a multifunction board, a universal programmable read-only memory board, an erasable PROM/PROM/ROM board, and a low-cost mounting chassis with power supply included.

The CPU board, designed for the LSI-11 bus, uses three new custom DEC chips. Two of them, for data and control, implement the basic processor. They are both in one 40-pin dual in-line package. The data chip takes care of math and logic functions, address- and data-bus transfers, and most interchip communications. The control chip contains the control store ROM; it sequences through the microprograms.

The third chip is a memory-management unit (MMU). It makes available two multitier software modes (kernel and user), ups the addressing range from 16 to 18 bits (64 to 256 kilobytes), allows more than one program to reside in memory at the same time, and protects resources.

With an optional double IC, 46 floating-point instructions (the same found on the PDP-11/34, /60, and /70) are also provided. This allows floating-point math to be performed 5 to 10 times faster than if written with basic instruction-set software. Because the routines are in microcode rather than a higher-level language, memory space is also conserved. The MMU contains the floating-point registers and accumulators, so it must be installed before this option can be used.

The multifunction board contains 8 kilobytes of ROM, 32 kilobytes of RAM, a crystal-controlled 60-Hz clock, and a serial input/output line for connection to a data terminal, mass-storage device, or the new PROM programmer. In conjunction with any LSI-11 CPU, this creates a compact and capable computing machine. The LSI-11/23 has the total functionality of the PDP-11/34. It is capable of running real-time, multitasking software during development and run time.

any, will occur as the silicon vendors grow up to meet the minis. "Microprocessors are basically applied in two ways," says Thomas Walton, marketing manager for microproducts at DEC. "One is for logic replacement, and the other is for data processing. We can apply minicomputer performance against the middle and upper ranges of microprocessors used for data processing, but we do not want to be in the logic replacement business."

"Our 16-bit boards are an extension of our existing Multibus-compatible product base as opposed to a scaled-down minicomputer," remarks Jim Lally, Intel's operations manager for microcomputer systems for original-equipment manufacturers. "There will always be some fractional overlap—people buying more capability than they need—but in general the market is cleanly segmented due to strategies that are totally different. For instance, our operating system is PROM-based—it resides in read-only rather than random-access memory."

Existing markets may be distinct. But new markets are always being created as the present ones expand, and it is not yet clear who will get that business.

Niche hunting. "There are application areas, like small business systems, where computing has been alien either conceptually or because of high cost," observes Charlie Bass, general manager of Zilog's system division. He believes that this market and others are still up for grabs. "We're looking at the way minicomputer people have handled their traditional marketing and distribution, and they're looking at the technology," he says. "We're converging and it's going to be head to head."

The migration by the chipmakers into more powerful hardware really began with the advent of the development system. Bass feels the next step is to provide for multi-user interconnection "to begin doing some geographically distributed networking." Beyond that is the next generation of 16-bit processors. "When that product hits the street, the overlap will be even more dramatic," Bass contends.
Military communications has come a long way since the 1850s when on a good day the U.S. cavalry was able to use a sun reflector to send a message 125 miles without a relay station. That manual system used a Morse-like digital code and was easily encryptable.

Today the military is using digital procedures again and encryption is even more popular, though the equipment of course wears a modern uniform. Sometimes it is upgraded commercial equipment, like new digital line-of-sight gear; at other times it is custom-designed, like a new troposcatter system. In fact, military digital microwave radio equipment, more often than not, is the catalyst for advances in the commercial state of the art.

The swing to digital technology is due simply to the availability of inexpensive large-scale integrated circuits for system implementation. Perhaps even more important from the military point of view, digital coding makes for easier encryption than do analog procedures.

Compatibility. Just like any other organization with a substantial base of installed equipment, military services have to amortize their communications equipment over a long period. So, compatibility with existing equipment and cost-effectiveness is very much the name of the game.

Digital line-of-sight microwave radios are well-suited for interfacing to the overseas portion of the U.S. Defense Communication System (DCS) where U.S. Government-owned facilities are extensively used. Under the Digital Radio and Multiplex Acquisition program (Drama), the Army is responsible for acquiring suitable modified, commercially developed digital communications equipment. The acceptance criteria included achievement of desired performance, operational capability in host countries, and ability to operate in conjunction with other systems.

Drama. The first result of this effort is the Drama digital radio. This radio is expected to be tested in prototype form in 1979, go into production in 1980, and be installed first in Germany and Hawaii. It can handle a maximum data rate of 26 megabits per second using conventional multiplexing hierarchies such as the Bell System T1 standard.

Depending on the digital modulation scheme used, the digitization of radio channels doubles or even quadruples radio-frequency spectrum requirements compared to the equivalent analog frequency-modulation approach. Spectrum is therefore provided by agreement with the host nation, because bandwidth conservation is important. So Federal Communications Commission Docket 19311, intended for spectrum control of high-capacity systems, was imposed on Drama since there were no applicable European standards at the time it was specified.

Again, keeping compatibility in mind, the radio system amplification was chosen to allow digitization of 90% of the existing fm links with no antenna reconstruction. The radios are being produced by TRW's Defense Systems and Space Group in Redondo Beach, Calif. and according to J.R. Mensch of the Defense Communications Engineering Center in Reston, Va., they will meet the...
Has your power supply vendor left you high & dry?

If you're involved in a program to replace a power supply that is no longer available or your previous supplier is no longer around or can't deliver, Powercube standard modular power circuits may be the answer.

Used for over a decade by contractors for major military and space programs, these proven 1" × 1" × 2" Cirkitblock® modules meet the toughest specs for size, weight, performance and environment.

We can optimize your design and save you money without getting bogged down in component selection, vendor delays or interface problems. Most Cirkitblock preregulators, power generators and output modules are available off the shelf.

Call the quick action company 617-667-9500 or circle the reader response number.
I JUST SPENT A LOT OF MONEY ON AN AUTOMATIC WIRE WRAPPING MACHINE. NOW QA WANTS ME TO BUY ATE! WHY?

In most cases automatic machines are used to wrap 85 to 90% of the wiring only and wiring is completed by manual means prone to error rates of several additional percentage points.

Automatic wire wrapping machines have reduced wiring errors considerably from previous manual means to a neighborhood of 1% or less. However, the number of wire wrapped points on typical panels have continued to rise. It is common to see 5,000 to 10,000 terminations with some to 30,000 points. These panels, with 1% errors, could show 5 to 25 errors per panel. Visual inspection will not find the "mis-wires." They are discovered in the system test area where "costs to detect" have been multiplied 10 fold.

Wire nicks due to routing over pins or insulation damage caused by wire build up, are not detected at system test level and can cause future expensive held problems.

"Cold Flow" shorts associated with tight routing of wires can only be found by electrical testing.

Due to the complexity of system software/hardware interleaving it is impossible to completely test all combinations of wiring at system test level increasing the probability undetected wiring errors will be passed through to the customer.

Pay back periods on ATE have been shown to be eighteen months or less with some as quickly as twelve months. Where bottom line profit is important, ATE shows a good ROI.

The Difference in Testing!

DIT-MCO INTERNATIONAL CORPORATION
5612 Brighton Terrace
Kansas City, Missouri 64130
Telephone (816) 444-9700
Telex Number: 42 6149
European Technical Representative
RADIX HOUSE
Central Trading Estate
Staines, Middlesex, TW18 4XA England
Telephone (0784) 51444

requirements for digital line-of-sight transmission in the defense communications system for many years in the future. "The current anticipated production price for the radio is very compatible and competitive with the center's existing FM standard radio. Operation and maintenance costs, however, are expected to be considerably less," Mensch states.

The cost-effectiveness of the digital conversion is very good in this case. When this benefit is added to the radio's state-of-the-art capabilities in space and frequency diversity, ready interface with standard military KG-81 cryptographic equipment and low probability of failure (once per 100,000 hours), it's clear why Mensch is enthusiastic.

Troposcatter next. In use since the mid-1950s, the military's tactical troposcatter communications system is an analog design that is getting harder to maintain and "even if retrofitted can accommodate only very low data rates," says Walter J. Conner of the Raytheon Co. in Sudbury, Mass. To solve this problem, Raytheon developed the all-digital AN/TRA-170 troposcatter radio for the Tri-Service Tactical Communication Program (TRI-TAC).

This radio, in contrast to the older analog radio, which suffers performance degradation due to multiple propagation-caused time delays, can compensate for the delay. Available in three versions, depending on range (100, 150, or 200 miles), the 4.4-to-5.0-gigahertz radio achieves a bit error rate of 1 in 10^5.

The key to this performance, unheard of for a troposcatter radio, according to M.G. Unkauf of Raytheon, is a distortion adaptive receiver (DAR). This receiver minimizes modulator-demodulator blurring or inter-symbol interference between adjacent or closely spaced data bits that the delay causes.

At the transmitter the data stream is gated to produce an off time between adjacent bits. If the effective duration of the multipath delay encountered in the troposphere transmission is less than the off time—a typical case—the pulses may be distorted, but the intersymbol interference will be small and the pulses will not overlap. Since the distortion effects change very slowly compared to the megabit data rate of interest, the received signal looks like a data stream of identically distorted, nonoverlapping data bits.

"The system was designed for multipath experimental data that was available to us," says Geoffrey Smith of Raytheon. "Typically, this means delays from 0.1 microsecond to 0.3 µs."

The receiver looks like an adaptive matched filter, which means that each received data pulse is multiplied by a receiver-generated replica or reference signal. The resulting product is then put through an integrating circuit that operates over the time duration of each pulse.

Examination of the sign of the in-phase and quadrature components of the result of the integration lets the final level—a 1 or a 0—of the data pulse be determined and reproduced. The advantage of the DAR approach is that it does not require sophisticated and expensive adaptive equalization—a signal-processing technique—at the receiver for inter-symbol interference correction and yields near theoretically optimum performance anyway. Since the DAR is also quite suitable for digital implementation, it turns out to be another cost-effective solution.

The only problem, says Smith, is that the transmitter gating about halves the net transmitted power, causing reception problems. Raytheon therefore recovers most of the lost power by sending two signals at a time by means of two properly interleaved subcarriers.

Narrow. Some 99% of the transmitted power is confined in either a 3.5- or 7.0-MHz band around the carrier, so that spectrum utilization is minimized. The radio can handle up to 2.048 Mbaud encryption can be readily provided by external, Government-furnished equipment. And it is all rugged—antenna wind-loading specifications call for operation in 115-mile-per-hour winds.

All three radios are under full-scale development; test units will be complete in a couple of months, says Smith. He anticipates service use in 1982 and gradual replacement of the existing analog radios.
FLUKE’S MICROPROCESSOR-BASED SCANNER IS COMPATIBLE WITH EITHER IEEE 488 OR RS232.

Or scans automatically without a controller!
That’s right — the new Fluke 2204A scanner is so flexible you can use it for R&D applications like component research, life-cycle and environmental testing, quick-change production line test set-ups, and even precise process monitoring jobs that demand the highest possible reliability.

System building block
When you build your system around the 2204A, you have a mainframe capacity up to 100 channels, and scan speeds up to 125 channels/second. Whatever capacity you need up to 1000 total channels is easily provided by chassis extenders.

Choose from either general purpose (2-wire) or low thermal [<1 μV, 3-wire] relay scanner cards. Both switch up to 170 VDC and have excellent high frequency AC response. We provided for convenient four-terminal ohms measurements, and high-accuracy temperature measurements through an exclusive isothermal input connector.

When it comes to checking out or trouble-shooting your system, you can do it conveniently and quickly in the manual mode right from the front panel of the 2204A. The whole system can be synchronized by using the scanner’s output trigger pulse.

Now, about what voltmeter to use.
The 2204A and our 8502A 6½-digit voltmeter make an ideal pair that we call the 7600A system. The combination of these two precision instruments gives some unique system advantages that no other scanner/DVM combination can provide:

• Utilization of the maximum speed potential of the scanner on the bus, afforded by the 8502A’s high speed.
• Excellent noise rejection due to the 8502A’s unique digital filtering characteristics.
• Scanner data that can be massaged without a controller. The 8502A’s strong math capabilities plus scaling, offsetting, peak reading, and “hi-pass-lo” decisions give you immediately useful information, with no additional computation necessary.

• Time and money savings, because the 7600A system comes factory tested and shipped together, with all the cables and connectors you need. And at no increase in cost over individual instrument prices!

CALL (800) 426-0361, TOLL FREE or contact any of the 100 Fluke offices and representatives, worldwide. In the U.S. and countries outside Europe write: John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043, U.S.A.

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.'
Quick now, what country, a major factor in the worldwide semiconductor industry, is both a major importer and exporter of semiconductor products? There are two right answers: Japan and the U.S.

Furthermore, the countries are good customers of each other, says a statistics-laden report from BA Asia Ltd., an affiliate of the giant Bank of America. Yet this relationship is hardly static, it adds, for Japanese semiconductor makers are well launched on aggressive export drives, while imports into the country are starting to drop.

The report [Electronics, March 1, p. 33] surveys the prospects for every major electronics industry in Japan in coming to its conclusions. In sum, it says that, at least in the near future, there remain significant market segments open to U.S. semiconductor producers.

To reach that conclusion, Robert H. Silian, head of the Consultancy Group at Hong Kong-based BA Asia, and his co-workers took a hard look at where the Japanese producers are spending their funds for semiconductor research and development, both in discrete devices and integrated circuits. "Within the total spectrum of Japanese IC capability, there still exist certain areas that appear to be receiving relatively less emphasis and where imports may still represent an important resource," Silian says. These include:

- Monolithic and hybrid analog-to-digital and d-a converters, especially high-performance devices.
- Wideband, high-power radio-frequency circuits, hybrid or monolithic in type.
- Digital electronic tuning ICs for television receivers.
- Bipolar programmable read-only memories and metal-oxide-semiconductor erasable PROMs.
- Nonvolatile random-access memories and electrically erasable ROMs.

However, these opportunities will replace lost Japanese market sectors for foreign semiconductor makers, who will also face increased competition for their traditional markets from Japan. Exports already outrank Japanese imports (see chart) and are rising at about a percentage point a year as imports drop sharply from 20% of domestic production in 1974 to perhaps 14% in 1978.

The exchange between the two countries consists mostly of high-technology items; in fact, the U.S. had an estimated 19% of the Japanese IC market and only 2% of the discrete market. Similarly, IC exports to the U.S. are high-technology items, like 4,096- and 16,384-bit RAMs, and they are climbing from

**Giants.** The world semiconductor industry is dominated by the U.S. and Japan, with over 50% and 30% of total production, respectively. Each buys from and sells to the other.
34% of the 1977 IC exports to perhaps 40% in 1978.

The future. With price competition less of a factor in Japanese purchasing decisions than in the rest of the world, the report anticipates domestic semiconductor makers will stay competitive with the foreign competition as long as the exchange rate does not reach 160 yen to the dollar, which Silian’s group thinks unlikely. Moreover, the growth areas for ICs—computer, communications, industrial, etc.—are precisely those that the strongest Japanese producers can best serve.

Also, the Japanese semiconductor industry is in the midst of an ambitious effort to upgrade Japan’s computer technology, with the VLSI project (Electronics, June 9, 1977, p. 99, and Nov. 23, 1978, p. 119). The immediate aim of the very large-scale integration project may be superpowerful computers, but there will be quick fallout into other electronic areas.

Concentration. The report points out the obvious reason: the traditional major electronics manufacturers in Japan seized the IC lead there and have no intention of dropping it. Thus the top IC makers tend to be the leading computer makers, as well as being the leading manufacturers of telecommunications equipment, consumer electronics, and the like. (It adds up to a 30% share of the $9 billion 1978 free world consumption of semiconductors—and hardly a percentage point of that went into military products.)

One result is that the top five semiconductor producers make 66% of the sales, while at the same time using probably 60% of the total production. Although the Japanese semiconductor market is slowly moving out of its captive status, buyers still tend to patronize the home teams.

Given the strong vertical and horizontal concentrations of the Japanese electronics industries and the “Buy Japanese” policies, foreign producers always have had their work cut out for them. Moreover, the turn toward outside purchases will tend to provide a mutual strengthening of the semiconductor makers, as well as whetting their appetites for foreign markets, the report says. 

A CRT Yoke for all reasons

Military
Airborne (HUD, HDD, VSD, HSD), shipboard, ground systems, missile systems.
Compact, lightweight, encapsulated to withstand physical stress. Special ferrite core designs.

Commercial
Computer terminals, monitors, medical applications, hard-copy machines, etc.
Engineered and tooled for volume production. Cost-effective and geometry corrected.

Special Designs
Phototypesetting, random graphics, flying spot scanners, mappers, vidicons.
Designed for low residual and superior resolution using special assembly techniques.

Send us your reasons for needing a better yoke. We’ll supply technical data sheets, recommendations, engineering assistance.

Syntronic instruments, Inc.
100 Industrial Road, Addison IL 60101
Phone (312) 543-6444
Probing the news

Components

Why Europeans are on edge

Getting ready for the annual Paris components show, parts makers are troubled by uncertain business in the second half

by the European editors of Electronics

As always, the stands at the annual Salon International des Composants Electroniques at the Paris fairgrounds will be laden with new hardware this year. But, more than ever, the thousands of components buyers and sellers who flock to the April 2-7 show at the Port de Versailles on the outskirts of Paris will come for a view of what is ahead in components markets, as much as for a look at the wares to be displayed by more than 1,300 companies.

The reason for the sense of urgency is uncertainty concerning the last half of the year, although business will not be at all bad during the first six months in the $8.7 billion components markets in Western Europe. There is nevertheless uneasiness about the turn world business may take if the oil shortage persists. Then there is the nagging problem of unemployment throughout Western Europe. That problem will be compounded by inflation, particularly in Great Britain and Italy. The dollar is another source of apprehension; when it slides, the prices of U.S. suppliers decline.

But particularly worrisome to components suppliers are the big piles of unsold color-TV sets in West Germany, and the most anxious group at the show will be those doing a good part of their business with set makers. Sooner or later the glut in West Germany will put pressure on components markets in neighboring countries as suppliers try to offset their slowing deliveries to German set makers. Purveyors of professional-grade parts, in contrast, are likely to do well.

"There is an increase in defense spending everywhere," says Peter Fredholm, sales manager of Sivers Lab AB, a Swedish company in the Philips Gloeilampenfabrieken group. "The trend has been good for the last three to four years and it is still good," he adds. Telecommunications producers and computer makers are doing well, too, so there will be some semiconductor high fliers.

Although it is truly international, with wares from some 30 countries on the stands, the Components Show has heavy French participation. And for that reason optimism may seem high to visitors from across the Rhine or the other side of the English Channel. Unlike the Germans, the French are fairly far from a saturated color-TV market. At the end of 1978 only about a third of the country's nearly 19 million households had color sets. Sales this year will probably reach 1,650,000 units, up about 8% over last year's 1,532,000.

Computers selling well. What's more, the computer sector is running particularly strong. The flagship "French" computer company, CII-Honeywell-Bull, for example, bounced up its sales by nearly 18% last year. The backlogs of companies like Thomson-CSF and Electronique Marcel Dassault, world-class manufacturers of professional hardware such as radars, avionics, and broadcast equipment, will keep them good customers of components suppliers through the year. The same goes for producers of telephone switchgear. And there is a good chance that French components suppliers can do as well this year as last. Then, according to the trade association for active and passive components, sales ran some $1.865 billion (calculated at the rate of 4.25 francs per dollar). That is close to 14% above the $1.637 billion for 1977.

French semiconductor suppliers outperformed the averages, lifting their sales figures last year by nearly 19% to $457 million. And it could happen again. So far this year the book-to-bill ratio for Thomson-CSF's
Aerospace technology at a down-to-earth price... the $3 pot.

New Spectrol Model 157 Precision Pot

Spectrol now introduces the first low-cost, high-quality, 7/8" singleturn conductive plastic pot with features you'd only expect to find in a more expensive aerospace pot. Features like rugged machined-aluminum housing...ground stainless-steel shaft...short length behind panel (.345")...no glued joints...high-current capacity...standard linearity of ±1%. Wirewound and cermet units are also available in this series, and they come in servo or bushing mounts, with a center tap option. For more information, contact your nearest Spectrol factory or authorized representative.

SPECTROL ELECTRONICS GROUP

UNITED STATES Spectrol Electronics Corporation P.O. Box 1220, 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 21551 • TELEX 44692
ITALY SP Elettronica spa Via Carlo Piscicane 7, 20018 Pero (Milano) Italy • 35 30 241 • TELEX 36091

Circle 97 on reader service card
Probing the news

Sescosem Semiconductor division has stayed above one, reports Guy Dumas, who runs the division. But Dumas will keep a close watch on the far side of the Rhine.

West German stall. As they stroll through the stands, West German components people will be mulling over the flip-flop in their home market. Once it was the set makers who kept them riding high. Now the strong demand comes from producers of industrial equipment. A turn for the better, say suppliers of state-of-the-art semiconductor devices.

Meanwhile, these are tough times for companies trying to sell passives, electromechanical devices, and picture tubes. And no one expects it to get better soon. There is a stock of more than 500,000 color sets waiting for buyers in producers' warehouses.

As set makers consume about half the components sold in the country, the troubles with TV mean "a contraction of demand for semiconductor products from the entertainment sector by more than 10%," says Fritz-Georg Höhne, director of worldwide marketing at AEG-Telefunken. Höhne sees the demand dropping even more in the near future, possibly 15%.

"Except for the TV dark zone, the overall semiconductor market isn't performing all that badly," comments Dirk G. Vogler, manager for marketing administration at Texas Instruments GmbH. In this assessment TI's man is not alone. As do his counterparts at AEG-Telefunken and Intermetall GmbH, lead house of the ITT Semiconductors Group, Vogler sees strong impulses coming from data processing, industrial electronics, and telecommunications gear manufacturers. They provide a big enough push "to make this year's semiconductor market at least as good, if not better, than last year's," Vogler estimates. The gain could be 10% and he notes that shortages have developed for some TTL devices, for low-power Schottky circuits, and for memories.

British chill. Artie weather conditions and a blizzard of strikes have set the British economy shivering. Although there are some chill-proof sectors in semiconductors, the outlook for components suppliers is generally bleak.

Custom Control Assemblies

Potter & Brumfield
Looking. Some 1,300 exhibitors are expected to show their wares. Seen here are just some of the booths at the 1978 show.

One pertinent reading of the climate in the marketplace is that of the Association of Franchised Distributors of Electronic Components (AFDC). It is predicting 8.6% growth this year to $1.5 billion for components of all kinds, including fans and racks. Discounted for inflation, the growth disappears. What’s worse, cautions John Walker, managing director of Comstock Electronics Ltd., “these figures were put together before the recent strikes.”

The prevailing mood is reflected by the assessment of Albert Shipton, UK marketing manager of General Instrument Microelectronics Ltd. “It’s tough,” he says, “and a lot tougher than most people will admit.”

Italian pasta. Viewed from afar, what goes on in Italy’s economy always looks worse than it does from the inside. And at the moment on the inside there is a mood of quiet optimism. Set makers are counting on a gain of some 10% this year and there are signs of improvement in semiconductor ordering by producers of industrial equipment.

Not much is happening in the way of growth at telephone hardware makers. The government-controlled telephone company still has trouble getting lira to invest. As for computers, Olivetti CCC, the country’s largest office equipment maker, has been hit by a round of strikes; if it drags on, Olivetti’s components intake will obviously shrink.

Even so, semiconductor sales should rise between 12% to 14%. The Italian market now looks quite good, reports Enrico Villa, director of marketing for SGS-Ates, the semiconductor producer in the Government’s telecommunications/electronics group STET.

But industry executives are unsure how long the good times will last. The continuing political crisis keeps the government from making some crucial decisions. Ottorino Beltrami, president of the Associazione Nazionale Industrie Elettroniche et Elettroniche, believes that general economic conditions in Italy and its major trading partner, West Germany, “will strongly determine in the coming months whether 1979-1980 will be good years or see a return to the doldrums of 1975.”
Biomation's K100-D -- no other logic analyzer even comes close.

No wonder the K100-D is our fastest selling new logic analyzer ever. It gives you 16 channels, 1024 word memory, clock rates up to 100 MHz, signal timing resolution to 10ns – plus a built-in display and keyboard control.

Biomation's K100-D puts it all right at your fingertips -- more performance and features than any logic analyzer ever.

It starts with the microprocessor-controlled keyboard and interactive video display. To give you fast, precise control, the display serves as a comprehensive control status menu, with all selectable parameters in reverse video. There's a single, labelled key for each function, corresponding directly to status display choices. So guesswork is eliminated.

For example, in the data domain, you can direct the display to read in hexadecimal, octal, binary or ASCII, or any combination, by selecting one of four control buttons. There's also a unique "sequence" key that enables you to rearrange the order in which channels are displayed, to aid in data decoding, to simplify side-by-side comparison of timing signals and to enable you to cancel any channels you're not interested in seeing. A separate key controls horizontal expansion.

That gives you an idea of the K100-D's display versatility. Here's a picture of its astounding capture capability.

By providing timing analysis of signals as fast as 100 MHz, you can capture logic signals with resolution to 10ns. And the 100 MHz clock rate protects against obsolescence as the speed of your systems gets faster and faster. The K100-D also has a latch mode that can capture glitches as narrow as 5ns.

With the 32-channel input adapter, the K100-D is ideal for exploring the new world of 16-bit microprocessors. To give you unprecedented analysis capability, there's a built-in Auto Stop capability you can use to detect, record and display any match (or mismatch) between incoming data and previously recorded data held in a reference memory. Or using Search Mode you can key in a specific word and the K100-D will find it in memory.

To get the full impact of the K100-D, you really do need to have it at your fingertips. That's why we would like to arrange a demonstration. Call us at (408) 988-6900. Or, for more information, write: Gould Inc., Biomation Division, 4600 Old Ironsides Drive, Santa Clara, CA 95050.

GOULD

Circle 100 for Information
Supporting computer design amid evolving technology

Large virtual memory, built-in testing, personalized logic arrays form the underpinnings of IBM's System/38
System/38 shows how IBM aims to keep up with the times

by Anthony Durniak
Computers Editor

Computer architects are in much the same predicament as the sorcerer's apprentice. Having invoked semiconductor technology to solve their hardware problems, they find its forward momentum threatening to swamp their other requirements. The most obvious of these is the need to preserve the end user's considerable investment in software while at the same time giving him the benefit of ever faster circuitry. Just as important is the need to manufacture the ever more complex chips in volume and with guaranteed reliability, which means solving the problems the devices raise in the areas of power dissipation, packaging, logic flexibility, and above all testing.

The General Systems division of IBM faced many of these issues in the design of its System/38 [Electronics, Nov. 9, 1978, p. 81] (Fig. 1). In three key areas—logic chip design, chip and system testing, and virtual memory management—the division uses solutions that are unusual and in some cases unique. They may also furnish an insight into the directions in which the industry leader will go in fabricating and using large and very-large scale integrated circuits. For, although IBM will not say so, the techniques used in the System/38 are expected to provide a solid foundation for its future computer designs. Already its Data Processing division has announced a series of 4300 processors built around the same testing technique as the one used in the System/38.

1. Most significant. In the System/38, General Systems division adopts solutions in the key areas of logic chip design, system testing, and virtual memory management that may show how IBM intends to fabricate and use large-scale and very large-scale ICs.

2. Central channel. System/38 hardware centers on an input/output channel that operates at speeds up to 5 megabytes per second. Attached to it are not only the central processing unit but also I/O controllers based on microprocessors or programmable logic arrays.
and even the same basic hardware element—an array of Schottky transistor-transistor-logic slices called a master slice [Electronics, Feb. 15, 1979, p. 85].

To make these master slices, IBM's East Fishkill, N. Y., facility builds identically laid-out substrates and then individualizes them with different layers of metalization. In this way it achieves both economy of scale in semiconductor fabrication and a wide range of options for its system designers.

"The whole topology of the design practice changes," explains the System/38 project manager, Brian G. Utley. Rather than being constrained to either a functional partitioning between the chips or a slice approach, he observes, "you can aggregate or split a function from chip to chip, because of the large number of both gates and input/output connections available."

**Sophisticated tools**

In Utley's experience, though, such an approach requires sophisticated design tools. The most important of these tools, as Jehoshua Pomeranz, Rolf Nijhuis, and Chet Vicary explain in their article on page 105, is a computer-aided design system that converts logic diagrams into layouts for the chip's metal layers.

A primary concern of both semiconductor manufacturers and computer designers is the invention of thorough enough tests for the increasingly dense circuitry of today's logic chips and boards. IBM gains access to the previously inaccessible internal chip signals so critical to troubleshooting by weaving a shift register through the logic on each chip and then loading it with test patterns. As Neil C. Berglund points out on page 108, this approach can then be extended to the board level.

A single eight-layer 10-by-15-inch board does in fact hold the System/38's entire central processing unit—all 29 of its gate arrays personalized into 22 different part types, plus five memory chips used for local registers. There are two versions of the CPU: model 3, which has a 400-nanosecond cycle time and can support between 0.5 and 1 megabyte of main memory, and the faster model 5, which has a cycle time of 200 ns and can handle up to 1.5 megabytes of main memory.

These storage capacities are due to another innovation—the use for the first time of IBM's new high-density memory chips [Electronics, Nov. 9, 1978, p. 39]. The slower model 3 employs a new 64-K part with a cycle time of 1,100 ns, while the faster model 5 uses a 32-K part with a 600-ns cycle time. Also, a new 18-K random-access memory is used in the model 3 for its 4,096 32-bit words of microinstruction control store, whereas the faster model uses an older 4,096-bit RAM for its 8,192 words of control store.

The central position in the System/38 hardware, however, belongs not to the CPU, but to a bus called the input/output channel (Fig. 2). A dedicated portion of the CPU controls the channel, which operates at a transfer rate of up to 5 megabytes per second. Another dedicated portion of the CPU—the hardware for translating virtual memory addresses into physical locations in main memory—links the CPU's main memory to the input/output channel.

Also attached to the bus are a group of independently operating intelligent input/output controllers. For a low-speed 1/o device like a cathode-ray-tube terminal, printer, or tape drive, an 8-bit microprocessor-based I/O controller is used. Higher-speed devices like disk drives employ IBM's Magnetic Media controllers, which are based on programmable logic arrays.

Each system also includes a System Control Adapter, a keyboard and display console that, as Berglund explains, handles the system's maintenance functions.

The virtual memory system of the System/38.
The configuration of transistor, diode, and resistor diffusions is identical in every gate. These device regions are arranged in horizontal bands separated by spaces reserved for signal interconnection; these spaces amount to almost half the chip area in sum. Figure 1 shows the structure of a typical transistor and Schottky diode plus the contact with one end of a resistor: the entire surface area of the transistor emitter is 3 by 8 micrometers, while the Schottky diode measures 5 by 6 μm and the resistor 4.5 by 70 μm.

Above these devices lie three layers of metallization (Fig. 2), the lowest two of which may vary from chip to chip. The paths left for the wire channels on the lowest level run parallel to the straight rows of circuit elements, and the wire channels on the middle level run at right angles to the first. At every crossing it is possible to make a vertical connection, or via, between the two layers. The uppermost metal layer and the vias between it and the second layer are fixed for all chips and are primarily used for power distribution and as chip signal ports. The metal used for the layers is an aluminum-copper alloy; the insulation between is silicon dioxide.

The next-to-last fabrication step is to vacuum-deposit a protective layer of chromium-copper-gold over the 132 connection points, on which dots of lead-tin solder are then deposited. Finally the completed chip is inverted into the ceramic carrier, where the solder dots melt enough to bond the two together, forming electrical connections between the chip and a metal pattern on the ceramic (Fig. 3).

The metal shapes that define a particular logic gate are stored in the Engineering Design System in what is called a book. There are over 100 such books in the circuit library. The signal input/outputs of each book are defined as logic service terminals (LST). Since the EDS interconnects the LSTs of different books as specified by the logic requirements, it places them on the chip at via locations for easy access to both planes of the wiring channels. The 94 chip signal ports also have LSTs, but with fixed locations on the second level corresponding to the location of solder dots on the third level.

Gate in the majority

The predominant logic gate is configured with either a three- or four-emitter input transistor, one output transistor, the Schottky clamping diodes, and two to four resistors (Fig. 4). All of the multi-emitter transistors share a common collector and most have multiple bases as well. One resistor powers the bases of the multi-emitter input transistor and one the base of the output transistor. The two remaining resistors are not part of the circuit book definition; they are under the control of the wiring program rules, and their inclusion is dependent on the specific intercircuit net configurations and net performance requirement.

In addition, the voltage drop between each input and output on the net is calculated and, if too large, can be reduced by specifying a larger wire width for a particular net. (However, if the total net wire area increases too much, the network performance in general will suffer.) For off-chip communications a simple emitter-follow-er transistor with a base resistor is provided. This
current-amplifier circuit is used to drive the relatively long and high-capacitance off-chip networks. Resistors biased to $-4.25\, \text{V}$ are available for interchip connections on both driver and receiver circuits. These resistors are also excluded from the circuit books and are instead included in the definitions for chip-to-chip net connections. Additional off-chip terminator resistors are available for connections critical for performance.

To communicate off chip by means of an emitter follower, the on-chip voltage logic level is translated down by a base-emitter voltage potential. To restore this voltage level at the receiving chip, any input transistor of the receiving circuit is wired as a diode by having its base connected to the collector. Since almost all the transistors of the multi-emitter TTL circuits have separate base definitions, any input emitter can function independently as either an internal or an off-chip receiver.

**Building blocks**

To create the chip functional design, the system designer works with logical descriptive blocks. The automated EDS produces a logic diagram of the chip and employs a simulation scheme to verify the design. Once the logical description is approved, the EDS automatically matches the logical blocks to the physical books, chooses the chip locations at which to place these books,

---

3. **Bondage.** There are 132 solder dots on the finished logic chip (left). The chip is inverted onto the 116-pin ceramic carrier (above) and the two are heated till the solder reflows and bonds them together, several chip solder connections being linked to the same pin.

---

4. **Common gate.** A typical gate in the array contains a three- or four-emitter input transistor with an output transistor, Schottky clamping diodes, and resistors $R_1$ and $R_2$. Resistors 3, 4, 6 and 7 are added as needed to balance interconnections.
and makes the required interbook and chip input/output connections. The program strives to achieve a design with the shortest possible interconnection lengths, in order to meet the electrical and performance restrictions included in the programs.

A designer is free to intervene manually to fix either book location or wire placement. Extensive checking programs assure correct circuit function, compatibility of various circuit shapes, and correct interwire spacing.

**Determining delays**

The description of the chip characteristics in the EDS include the delay equations of every circuit book. These equations contain delay terms that are a function of the circuit output load, so that at the completion of a particular chip design, all the output loads are known. The EDS can compute these, insert them into the circuit delay equation, and predict a logic path's performance.

One of the benefits to system performance of integrating many logic gates on a single chip is that the signal paths can track each other closely. But care must be taken to ensure this actually happens. The results of the automatic layout programs must be monitored to prevent logically identical paths from being given radically different physical path lengths.

Once the layout is complete, the EDS produces control information for an electron-beam tool that writes the pattern for the metalization layers directly onto wafers coated with photoresists. This is a very quick way to produce prototype chips. Moreover, once their design is finalized, the same system can be used to mass-produce the chips. If desired, however, the EDS can generate conventional photolithographic masks.

In the customization process, a selective lift-off process is used on the layers of metal instead of subtractive etching. This allows better coverage over device areas and permits a minimum line width of 4.4 μm with 2.5-μm spacing.

Another feature of the EDS is its ability to generate complete data for functional testing of the chips.

The authors would like to acknowledge the contribution of Huntington W. Curtis who provided some of the information on the chip's fabrication.

---

**Level-Sensitive Scan Design tests chips, boards, system**

by Neil C. Berglund
IBM Corp., General Systems Division, Rochester, Minn.

The denser the concentration of functions within a system, the more urgent the need to test them. And the System/38 is dense: it packs about 20,000 circuits on 29 logic chips together with five memory arrays on one 10-by-15-inch circuit board. It was therefore designed as much for testability from the chip level up as for economical manufacture.

The principal obstacle to testing large-scale integrated devices is the inaccessibility of internal signals. This must somehow be circumvented if problems are to be isolated initially during the debugging of engineering prototype hardware, later during manufacturing testing, and later still in field service at the customer's site. Past techniques tested the chips with complex sequential patterns that attempted to put all the internal circuits through all their paces and transferred the results to the output pins of the chip for observation. But given today's complex chips, this process takes far too long and makes inefficient use of computer-generated test data.

System/38 uses an approach called Level-Sensitive Scan Design (LSSD) to solve testing and test-data-generation problems at all levels of packaging—chips, boards, and systems. The LSSD technique enables every LSI chip to be completely tested for dc faults with the aid of computer-generated test data. When extended to the board level, this technique allows a system to test itself or be diagnosed by a field-service engineer.

With LSSD, the shift register latch (SRL) is the only type of storage element other than random-access-memory chips permitted in a logic design. An SRL is actually a linked pair of polarity-hold latches (type D) connected to form a single stage of a shift register (Fig. 1). The second latch of this pair, L₁, exists solely to enhance chip testability, though it can be used for other purposes as well. The first latch, L₀, is designed to serve both system design and testing requirements.

The L₂ latch has a single data input permanently connected to one output of its paired L₁, plus a single B clock input for loading it from L₁. The L₁ latch can be set from two sources by two different clock inputs and has two outputs, reflecting its dual role as part of the test system and as a storage element for the system designer. Its test input, called the scanned data input (SDI), is connected to the L₂ output of a different shift register latch, and its A clock input loads it with data from that source. Its other input comes under the control of one of the two system clocks.

![Image of LSSD diagram](text)

**1. Limited memory.** Level-Sensitive Scan Design technique restricts the types of memory elements in a design to random-access memories and shift register stages made of paired latches. Latch 1 is both a test and a storage element, latch 2 primarily a testing element.
To convert all the shift register latches on the chip into a single long shift register, the first stage's L2 output is connected to the next SRL's L1 input, and so on through the last SRL (Fig. 2). The first stage's L1 test input is connected to a chip input pin designated SDI, and the last stage's L2 output is connected to a chip pin designated scan data out (SDO). The A and B clock inputs of each SRL are connected in common to a pair of chip input pins so designated.

Thus the designer has lost the use of four chip pins and the circuits required to implement the L2 latches and associated clock drivers, but the connection of the SRLs into a shift register in no way interferes with the chip's performance of its normal functions. When the chip is tested, the four pins and the L2 latches enable the test system to control and retrieve the contents of any latch on the chip by means of a simple shift technique.

Testing, testing . . .

To test a chip, a test pattern—a serial string of binary data—is applied to the SDI pin of the chip. The A and B scan clocks are then pulsed, causing the test pattern to be shifted, or scanned, into the SRLs on the chip. All the latches on the chip having thus been initialized, stimuli applied to the input pins cause the combinatorial logic on the chip to assume some particular state. Some of the combinatorial logic is connected between the chip input pins and the SRL data inputs; the rest is connected between an SRL's L2 output and the output pins. In the latter case, the output pins can be observed to determine if the combinatorial logic is functioning properly—but to test the logic connected to SRL data inputs, its state must be transferred into these stages' L1 latches by pulsing the system clocks C1 and C2. Then the A and B scan clocks are pulsed once more, and the serial binary data coming out of this chip's SDO pin is observed.

These serial data output patterns represent the state of the SRLs after the system clocks were operated—in other words, the state of the combinatorial logic before the system clocks were applied. This data is compared with the expected state of the SRLs as determined by a computer simulation model. In this manner the logic on the chip is tested for typically 98% to 100% of all dc faults with program-generated test data.

Complex sequences of system clocks are not necessary to test all stages of counters, shift registers, and other logic elements buried in the logic of the chip. Instead, using the LSSD technique, patterns are loaded that test all stages of a counter, for instance, without stepping it through all its states. Each system clock is pulsed no more than once per test pattern, and this, in fact, is sufficient to test not only the combinatorial logic connected to the data input but also the clock driver of the SRL and the SRL itself.

But what of the cost of such a system? On first analysis, the LSSD system appears to carry a significant overhead in unusable circuits. The L2 latch, the extra clock drivers, and the extra input to the L1 latch do require circuits that are unavailable to the designer for his unrestricted use in implementing the processor function. These circuits represent the hardware cost of LSSD and can approach 20% of the available circuits.

In fact, though, these circuits do not have to remain strictly as overhead. They can be used to help realize the processor function and for several other features, in addition to their use in the LSSD system. At the chip level, for example, latch L2 can be used to make functional shift registers, counters, and control latches. This is accomplished by logically OR-ing a system clock with the B clock input to L2. (As the A and B clock inputs are used only when the chip is tested, no interference exists if L2 is used functionally.) When combined with such a two-phase, nonoverlapping clock, the L1 and L2 latches act as a master-slave storage element that can implement any function that can be achieved with the more traditional storage elements—J-K flip-flops, for instance. Furthermore, the L2 latches of a register are thus enabled to provide a double-buffer function with many uses—a backup register for retrying, for instance, or a double buffer for data storage.

Pros and cons of two-timing

Admittedly, a two-phase clock system does have disadvantages for counters, shift registers, and similar functions, since two clock pulses are required to advance them one position. On the other hand, it actually can be an advantage for the overlapped processing often employed in high-speed processors, which find it faster to start the next instruction before the current instruction cycle is completed. The SRL is unusually well suited to this mode of operation, since the L2 can hold the information necessary for the current instruction cycle while L1 is loaded to begin the next cycle.

For testing the entire processor, the LSSD shift register concept is extended to the board level (Fig. 3). When the SDO of one chip is connected to the SDI of the next, all the chips on the board form one long shift register. In
3. **Self-testing.** Connecting the logic chips' SDI and SDO pins together extends the shift register throughout the processor's board. Attaching these pins to the computer's system control adapter allows the computer to check the latches' state against a pattern in its memory.

Practice, however, the chips are grouped into several shift registers of shorter length, then loaded in parallel to reduce test time.

Test patterns for the entire board are computer-generated in the same manner as for the chips. The board is inserted in a test fixture, test patterns are loaded into the SRLs of every chip, stimuli are applied to the board's input pins, and the system clocks are pulsed. The signals on the output pins are checked, the contents of the SRLs are scanned out, and both are compared with the expected results. Essentially no additional hardware is required to support board-level testing because the LSSD hardware in each chip is enough for the purpose.

**Out in the field**

After the entire processor board is installed in a system, the same LSSD technique is applied to it in the customer's environment, whether to have the system test itself each time the machine is turned on or to aid service personnel in diagnosing a problem. In the field, however, the testing problem is more complex, since the board is now mounted in a system rather than in a test fixture. Because of this, the board's pins are connected to channels, memories, and the like, so that the signals on them are not directly observable. But the processor's shift register latches can still be controlled, and since they are connected to 90% to 95% of the logic, an effective test can still be performed.

Historically, processors are tested in the field with diagnostic programs. With the LSSD techniques, test patterns can set up conditions to test for specific faults much more easily than can diagnostic programs, which are limited to the capabilities of the machine's basic instruction set. LSSD patterns provide only a dc test of machine operation, so that for full system verification they must be combined with diagnostic programs operating at machine speed to locate time-dependent or ac problems.

To handle the LSSD concept at the system level, the board's SDI, SDO, and A and B clock connections are attached to the system control adapter (SCA). Using its own microprocessor, the SCA performs several tasks related to system maintenance. For example, it can enter serial data on SDI and observe the serial data on SDO while pulsing the A and B clocks to the shift registers on the board, in this way controlling and checking the state of nearly every storage latch on the entire board.

A small quantity of maintenance interface logic on the processor board enables the SCA to cut off the C1 and C2 system clocks and pulse them, too, for test purposes. With this support, the SCA reads test patterns from a system file, loads them into the latches on the board, pulses the system clocks, retrieves the contents of the latches, and compares the results with the expected results also obtained from the file.

Since the shift registers used in LSSD provide a way of altering or displaying the state of every storage element in the processor, they also lend themselves to the support of manual console operations. As an aid for the diagnosis of hardware and program problems, computer systems generally have a console for displaying and altering the contents of registers, memory, and critical control latches, and System/38 is no exception.

The SCA makes use of the processor's on-board maintenance interface logic to bring the processor to a controlled stop while the SRLs are scanned, then restart it when the scan is complete. In addition, the SCA scans the data from the shift registers and formats it for display on the cathode-ray tube. If the displayed data is altered by a field service engineer, the SCA will take the altered value and replace it in the processor by scanning new contents into the machine latches. This technique, in addition to saving the extra hardware normally required to get into and out of the facilities to be displayed and altered, makes it possible to alter and display the state of every latch in the processor.

In System/38, IBM has found the LSSD technique to be an effective approach for designing processors using LSI circuits. LSSD, though originally conceived to solve LSI chip test problems, has been used to provide an integrated test and maintenance approach from the chip to the system level.
Hash index helps manage large virtual memory
by Merle E. Houdek and Glen R. Mitchell,
IBM Corp., General Systems Division, Rochester, Minn.

A major design decision with the IBM System/38 was to employ an address structure with sufficient bits to reference all main and secondary memory without reusing an address. Such a structure provides improved data integrity, protection, and security.

Clearly, the 16-bit address used in many small computer systems was not enough. Even the 24-bit address often used on larger systems for access to 16 megabytes of storage lacked the desired flexibility. So it is that the System/38 uses a 48-bit address, providing a virtual address space of 281 trillion bytes—16 million times that of the System/370.

Managing virtual memory

Virtual memory is a scheme that permits the user to treat the main memory and auxiliary storage, such as disk drives, as a homogeneous unit. Essentially it is a management scheme that moves information from the disk drives to the main memory and back, as needed for processing a program.

These transfers are transparent to the user, who refers to the information with an unvarying address—the virtual address—with no need to know its location. However, the location of information does change, and the computer must keep track of the shifting internal addresses. Also, the addresses in the smaller main memory are shorter than those to be found in the user's virtual address.

To keep track of information, the management scheme must translate between the unchanging virtual memory addresses of the user and the machine addresses. Yet conventional translation techniques would take more than a billion bytes of lookup tables to support the System/38's 281-trillion-byte address space.

Instead, the System/38 employs a two-tier translation scheme with an algorithm that uniformly distributes the virtual addresses throughout a significantly shorter directory used to specify the main memory address. In virtual addressing, the memory space is divided into segments that are further subdivided into 512-byte blocks called pages. When a page resides in the computer's main storage, all 512 bytes are assigned to what is called a frame. The translation task essentially is to turn the page address into the proper frame address.

By page and byte

The virtual address has two parts—one identifying the page, called the page address, and one identifying a byte within the page, called the byte identifier (Fig. 1). Similarly, the first part of a main storage address identifies the frame and is called the frame identifier. The second part of the address identifying the byte within the frame is identical to the virtual address byte identifier. So no byte identifier translation is needed.

The page address, however, must be translated into
3. Scrambled hash. Rather than search the entire page directory, a hash generator produces a value that is looked up on an index table that points to the directory entry most likely to contain the matching page address, as several addresses have the same hash value.

the frame identifier. This is accomplished with two tables. The first of these, the page directory, contains one entry for every frame in main storage (Fig. 2). The index value of the entry corresponds directly to the frame identifier.

Translating directory

Whenever a page moves into a frame in main storage, the corresponding entry in the directory has a field containing the page-address portion of the virtual address. To locate a page in main storage, the management hardware compares this field with the page-address portion of the virtual address. When the two of them match, the index of that page-directory entry becomes the frame identifier.

However, serially scanning the entire page directory every time a virtual address is translated would probably take too long. Consequently, an index of the directory is formed with the aid of the second table, the hash index table, and what is called a hash generator.

Actually the first step in the translation (Fig. 3), the hash generator is an algorithm that combines (hashes) specific bits from the virtual address to select an entry from the hash index table. This entry is a guide to the entries in the page directory.

The combining process of the hash generator could result in the same hash value for several addresses. Therefore, part of each page-directory entry is reserved as a pointer to the location of possible additional entries with the same hash. Thus entries with the same hash value are found on a linked list (of chain) in the page directory. An end-of-chain indicator distinguishes the last entry on each chain.

During the translation of the virtual address, the searching mechanisms need to find only the chain expected to contain the virtual page and then search its entries, looking for the match with the virtual page address. The index of that page directory entry becomes the frame identifier for that virtual page.

End of chain

An end-of-chain bit may be encountered before a match is found, which signals that the page is not in the main memory. A special routine then goes to the input/output channel and brings the page corresponding to that virtual address from secondary disk storage to
5. **Generator.** Since two types of segments are allowed in the System/38 there are two segment identifiers. An exclusive-OR combination of the large and small segment identifiers and the inverse of the page identifier produces the hash value.

main storage and updates the page directory. The I/O channel uses the full 48-bit virtual address and a similar translation technique to produce the physical address for the disk drive.

This two-tier indexing process will speed the translation, but only if the lengths of the page chains are kept short. Using a larger hash index table results in more page chains in the page directory and consequently fewer entries per chain. Thus the large hash index table enhances the translator performance since fewer page directory entries have to be inspected.

**Uniform distribution**

Equally important is a hashing algorithm that generates a uniform distribution of entries into the hash index table. Without uniform distribution of the entries in the hash index table, some entries would be favored over others, which would result in longer page chains for those entries and consequently a higher average number of entries probed.

Research into uniform distribution schemes has shown that the average number of page directory entries probed, $N$, is dependent on the ratio of the hash index table size to the page directory size, $R$, or:

$$N = 1 + \frac{1}{\sqrt{R}}$$

For example, if the hash index table is twice the size of the page directory, the average number of probes will be 1.25 entries.

The hashing algorithm required for uniform distribution depends on how virtual addresses are assigned. In the case of the System/38, it must take into account the division of the virtual address space into the independent address spaces called segments. Within each segment are several pages, so the page-address portion of the virtual address is broken up into two identifiers (Fig. 4). One identifies the segment; the other identifies the page within the segment.

Since the segment of the virtual address space is reserved for one block of information regardless of the block size, the segment is generally larger than the block it contains. This situation leads to some unused virtual addresses and, in general, to a sparse usage of the virtual address space.

Also, System/38 has two types of segments—small ones of about 65,000 bytes and large ones of about 16 million bytes. Therefore, the segment identifier of the virtual memory is further divided into large segments and small segment identifiers. So efficient recall of data through this virtual memory scheme requires some technique to transform the resulting nonuniform distribution of virtual addresses to a uniform distribution of the hash index table entries.

The algorithm used in the hash generator must perform this transformation. It also should ensure that consecutive pages and consecutive small and large segments do not hash to the same location in the hash index table. After all, there is a relatively high probability that consecutive pages or segments being referenced together as information are sought.

The hash algorithm used on the System/38 meets these requirements (Fig. 5). It takes the exclusive-OR of the reverse order of the page identifier bits with the low-order bits of both the small segment identifiers and the large ones.

**Accommodating variations**

The effect of this hashing algorithm when the system is using a large number of small information blocks is that more bits from the segment identifiers and fewer bits from the page identifier affect the generation of the hash. At the other extreme, in a system using a few large blocks of information, fewer bits from the segment identifiers and more bits from the page identifiers are effective in generating the hash.

In this way, the hash generator compensates for variations in the size and number of information blocks contained in the system. Since virtual address bits are taken from both the small segment and the large identifiers, the ratio of the number of large to the number of small segments is not important to the effectiveness of the hashing algorithm.
Forth’s forte is
tighter programming

Organized as a dictionary, language lets user add own definitions
provides structured control, mixes easily with assembly code

by Stephen M. Hicks, Forth Inc., Manhattan Beach, Calif.

When it comes to programming microcomputer
systems, flexibility is more than a code word. It is an
attribute that can spell the difference between success
and failure. Fortunately, there is a high-level program-
ing language where flexibility is the watchword: Forth.
Unlike other high-level languages that insulate the
user from the machine, Forth allows easy movement
between higher-level, machine-transportable program-
ing and assembly modules for input/output control or
time-critical routines. It exploits what is called indirect-
threaded coding, which means that statements are built
from a dictionary of definitions coming both in the

: QUADRATIC  DUP 3 * 12 - * 20 + ; OK
50 QUADRATIC . 6920 OK

: TABLE 10 0 DO CR I . I QUADRATIC . LOOP ; OK

TABLE
0 20
1 11
2 8
3 11
4 20
5 35
6 56
7 83
8 116
9 155 OK

: PLOT CR 0 DO 42 ECHO LOOP; OK
45 PLOT

*: ***************** OK

: PICTURE 0 DO I QUADRATIC PLOT LOOP ; OK
7 PICTURE

**: ************
:** **********
:** **********
:** **********
:** ************
:** ***************** OK

1. Ready to go. Four Forth operations are executed in this sample development session. QUADRATIC computes \(3x^2 - 12x + 20\) with \(x = 50\). In TABLE, QUADRATIC is used with 0 through 9 as arguments to form a list. Finally, PLOT and PICTURE draw lines of asterisks.
operating system and from the programmer. Moreover it permits structured programming, which is to say the programmer transfers control down a hierarchy from the most general to the most specific routines.

Forth is extensible: the user can fabricate his or her own operations, data types, etc., and these definitions are treated exactly like Forth's own. So they are immediately available when the system comes up, with no need for access to a software library or subroutine.

Supportive language

The language supports all number bases and permits at-will variation of the base, with no run-time penalty. Users have immediate feedback, because either Forth or assembly operations are ready for immediate execution as soon as they have been written. Most operations may be tested just by typing their names and arguments.

Also, Forth runs stand alone, avoiding the trouble and expense of obtaining other software for the operating system. Identical syntax is used throughout—in the language itself, in the assembler, in the editor, and in the keyboard-command interpreter.

Available on floppy disk from Forth Inc., the language now runs on the 8080, Z80, LSI-11, 6800, and 1802. Versions for the 8086 and 9900 should be available in the spring. It is also available for several minicomputers, including Digital Equipment Corp.'s PDP-11, Data General's Nova and Eclipse, the Honeywell Level 6, Computer Automation's LSI 4, and others.

Forth comes with a complete operating system: compiler, built-in assembler, text editor, I/O drivers, and a keyboard interpreter. The entire package is itself written in Forth and takes only 6 kilobytes in a read-only memory for a minimal implementation; this is a complete resident system with no need for memory swapping (paging from a disk). Adding features such as data-base management or double-precision arithmetic would push the memory requirement beyond the 6 kilobytes, however. A complete data-base management system requires about 10 kilobytes.

The language runs in a 16-kilobyte development system using a disk for source programs and data. It suits substantial projects like multiuser programming. For microprocessor systems, a utility program is available to prepare application programs to operate out of

This article is the third in a series on using high-level languages to program microcomputers. The first is an overview [Jan. 18, p. 105]; the second discusses optimization by assembly coding [Feb. 1, p. 121].

### Table: Forth Operation Definitions

<table>
<thead>
<tr>
<th>Byte</th>
<th>Contents</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9</td>
<td>Length of name</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>First 3 characters of name</td>
</tr>
<tr>
<td>3</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>link</td>
<td>Link field; contains address of the previous entry in this dictionary chain.</td>
</tr>
<tr>
<td>6</td>
<td>code</td>
<td>Code address field; contains address of the machine code starting the address interpreter</td>
</tr>
<tr>
<td>9</td>
<td>a (DUP)</td>
<td>Address of the dictionary entry for DUP</td>
</tr>
<tr>
<td>11</td>
<td>a (LIT)</td>
<td>Address of unnamed literal routine, which executed, will pick up the literal from the following byte and push it on the stack.</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>a (*)</td>
<td>Address of the entry for *</td>
</tr>
<tr>
<td>16</td>
<td>a (LIT)</td>
<td>Another literal follows. Eight-bit processors may have 8-bit or 16-bit literals; 16-bit processors have only 16-bit literals.</td>
</tr>
<tr>
<td>17</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>a (-)</td>
<td>Address of the entry for -</td>
</tr>
<tr>
<td>21</td>
<td>a (*)</td>
<td>Address of the entry for *</td>
</tr>
<tr>
<td>23</td>
<td>a (LIT)</td>
<td>Another literal follows. Note that all numbers are stored in binary.</td>
</tr>
<tr>
<td>25</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>a (+)</td>
<td>Address of the entry for +</td>
</tr>
<tr>
<td>27</td>
<td>a (...)</td>
<td>Address of the entry for ; This routine terminates compilation or execution.</td>
</tr>
</tbody>
</table>

2. Definition. Forth operations are stored as definitions in a dictionary. Shown above is the QUADRATIC operation of Fig. 1 as it appears in memory. Using reverse-Polish notation, QUADRATIC executes from the top to the bottom, relying on a stack for intermediate results.
programmable ROM. It compresses the operating system into about 512 bytes.

This run-time support package is larger than that required by most assemblers. Thus, for very small programs, Forth offers little or no size advantage over assembly code, although there would still be substantial advantages over other high-level languages.

For systems larger than about 2 kilobytes, Forth produces a program smaller than an assembler. In fact, the bigger the program, the greater Forth's memory efficiency, due largely to its dictionary structure.

**Dictionary structure**

Forth is different from conventional languages, which translate a source program into an object program. Instead, it consists of a dictionary of operations, which may be combined as necessary to form a new command. An incremental compiler translates each new statement into a dictionary definition, ready for execution. When the Forth program is executed, the operations indicated in each definition are carried out. New operations are defined in terms of those defined previously.

The system is delivered with more than 100 operations in the dictionary. The user need not know them all, because many are for internal system use. The dictionary is homogeneous, meaning that the programmer need not worry about where the system definitions end and the user's applications begin.

Forth operation names can be as long as 64 characters and can contain nonblank characters, such as letters, numbers, mathematical symbols, and even nonprinting ASCII codes. Examples of some actual operation names are SWAP, */MOD, and VOCABULARY. While the names can be any length, only their first three letters and their length are used for identification; 1BUFFER and 2BUFFER are different, but BUFFER1 and BUFFER2 are the same.

Since the language is extensible, the user can define new operations, usually with a colon definition. The colon, itself a dictionary definition, signals a defining operation and creates a dictionary entry for the new command, whose name immediately follows the colon. A semicolon ends the definition. The words between the name and the semicolon are already defined and will be executed when the definition is invoked.

Before discussing colon definitions, it is necessary to look at the operation of the stack, which is used to pass parameters among routines at run time. During execution, almost all high-level languages use at least one of these last-in, first-out data structures. Most languages, though, hide the stack, insulating the user from the structures of the machine. However, the Forth programmer explicitly controls the stack with postfix syntax, also called reverse-Polish notation. Using a postfix calculator is good practice for learning the language.

**Postfix formulas**

The following examples illustrate postfix formula calculations. These formulas are executed directly; the Forth computer is being used as a calculator, not to write new programs. However, any formula can be used within a colon definition.

To find 783 − 9903, one would enter 783 9903 − . using postfix notation. Here, the minus sign is the name of the subtraction definition, and the period is a print order. When this formula is evaluated, the number 783 is pushed onto the top of the stack, followed by 9903. The subtraction operation then destroys the original numbers, and replaces them with their difference. Finally, the period prints this number, now on top of the stack, as −9120 OK. The OK means the task is finished and the program is ready to accept new input.

With Forth, the number base can be changed any time. For example, 783 9903 − OCTAL will cause −21640 OK to be returned. The system will stay in octal until it is set to some other base, by using DECIMAL, HEX, or BINARY, either from the keyboard or in a program. Any number base from 2 through 36 may be used, but is apparent only in the entry of numbers and delivery of the results. All internal computations are done in binary, so there is no execution time penalty.

The stack also plays a role in using an existing definition in a new one. Suppose the task is to evaluate:

\[(2 \times \text{TIME} - 14) \times (\text{TIME} + 5)\]

where time is an integer. The solution uses several predefined Forth operations, including @, which fetches the one-word 16-bit value from the location of a variable.

One way to compute and print this formula is to type:

\[2 \text{TIME@} \times \star \quad 14 \text{TIME@} \times \star \quad \text{DUP.}\]

First the number 2 is placed on the stack. Then the variable TIME places its address on top of the stack with the 2 below it. The @ replaces this address with the integer stored there. The asterisk multiplies the top two stack numbers, replacing them by their product, and 14 − subtracts 14 from that value.

Now the stack contains the result of the first part of the formula. TIME@ 5 + computes the second half of the formula. The * multiplies the two together and puts the result on top of the stack. DUP makes a copy of the result and the period prints it. The copy insures that the value is still on the stack in case the user wants to store it or to perform further computations.

**Colon definitions**

If such a formula must be used repeatedly, it could be stored as a colon definition, thus becoming a new Forth operation. The programmer can give this computation a name, say FORMULA:

\[\text{FORMULA} \quad 2 \text{TIME@} \times \star \quad \text{TIME@} 5 + \star;\]

The colon begins a definition, and the word following the colon is the name given to the operation being defined. The semicolon ends the definition, and Forth will not print any value when this definition is entered, but will respond OK. Now the new definition will be available, either directly from the keyboard or in a later definition. For example, FORMULA will compute and print the value contained in that formula.

Suppose FORMULA must be able to accept an argument from anywhere: from any variable, from the keyboard, or from the result of a previous computation. In such cases, the operation takes its argument from the stack. The following definition will do this:
The term `DUP 2 * 14` computes the first part of the formula, first making an extra copy of the argument so that the original stays on the stack. `SWAP` reverses the top two numbers on the stack so that `5 +` adds 5 to the original argument, and the asterisk completes the computation. Now `TIME @ FORMULA` will use the value in `TIME`, and `FORMULA` will use the number 5, etc.

In a typical development session, definitions are typed in directly from the terminal and some are executed to test them (Fig. 1). The computer’s responses are underlined, except for the numbers in the table and the plots. First, an operation called `QUADRATIC` is defined. Then it is used to take an argument (50) from the stack, and compute `3X^2 - 12X + 20`, with `X = 50`.

The `QUADRATIC` operation appears in most of the following definitions in Fig. 1, showing how existing definitions can be reused in new ones. The `TABLE` definition, which prints a table of values, uses `QUADRATIC` to calculate its entries. `PLOT` takes one argument and plots a bar of that number of asterisks, and the operation `PICTURE` uses that number of values of `QUADRATIC`, from zero through one less than the argument.

Figure 2 shows a tabular representation of the dictionary entry, generated in memory, for the `QUADRATIC` definition developed in Fig. 1. The first 8 bytes are characteristic of all definitions. The code address is unique for each kind of definition, this one being a colon definition. Other kinds are `VARIABLE`, `CONSTANT`, and `CODE` definitions, in which the code address actually points to machine code following directly in the definition. Users may add their own kinds of definitions, as well as definitions of standard operations.

**Structural control**

Forth provides structural control, a major improvement in program writing that has come into substantial use over the last few years. Structured programming employs certain hierarchical forms of conditional branching and looping that prevent an arbitrary flow of control. This contrasts with earlier languages’ `GO TO` statements; once one of these is executed, to backtrack in the program to find an error is complicated.

The simplest Forth control structure is `IF ... THEN`, for conditional branching. When the `IF` is encountered, the program interprets the next stack entry as a Boolean argument; a zero indicates false, any other value true. The code within `IF` and `THEN` can be any list of commands of any length and is executed if the Boolean value is true. Execution of the program continues after the `THEN` statement, whether the test is true or false.

If specific code must be executed in the event of a false test, `IF ... ELSE ... THEN` can be used. The false code is located between the `ELSE` and `THEN` statements. A bonus in Forth is that the expressions based on Boolean tests can contain other such tests. An `IF ... THEN` may appear inside the true portion of another `IF ... THEN`, for example. This nesting, as it is called, may be done to any depth.

For looping, Forth includes a `BEGIN ... END` expression. The code inside the loop is executed, leaving a value on the stack. `END` treats this as a Boolean value that terminates the loop if true. Otherwise, the looping continues. A similar operation `BEGIN ... IF ... WHILE` returns to `BEGIN` as long as the `IF` is true.

The structure `DO ... LOOP` takes two numbers from the stack; the first is an index, and the next is the terminating value plus 1. For example, the expression `100 DO ... LOOP` goes through the loop a hundred times, with index values going from 0 through 99. Inside the loop, an operation named `I` retrieves the current value of the index and leaves it on the stack. This index advances by 1 for each iteration of the loop.

A related operation, `+LOOP`, takes the increment value off the stack. The increment can be a constant other than 1, or it can be computed inside the loop.

Looking up definitions does take a certain amount of
4. Source screen. Forth stores code in 1,024-byte screens, which are displayed as 16 lines of 64 characters on a CRT. This screen contains the definitions depicted in Figs. 1 and 3. The Forth text editor is used to prepare and maintain such screens.

```
0 ( QUADRATIC OSCILLATOR)
1 : QUADRATIC DUP 3 * 12 - * 20 + ;
2 : TABLE 10 0 DO CR I . I QUADRATIC . LOOP ;
3 : PLOT CR 0 DO 42 ECHO LOOP ;
4 : PICTURE 0 DO I QUADRATIC PLOT LOOP ;
5
6 : HEX
7 CODE START A SUB 1E OUT NEXT JMP
8 CODE STOP 1 A MVI 1E OUT NEXT JMP
9 DECIMAL
10
11 : DELAY 0 DO LOOP ;
12 : CYCLE START DUP DELAY STOP DELAY ;
13 : TEST 50 0 DO I QUADRATIC CYCLE LOOP ;
14
15 OK
```

Time. Sometimes speed is critical, or a program to interface a newly added I/O device must be written. In such cases, the Forth assembler comes into play to define machine language or primitive operations.

These routines can be used exactly as any other Forth definitions. The assembler, too, uses postfix syntax, so operands and addressing modes are written first, followed by the (mnemonic) operating codes. The operands and modes place data or addresses on the stack. The op code combines those arguments with the binary instruction code, and places the completed machine-language instruction into the dictionary where the definition of the new operation is being created.

**The assembler et al.**

The assembler takes one pass to translate source code and uses no symbol table. Instead, the stack is used for the operand memory addresses provided by Forth variables, constants, or computations.

The assembler has its own set of conditional instructions, including IF...THEN and BEGIN...END. These operations create conditional testing and branching instructions in the language of the machine being used. Higher-level and assembly versions of these control operations are kept separate because they reside at different addresses in the dictionary.

How can a one-pass assembler handle forward branches of unknown length, as with IF...THEN statements? The IF assembles a conditional branch instruction into the routine, leaving the unknown address blank. It also places the location of that blank address onto the stack (the same used to run Forth). When THEN is reached, the destination address of the branch is known, and the blank is replaced with its proper value.

The Forth assembler definitions START and STOP in Fig. 3 use 8080 machine language to turn on and off a device connected to an output port. DELAY is a timing loop, here written in Forth, it could have been written with the assembler instead. It accepts one argument, proportional to the length of the delay. Next CYCLE is defined. It accepts one argument, a delay, and turns the output port on and then off for that time. Finally, TEST uses QUADRATIC to compute a series of delay cycles to the I/O port.

Forth's organization goes beyond the dictionary structure and the structured control found in both high-level and assembly codings. It includes a block-oriented virtual memory scheme that contains the programmer's source code and any data he may wish to store.

**Virtual memory scheme**

In the random-access virtual-memory system, an operation called BLOCK takes a disk-block number from the stack and returns the address of a memory buffer containing that block's data. A buffer typically is 128 bytes in most microprocessors and 1,024 bytes in most minicomputers. BLOCK reads from the disk as necessary. If the data is already in a buffer from a previous call to BLOCK, no read operation takes place.

Two other operations are important in this virtual memory system. BUFFER gives the programmer the address of an empty buffer, and FLUSH writes all updated buffers to the disk, as at the end of a session.

Forth stores its source code in 1,024-byte units called screens. Each screen is displayed as 16 lines of 64 characters on a cathode-ray tube or a printing terminal. Because definitions are short, seldom over three lines, the entire code for an operation is displayed at once. A command called LOAD takes a screen number off the stack, and reads that 1,024 bytes of data exactly as if it had been typed directly at the terminal. The screen can contain high-level or assembly definitions or an operation to be executed immediately.

Figure 4 shows a listing of a Forth source screen containing definitions developed in Figs. 1 and 3. Parentheses surround comments, which may appear anywhere. Forth's resident text editor is used to prepare and maintain such screens.
Even a quick glance at the face of our new Model 3003 tells you it's no ordinary signal generator.

Right away you can see the unique internal and external modulation features, such as the provision for complex or simultaneous modulations with AM-AM, AM-FM or FM-FM.

The 3003 gives you twice as many modulation frequencies as most other generators. Besides the standard frequencies of 400 Hz and 1 KHz, you can choose and pre-set two more frequencies between 100 Hz and 10 KHz. And like other models in the 3000 Series, this one is accurate to 0.001% over the entire 1 MHz to 520 MHz range. (We also have a unit that goes down to 1 KHz.)

But the main thing you'll notice is how convenient the Model 3003 is to use: internal or external FM deviation and AM modulation are easily set on the big front-panel meter. For extra readability and accuracy, you get two AM scales and four FM scales. Everything is so clearly labeled that learning to operate the instrument takes only a matter of minutes.

One thing you can't see on the face of the 3003 is the price. At a low $3,350, we're really hiding one of its most attractive features.

Wavetek Indiana, Inc.
66 N. First Ave., P.O. Box 190, Beech Grove, Indiana 46107. Telephone (317) 783-3221, TWX 810-341-3226.

Performance is written all over our face.
Peak detector recovers narrow pulses accurately

by Jerome Leiner
Loral Electronic Systems, Yonkers, N. Y.

This peak detector can accurately process input data pulses as narrow as 50 nanoseconds and as high as 3 volts. The recovered voltage is always within 1% of the input signal's true value.

In the circuit shown, emitter-coupled logic generates a −0.2- to −3-volt signal for input into amplifier A1. Assuming a pulse with a 50-nanosecond width and a rise and fall time of 5 ns, that leaves storage capacitor C4 only 45 ns in which to charge. The LH0024 op amp used for A1 has wide bandwidth and a high slew rate to accommodate the fast charging required.

Q1 acts as a buffer to prevent C4 from discharging through R7 between system reset pulses. The voltage at Q1 appears at Q2 and is fed back to A1, to be compared with E_in. When E_out reaches E_in, D2 becomes back-biased and the stored charge is held until C4 is intentionally discharged by the reset signal. D2 remains back-biased during discharge.

A1 is normally used as an amplifier, and so it will be driven into negative saturation whenever the input signal drops below the output level. D1 prevents this by clamping the amplifier output.

C1 and R2 provide A1 with input- and feedback-signal stabilization. C3 compensates for A1's input capacitance. Note that if C1R2 were placed at the output of A1, a larger charging current would be required for a given input signal. Because this current is usually limited, A1's effective slew rate would be reduced.

The peak detector is optimized by shorting D2 and then adjusting C1, R2, and C3 for minimum overshoot and ringing on a series of fast data pulses.

Fast and precise. Using one op amp, one transistor, and two field-effect transistors, peak detector recovers data pulses having amplitudes of up to 3 volts and widths as narrow as 50 nanoseconds. Output voltage is within 1% of the input data’s true value under all signal conditions.
Optoisolator initializes signal-averaging circuit

by J. Ross Macdonald, Department of Physics and Astronomy, University of North Carolina, Chapel Hill

Long-term averaging circuits require an initializing voltage on their capacitive storage element in order to become almost immediately operational on power up. Here, an optoisolator is used to quickly charge the capacitor with a voltage derived either from the input signal itself or from any dc voltage, the two sources most widely used. The optoisolator circuit is superior to an initializer that uses a relay, which, besides having the disadvantage of being electromechanical, also draws power continuously.

In a circuit that averages a signal over a long period (see figure), the resistor-capacitor (RC) time constant may be on the order of a minute or more. Thus, the output of the averager (V₀) during the time t = 0 - 1 minute is considered to be the circuit's transient response to the input signal, where t is measured from the time that power is applied to the circuit. In most cases, especially when the circuit is part of a more complex system, it is not feasible to wait that long before the RC network starts generating a true average value.

The difficulty may be circumvented by using an optoisolator and a switch, S₁, to charge C on power up. Assume it is desired to charge C from a dc voltage, Vᵣ. When power is applied, Cᵣ, which may be 25 microfarads or more, is charged through Rᵣ. Consequently, as current flows through the photodiode, the value of the photoresistance element in the LM 6000 optoisolator is reduced from more than 10⁶ ohms to about 1 kilohm. Thus, in a few tens of milliseconds, C charges to Vᵣ through the element, if S₁ is placed in the Vᵣ position. As Cᵣ becomes fully charged, the resistance of the element quickly increases to at least 10⁸ ohms, and the circuit is ready to operate in its intended averaging mode.

When power is removed, Cᵣ discharges through D₁, so that the on-off power cycle can be repeated fairly rapidly. C also discharges slowly through R. This action is of little consequence in circuit operation on a subsequent power up. Note that S₂, a momentary-contact switch, allows the resetting process to be repeated at any time, even while the circuit is active.

To initialize C from the input signal, it is only necessary to connect S₁ to Vᵣ prior to power up (or at any time if S₂ is utilized). Otherwise the initializing operation is the same as before.

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.

**Speedy average.** Optoisolator enables long-term averager to operate almost immediately after power up by presenting an initializing voltage to circuit's sampling capacitor, C. Charge is introduced through isolator's low-resistance photoelement. Either a dc voltage or the input signal can be used as the initializing source.
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 local 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) 659-4175; Midwest Region, 2805 Butterfield Rd., Suite 450, Oakbrook, IL 60521 (312) 986-8989; Western and Northwest Regions, 20863 Stevens Creek Blvd., Bldg B3, Suite C, Cupertino, CA 95014 (408) 255-3944; Southwest Region, 1000 Quail St., Suite 290, Newport Beach, CA 92660 (714) 752-5535; Europe, Honeywell House, Charles Square, Bracknell, Berkshire, England, Rg 12. Direct Dial: 011-44-344-24555.

Guaranteed 2.0 Volt Memory Retention

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Access Time</th>
<th>Standby Current</th>
<th>Guaranteed 2 Volt Memory Retention</th>
</tr>
</thead>
<tbody>
<tr>
<td>SY5101L-3</td>
<td>650nsec</td>
<td>200µA</td>
<td>Yes</td>
</tr>
<tr>
<td>SY5101L</td>
<td>650nsec</td>
<td>10µA</td>
<td>Yes</td>
</tr>
<tr>
<td>SY5101L-1</td>
<td>450nsec</td>
<td>10µA</td>
<td>Yes</td>
</tr>
<tr>
<td>SY5101-8</td>
<td>800nsec</td>
<td>500µA</td>
<td>No</td>
</tr>
</tbody>
</table>

Off-The-Shelf Delivery From These SynerTek Distributors:

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

Circle 122 on reader service card
Timer generates sawtooth with switchable symmetry

by Roberto Tovar-Medina
Institute of Applied Mathematics, University of Mexico

With some inexpensive components, a 555 timer operating in the astable mode forms a circuit that generates triangular waves of selectable symmetry. The cost of the unit is below $6.

The triangular waves are generated by charging a capacitor with a constant current, \( I \), and discharging the capacitor through a current mirror that sinks \( I \). The symmetry is controlled by selecting the rate at which the capacitor is charged and discharged.

When capacitor \( C \) is virtually discharged and the switch, \( S \), is at position 1 as shown, pin 7 of the 555 (the discharge port) is high, and \( Q_1 \) and \( Q_2 \) are off. Thus, the capacitor is charged at a rate of \( I t/C \), where \( t \) is time, until the voltage at pin 6 (threshold port) of the 555 exceeds two thirds of the supply voltage, \( V_C \).

Pin 7 then moves low, \( Q_1 \) and \( Q_2 \) turn on, diode \( D_1 \) becomes back-biased, and \( C \) discharges through \( Q_1 \), \( Q_2 \), and \( Q_3 \) at a rate of \( I t/C \). When the voltage at pin 6 falls below a third of the supply voltage, pin 7 moves high again and the process repeats at a frequency given by \( f = 1/(2C V_C) \). At low frequencies (below 1 kilohertz), \( D_1 \) may be omitted, because \( C \) can charge through the base-collector junction of \( Q_3 \). At high frequencies, \( D_1 \) must be included to avoid the discontinuities in the triangular waveform that are caused by switching.

A fast charge time is attained if the output of the 555 (pin 3) is connected to pin 6 through diode \( D_2 \). This connection is achieved by placing \( S \) in position 2. The discharge time is the same as before. Connecting the discharge port directly to the threshold pin yields a normal charge time and a fast discharge time. \( S \) must be placed in position 3 to achieve this symmetry. In either case, the operating frequency is exactly twice what it was previously, or \( f = 3I/C V_C \).

Given the component values shown, the circuit oscillates at about 1 kHz. It can be made to work at frequencies up to 30 kHz, however.

---

Adjusting slope. Circuit built with 555, constant-current source, and current mirror generates triangle-type waves whose symmetry is selectable. Frequency is controlled by magnitude of \( I \), which is adjusted with potentiometer. Three-position switch determines rate at which \( C \) is charged or discharged, so generator can produce standard or fast-rising sawtooth waves or waves that are truly triangular.
A vibrant beat from Switzerland: the Quartz DE-26.*

Introducing the DE-26 Quartz from Switzerland. It's as conveniently miniaturized as any on the market. So is its price. It's made the way the Swiss make everything: reliable. Using state-of-the-art processes backed by repeated, methodical inspections.

In technology and in price, the Quartz DE-26 is designed for a broad and growing range of applications where reliability is as important as tight costing.

DE-26: the rational solution from Switzerland. Write for specs today.

* 32 kHz leaf-type tuning-fork crystal. Only 2 x 6 mm. Low resistance, high Q. Excellent resistance to shock and vibrations.

ETA SA
Fabriques d'ébauches / Division diversification 2540 Grenchen, Switzerland telephone 065/511121, telex 34284 assa ch A membre of the Ebauches Group.
Porcelain-on-steel boards can launch a thousand chips

Thermal and mechanical properties of popular appliance material cut processing steps in hybrid and pc-board manufacture

by Murray Spector, Alpha Advanced Technology Inc., Newark, N. J.

Porcelain-coated steel, the material found in every kitchen, comes close to being the ideal substrate long sought by manufacturers of both thick-film hybrid circuits and printed-circuit boards. It has excellent mechanical and thermal properties and is low-cost in large volumes.

Its ruggedness will enable the hybrid makers to move from their present small, fragile alumina substrates to ones at least the size of pc boards, having built-in heat sinks and ground planes, and promising eventually to carry over a thousand chips. Its good thermal properties will enable the pc-board manufacturers to print and fire conductive and resistive inks directly onto it (Fig. 1), cutting their costs tremendously by eliminating all the plating and etching now needed, as well as much of the component assembly.

Still other benefits will be shared by both groups. For instance, the metallic substrate can be bent and shaped easily. After enameling, it survives environments inimical to both ceramics and plastics. Finally, it is possible either to wave-solder discrete components or wire-bond chips to the new steel boards.

A porcelain-coated steel substrate has a core of low-carbon steel and a coating of fired-on porcelain enamel. The porcelain enamel is a ceramic with a firing temperature high enough to allow hybrid components to be fired onto it subsequently at 650°C. Conductors may be of copper, silver, palladium-silver, platinum-silver nickel, gold, or any other metal available as a screenable ink. Resistors are ruthenium-oxide-based, and the smooth surface of the porcelain often makes their fabrication so uniform that trimming is unnecessary. When necessary, however, it may be done abrasively or by laser—and with the circuit energized. This kind of active trimming is possible because of the thermal mass of the steel, which is so great that it prevents the resistor from heating up much during the process.

From heaters to circuits

Way back in the 1930s, heaters were being made of copper on porcelain-coated steel. So in the 1940s, when printed wiring boards were invented, there were immediate attempts to make boards with a metal core. But success came only in 1965, when steel boards were insulated with epoxy. Epoxy, though, cannot take the firing temperatures needed for hybrid circuits, so in 1967 the first serious attempts were made to use porcelain-coated steel in electronics. Some manufacturers of thick-film inks made inks that would fire at the right temperatures for it, but additional engineering problems with the inks and the coated steel held up the full emergence of the new substrate until about 1977.

Today porcelain-coated steel represents a new substrate technology. It has its limitations, which will be discussed later, but evaluations currently under way at several large potential users will probably result in its use.
this year in both military and consumer electronics—
avtomobiles, telephones, telephone switching circuits, television sets, and appliances. Still other possible areas of application are computers and medical electronics.

**The metal-working step**

The manufacturing process starts with the fabrication of the steel core by any of a number of common metal working techniques. For prototype runs, it is most economical to chemically mill the steel core. For larger quantities, a stamping process is best, being very inexpensive on a per piece basis once the tooling is in place.

The tooling, however, can be very expensive, because it needs to be unusual. Simply drilling circular holes straight down through the steel substrate is not enough. Picture one such hole in cross section. It would have a square shoulder, and a square shoulder causes a porcelain coating to pull away from it and create a ridge encircling the hole. The result would be a point of minimum insulation and of extremely high electrical field density—in other words, an insulation breakdown hazard bad enough to defeat the use of this design in many electronic applications.

The solution to this problem is either to flare or to bevel the edge of the hole. This rounding of the sharp corners has the additional benefit of facilitating the automatic insertion of leaded components.

Once the steel is formed into its final shape, it starts through the processes leading to enameling. It is cleaned and then pickled in an acid solution, which roughens the surface and promotes the adhesion of the enamel. Pickling is followed by a rinsing operation and then by nickel-plating, which further promotes enamel adhesion. After additional rinsing the steel is ready to be dipped into the enamel.

**Electronic-grade porcelain**

The enamel used is a formulation designed for continued operation in an electric field at elevated temperature. It is applied in a water solution to the part, which then must be very carefully dried before firing; otherwise the water will vaporize explosively and pit the enamel surface. The firing yields the finished substrate—a 0.028-inch-thick core of enameling-grade steel coated on both sides with a black ceramic layer 0.004 inch thick (Fig. 2).

Metalization is next applied to the porcelain. This involves screening on a metal paste and firing it. The Electronic Materials division of E.I. du Pont de Nemours & Co., Niagara Falls, N. Y.; Cermalloy, Cermet division of Bala Electronics, West Conshohoken, Pa.; Electronic Materials Corp. of America (EMCA), Mamaroneck, N. Y.; Electro-Science Laboratories Inc., Pennsauken, N. J.; and Thick Film Systems, Santa Barbara, Calif., all manufacture precious-metal conductors, resistors, and dielectrics formulated for porcelain adhesion and having firing points between 600° and 650°C. These inks resemble those used on alumina substrates except for their lower firing temperatures. Additionally, DuPont and Cermalloy both have copper inks available. Where through-hole printing is required on double-sided boards or substrates, a special ink formulation is necessary to provide the requisite kind of plastic flow, or rheological properties.

**Wave-soldering to copper**

Copper inks are especially suited to printed-wiring-board applications since they allow the use of 60/40 tin-lead solder. Precious-metal inks, preferred by hybrid-circuit manufacturers, have the disadvantage of requiring a more expensive silver-bearing solder to inhibit the precious-metal ink from being leached off the board during soldering.

Wave-soldering a porcelainized steel board with copper conductors is not the same as wave-soldering a conventional epoxy-glass printed-circuit board. Preheating temperature and soldering speed must both be higher than those necessary with the epoxy board.

The first adjustment must be made because of the high heat capacity of the steel core. The core acts as a heat sink to the copper and prevents it from reaching soldering temperature unless the board has been sufficiently heated beforehand.

Conversely, at the time of application of the solder, when the board is over the solder wave, the core acts as a heat source and could encourage the solder to flow too far up the component leads. This can be prevented by speeding up the belt.

The steel core of the substrate may be used as a ground plane. First the bare steel must be exposed; then contact is made to it by conductive epoxy or by deposition of a thick film.

**Comparing board materials**

The biggest difference between steel and plastic boards lies in their thermal conductivity. None of the plastics used in standard printed wiring boards is good at conducting heat—a problem there have been many
attempts to alleviate. One approach uses heavier copper laminates, but then the thickness of the copper demands that all lines and spaces be widened. Another approach is to back the board with aluminum or steel, but this is awkward and expensive and has gained relatively little favor with the industry.

A porcelain-coated steel board is far superior to a plastic type in thermal conductance, even when no direct contact is made to the steel core. By way of comparison a 2-watt precision resistor operating at rated power on an epoxy-glass board is 25.2°C hotter at its surface than an identical resistor mounted on an Alpha porcelainized steel substrate, trade-named Alphamet.

Even this performance can be enhanced by making ground contacts to the steel core and putting the core in metal-to-metal contact with a system's chassis. This is made possible by masking the steel so as to prevent porcelain from being deposited on any area to be directly contacted. The procedure often eliminates the need for heat-sinking components.

A second difference is that plastics all expand much more than steel with increased temperature. It is because of this characteristic that the pad areas around the holes on plastic boards have to be large, to compensate for any misalignment of the final etch pattern with holes. On porcelain-coated steel boards, the pad areas can be smaller because the much lower thermal expansion of steel allows more precise alignment.

Finally, standard printed-circuit board materials cannot be used reliably in high-temperature environments, as in an automobile engine, oil drilling apparatus, and thermal printing heads. These are all applications where porcelainized steel boards are found to be highly satisfactory substitutions.

**Steel vs alumina**

All-ceramic substrates, in contrast, are inferior to steel not only thermally but in their electrical and above all their mechanical properties.

Indeed, mechanical fragility has historically been the greatest drawback of alumina and beryllia wafers. It precludes their use entirely in many harsh mechanical environments, or only if equipped with expensive steel backing plates. The same fragility keeps yields low in both substrate fabrication and finished circuit assembly and creates a cost structure that increases exponentially with substrate size. Porcelain-coated steel, on the other hand, is virtually indestructible, and its cost per square inch is unaffected by size.

To illustrate comparative thermal performance, identical resistors were printed on alumina and Alphamet substrates. Then the increase of temperature at the resistor surface was plotted as a function of power in the resistors. As can be seen in Fig. 3, alumina heats up faster and to a higher temperature than the Alphamet.

It is worth noting that a simple conductivity concept is not enough for a proper theoretical analysis of a composite material like porcelain-coated steel. Instead, the conductance of all five layers of the structure must be considered—the two outer porcelain layers, the innermost steel core, and the two transition layers between the porcelain and the steel. In addition, unlike other substrates, porcelainized steel radiates a significant amount of heat. The emissivity of its black porcelain is a measure of its efficiency at this form of thermal transfer. A mathematical model taking all these factors into account has been found to generate experimentally verifiable results.

As already noted, the thermal performance of porcelain-coated steel may be further enhanced by supplying metal-to-metal thermal paths away from the substrate. This is typically done by providing the substrate with unporcelainized mounting pads for bolting it to a chassis. Finally, the steel core serves as an electrical plane, useful either as a ground plane or sometimes as a power distribution plane. Either use eliminates the need for one conductor and one dielectric layer.

Electrical performance may also be enhanced by the availability of two-sided construction. Conductor-filled holes can be provided as vias, or plated through-holes, connecting the two sides of the substrate.

For multilayer circuits the number of firings is halved by using a cycle of print-dry-print-dry-fire. In applications where crosstalk is a factor, circuits can be separated and then shielded from each other by their common steel substrate.

**Bending steel**

The presence of the steel core creates two other useful properties that are not to be found in other rigid substrates. First, the steel can be worked in three dimensions; on a simple level, the edges of a board can be bent so that it becomes its own chassis. Second, the porcelain surface absorbs no water, and the ceramics used in
4. Potted power. Porcelain-coated steel replaces alumina in substrate for power-supply circuitry. The same material also replaces the aluminum heat sink. Hybrid thick-film techniques were used in both cases. An unpotted module is pictured to the left.

5. Printed wiring on steel. This porcelain-coated steel pc board has been substituted for a plastic type in an electronic ignition system designed at Motorola. Note the discrete components. Final version of this circuit will be a thick-film hybrid on a steel board.

Hybrid substrates allow the porcelain-coated steel actually to be the outer wall of any package.

For all its advantages, porcelain-coated steel does present some problems, both technical and otherwise. The first is ion migration.

Porcelain enamel is a complex material. From an electrical point of view, it is generally considered to be simply an insulator. However, at a thickness of 4 mils, it is far from ideal in that role. The metallic oxides that comprise the porcelain ionize under the influence of heat and voltage. In a dc field, the ions move and constitute a leakage current to a working circuit. To minimize this problem, the current under an 0.080-in. pad (the size of a typical integrated circuit) should be less than 10^{-13} ampere. Also, the rate of ion generation should be so low that the adhesion of the metalization to the porcelain will not be affected by ion accumulation for 40 years.

The other technical problem is brown plague—the oxidation of silver alloy conductors at the edge where they accidentally come in contact with the steel core. The mechanism is not well understood, but can be avoided by using copper for ground contacts and keeping silver 0.060 in. away from the substrate edges.

The third problem is economics and concerns the cost-volume relationship. Tooling for steel substrate manufacture is so expensive that the process becomes cost-effective against epoxy-glass printed wiring boards only at a volume of over 100,000 substrates.

The last, and perhaps the largest, problem is psychological. The unavailability of all-ceramic substrates in large sizes at a reasonable cost has conditioned designers of hybrids to think in terms of circuit functions rather than systems. Designers now have to reorient themselves to today's reality in which 12-by-18-inch substrates are available, along with screen printers, drying ovens, and firing furnaces big enough to handle them.

Packaging power

Despite these obstacles, enameled steel substrates are being evaluated for many tasks. Figure 4, for instance, shows an application in a small power supply. The porcelainized steel substrate replaces an alumina substrate and an aluminum heat sink. Figure 5 shows a pc-boardlike application—an automotive electronic ignition system—in which screened-on metallic conductors are combined with discrete components on porcelain-coated steel. It is a transitional version, meant to be followed by a completely hybridized version.

Steel substrates are eminently suited to the rough under-the-hood environment of cars and indeed in any high-shock environment. For example, ceramic hybrid boards are often backed with metal in such shock environments. This is an expensive procedure since both materials require extremely precise machining if they are to mate well enough to withstand the shock. A ceramic-on-steel substrate eliminates the need for a two-piece part as well as the high cost of machining surfaces in the first method.

Similarly, a circuit board, when it is required to act as a mechanical member of a mechanical assembly, often needs a metal backing. In one system a large plastic pc board had to be stiffened with a piece of aluminum before it was able to serve as a panel for rack-mounted equipment. A porcelain-coated steel board, on the other hand, could replace the aluminum plate and the epoxy-glass board.

A look to the future

Applications for porcelain-coated steel are moving in two major directions, toward combining existing functions and toward altogether new functions.

Its potential for serving as both circuit board and chassis or even package has already been mentioned. Another possibility is for the same substrate to support thin and thick films and discrete components.

As for the jobs that only porcelain-coated steel can do, thermal sensors have already been designed on such a substrate for direct insertion into a car's engine block.
8085 program rapidly computes 8-by-16-bit product

by Gary A. Sitton
Baylor College of Medicine, Houston, Texas

More and more applications require finding the product of an 8-bit and a 16-bit word. Multiplication is easily done with this program using the versatile double-precision add (DAD) command in the instruction set of the 8085 microprocessor. The program thus uses less memory than other 8-by-16-bit multiplying algorithms, which require double-precision software geared to a 16-by-16-bit product.

One of the program's advantages is the time saved in multiplication. Defining the 8-bit word as the multiplier, n, the program needs no more than n shifts and double-precision additions.

The bits to be multiplied are introduced at register pair D-E and accumulator A. D-E and A are altered during execution but can be saved on the stack if so desired. Meanwhile, the DAD H instruction shifts the multiplicand left one position each time it is called by placing the 16-bit number in register pair H-L and adding it to the number already contained therein. The product is left in H-L upon program termination.

The execution time of the program will be directly proportional to the number of significant bits in the multiplier. If the total number of significant bits in register pair D-E and accumulator A exceeds 16, there will be no detectable error in the multiplication.

Fractional-binary program creates pseudorandom integers

by Robert L. Harding
Quaker Data Products, Middlebury Center, Pa.

Using the routine proposed by Tański,1 this program generates a true pseudorandom sequence of integers over any range of numerical values from 0 to 255. The former program is used as a subroutine, called W times for a given word length W, so that 2^W fractions, each extending from 0 to a value approaching 1, are generated. Each fraction, which is pseudorandom, is then multiplied by the desired range (0-255) to produce pseudorandom integers.

Although Tański has shown that a 31-stage register with feedback is ideal for use in a pseudorandom sequence generator, his article implies that the register provides 31-bit random numbers each time the subroutine is called. In reality, the subroutine tends only to double the previous number generated, with the result that eventually the numbers can be predicted. Thus pseudorandom words are generated for only a relatively short period of time.

In order to produce random numbers over a long period in any word size up to W = 31, it is necessary to clock the registers (i.e., call the subroutine) at least W
FRACTIONAL BINARY PROGRAM: PSEUDORANDOM INTEGERS

18-byte program translates a source of pseudorandom "binary fractions" into any desired RANGE (up to 255) of pseudorandom integers. Mapping operator is multiplication.

Select fraction word size, W, for tolerable degree of distortion of original randomness.

```
MVI C,W ; set loop counter
XRA A ; clear RESULT register A

LOOP: MOV B,A ; save partial product
CALL TANSKI ; pseudorandom bit-source
 ; sets S-flag (multiplier)
MOV A,B ; B: partial product
JP SHIFT ; if random bit = 0, skip
ADI RANGE ; if = 1, add multiplicand

SHIFT: RAR ; discard fraction bit
 ; from result. A: new product (integer)
DCR C ; count down W (word size)
JNZ LOOP ; until finished
 ; A: final result = 0 thru RANGE-1
 ; increment A to start values at 1 instead

RANGE EQU 36 ; for roulette example
W EQU 24 ; see text
 ; W (maximum) = 31 to keep bit-source pseudorandom
TANSKI EQU PRBN ; subroutine entry label
```

TANSKI: 8080A PSEUDORANDOM-BIT PROGRAM

```
PRBN: DAD H ; shift lower part, clear LO
MOV A, E ; shift higher bytes sequentially
RAL ; 8080A: use AC, CY
MOV E, A ; Z80 : RL E, RL D
MOV A, D
RAL
MOV D, A
XRA L ; calculate feedback
RP
INX H ; update LO if needed
RET
```

times to generate W fresh bits. Here, the fractional-binary program is used to call the Tański program to generate a random word.

Each random word is considered one binary fraction of W bits (low-order bit first) in a total of $2^W$ fractions. The numerical range (RANGE in program) over which pseudorandomness is desired is then multiplied by the given fraction, and the integer portion of the product is retained. This operation will translate the fractional range into integer values extending from 0 to the value (RANGE - 1) with virtually equal probability. Note that the program multiplies with a conditional-add and shift algorithm. Whereas the Tański program delivers the multiplier bit by bit (via the S-flag), this program uses a single register to accumulate an 8-bit product. The integers generated are thus pseudorandom within the specified RANGE.

The only pitfall in using the program lies in selecting the length of W. It must be large enough to produce fractions with sufficient resolution to preserve the original randomness. For example, if RANGE is selected to be 36 so that numbers can be generated for roulette, then
Five-state LED display monitors paging system

by D. F. Fleshren
Springfield, Va.

This paging station circuit uses a single red- or green-light-emitting diode to alert the user to any of five distinct paging conditions. It is a simple, extremely easy-to-build monitor designed to be part of a large paging system. Two relays and a 555 timer send a signal to the LED (a Monsanto MV5491 or Xcitor XC5491) to produce the following signals:

- Off (no power) indicates that paging has been cut off to that station or the region in which it is located.
- Steady green signifies that the station is operational, but is not being paged.
- Steady red is the individual station's paging signal.

- Flashing green tells the user that all stations in the system are being alerted.
- Flashing red signals an emergency situation to all monitoring stations.

An external signal triggering relay A controls the color of the LED, changing it from its green (idle) condition to red. Relay B is excited when all stations are to be called. This second relay puts the 555 timer in the astable mode, changing the LED's usual dc state to an on-off oscillation of about 7.5 hertz at a duty cycle of 50%. The frequency of oscillation can be adjusted by suitably selecting R1 and C1. In the emergency red flashing mode, both relays must be tripped by external signals.

This circuit can readily be adapted to signal a single panel-mounted lamp. To derive the five operating modes, the relay contacts must be replaced by the contacts on a suitably wired rotary switch.

Supply voltage for the 555 may vary from 9 to 15 volts; with a 12-V supply, current drain is about 40 milliamperes.

---

**Operating modes for 5-state monitor**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Typical application</th>
<th>Relays operated</th>
<th>Lamp display</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  power off</td>
<td></td>
<td>none</td>
<td>off</td>
</tr>
<tr>
<td>2  power on, circuit idle</td>
<td></td>
<td>none</td>
<td>steady green</td>
</tr>
<tr>
<td>3  paging</td>
<td>&quot;A&quot; only</td>
<td>steady red</td>
<td></td>
</tr>
<tr>
<td>4  all zone paging</td>
<td>&quot;B&quot; only</td>
<td>flashing green</td>
<td></td>
</tr>
<tr>
<td>5  emergency announcement</td>
<td>A and B</td>
<td>flashing red</td>
<td></td>
</tr>
</tbody>
</table>

**Multimode monitor.** Module indicates the state of a multizone paging system using red/green LED, 555 timer, and relay contacts. When pager is off, both LEDs are extinguished. When pager is idle, green LED turns full on. If monitor is paged, red LED turns full on. During all-zone paging and emergency announcements, relays are energized for timer so that red or green LED flashes.
Engineer's newsletter

What to do before the board tester comes

As the amount of in-service digital equipment expands apace, maintenance and testing concerns loom ever larger. Designing testability into digital circuit boards is a big timesaver. Dave Schneider of Giordano Associates, Sparta, N. J., and Bill Muller of Datapoint Corp., San Antonio, Texas, addressed this problem at a seminar on automatic test equipment sponsored by Benwill Publishing Co., Boston, and held in Los Angeles on Jan. 23–25, 1979. They listed some simple, practical (but often overlooked) production guidelines to aid testing:

- Keep all components off the solder side of the board, to allow in-circuit testers to be used for bare or loaded board testing.
- Don't overpack a pc board. The defect rate per board appears to increase linearly as chips per square inch rise from 0 to 0.7.
- In laying out a board (especially a microprocessor type), major bus lines should be laid out first with an eye towards quick isolation of shorts and other pc manufacturing defects.
- A good general rule of thumb: do not build any components into a system that take longer than five minutes to replace.

Al says Al limits a transformer's leakage flux

In sensitive equipment containing cathode-ray-tube displays, line-powered transformers can be an annoying source of electromagnetic interference even after you've wrapped a Mumetal shield around their cores. This solution doesn't attenuate the higher harmonics of the leakage flux enough, though it works well for the low frequencies. Al Schamel of Tektronix Inc., Beaverton, Ore., improves on the idea: he sandwiches a layer of aluminum between the transformer core and the usual Mumetal shield. Not only does this hold down both 60-Hz and high-frequency leakage, but it lets you use a thinner layer of the costly Mumetal.

Picking resistors resistant to pulses

It is by no means obvious from a resistor's steady-state power-handling specifications whether it will survive under pulsed conditions. "Pulsed Handling Capability of Wirewound Resistors" is a booklet from TRW/IRC which tells how to select these devices for a wide range of pulsed circuits. The first section of the booklet explains how to calculate the maximum energy that can be safely applied to a resistor in pulses ½ to 5 seconds long. Examples illustrate how to use this energy value to calculate the maximum allowable pulse voltage or current for a resistor. The booklet's second section goes into calculations necessary for pulses shorter than ½ second. Sample designs given are for square and exponential pulses. The booklet is available free from W. C. Robbins, TRW/IRC Resistors, P. O. Box 1860, Boone, N. C. 28607.

Wet your feet in a half inch of liquid-crystal display

If you're thinking of dabbling in large-area liquid-crystal displays, it might be worth your while to look into a new designer's kit from Beckman Instruments. This $11.95 kit includes a half-inch-high four-digit LCD, a connector/bezel assembly, a printed-circuit board, plus complete specifications and application information. A list of IC manufacturers that supply chips for interfacing to LCD's is also included. Contact the Display Systems division, Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634.

Jerry Lyman
How to add 55% more display to a 0.3” package

Now you can upgrade to our new 0.4” display without changing your 0.3” pin configurations. Larger, brighter LED digits add sales appeal to any device or instrument using displays. That’s exactly what Monsanto’s new 0.4” display can do for your product.

And the highly legible sculptured font improves aesthetics even further.

The Big 4 comes in 4 colors. These new seven segment displays are designed for high brightness, high contrast, and are available in:

- Green (MAN4500 Series)
- Orange (Hi-efficiency red, MAN4600 Series)
- Red (MAN4700 Series)
- Yellow (MAN4800 Series)

They’re available in common anode or common cathode and overflow models. And like all Monsanto displays, the new 0.4” digit offers low power consumption and solid state reliability for a longer operational life.

Write or call today. For more technical data or pricing information, contact Monsanto Commercial Products Co., Electronics Division, 3400 Hillview Avenue, Palo Alto, California 94304. Telephone: (415) 493-3300.

In Europe contact: Monsanto Europe S.A., Electronics Division, Avenue de Tervuren 270-272, B-1150 Brussels, Belgium.

Monsanto

FIRST IN LED MATERIAL AND TECHNOLOGY

Circle 133 on reader service card
Complete Protocol

Signetics 2652 holds the speed record for multi-protocol handling.

At 2Mbits/second, nobody beats our 2652 multi-protocol communications controller for operating speed. In fact, nobody even comes close. And that speed’s important when you’ve got to move data in time-sensitive environments. Between CPU and terminals. Or between CPUs.

Speed that cuts transmission costs is one key reason why more OEMs specify Signetics 2652 over any other protocol controller. But not the only reason. SDLC. DDCMP. Whatever your synchronous protocol—bit-oriented or character count—our 2652 can handle it. Completely. Perfectly.

The 2652 also cuts software development time, because many critical software routines are handled by its LSI firmware. And that includes CRC error control and zero insertion/deletion.

Add up the features. It’s clear that no other product can match our powerful protocol handler. Even when speed is not essential. Suppose you’ve got a
single protocol system now. Design in the 2652. Then when your needs change or grow, the 2652 will still be keeping your product current.

Operating from a single +5V supply, the TTL-compatible 2652 links to any 8 or 16-bit data bus. That means you can use it with micros or minis. Line controllers or network processors. And its super-fast data rate easily meets the demands of dedicated networks or satellite teleslinks.

So when you’ve got to handle protocols “by the book,” specify the 2652. Its field proven capabilities can put more money in your pocket. Check the chart below for some of the 2652’s key features.

For full details on the world’s fastest protocol controller, send us the coupon. Or visit a Signetics sales office or authorized distributor.

---

**KEY FEATURES OF SIGNETICS 2652**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rec/Xmt Modes</td>
<td>Synchronous</td>
</tr>
<tr>
<td>Protocol Compatibility</td>
<td>SDLC, HDLC, ADCCP, DDCMP, BISYNC</td>
</tr>
<tr>
<td>Slew Rate</td>
<td>DC to 2Mbps/sec (lower speed 1Mbps/sec version available)</td>
</tr>
<tr>
<td>Slew Rate Generation</td>
<td>External</td>
</tr>
<tr>
<td>Data Bus Compatibility</td>
<td>Processor/Minicomputer, 8 or 16-bit, tri-state</td>
</tr>
<tr>
<td>Error Controls</td>
<td>Odd/Even VRC, CRC-16, CRC-CCITT</td>
</tr>
<tr>
<td>Self-test</td>
<td>Local Loop Back</td>
</tr>
<tr>
<td>Package</td>
<td>40-Pin DIP</td>
</tr>
<tr>
<td>Availability</td>
<td>Immediate</td>
</tr>
</tbody>
</table>

---

To: Signetics Information Services, 811 East Arques Avenue
   P.O. Box 9052, Sunnyvale, CA 94086
   ☐ Please send details on the world’s fastest protocol handler.
   ☐ My need is urgent. Please have a Signetics specialist phone me.

Name: __________________________  Title: __________________________
Company: ________________________  Division: ________________________
Address: _________________________  MS: ____________________________
City: ___________________________  State: _________________________  Zip: ____________

---

Signetics
a subsidiary of U.S. Philips Corporation

Signetics Corporation
P.O. Box 9052
811 East Arques Avenue
Sunnyvale, California 94086
Telephone 408/739-7700
One simple DC voltage recorder or a dozen fiber-optic oscillographs. General Electric Instrument Rental can meet all your needs.

We stock in depth. Our computer controlled inventory includes recorders by top manufacturers like Esterline-Angus, Gould Brush, Dranetz, Honeywell and Texas Instruments. Carefully inspected, accurately calibrated and ready to ship, usually the day you call.

GE has 6 stocking inventory centers, 40 sales offices and more than 15,000 instruments including the recorders you need—right now.

For your Free Rental Catalog call collect 518-372-9900 or your nearest sales office listed below, or write the General Electric Company, Apparatus Service Division, Building 4 Room 210, Schenectady, NY 12345.

ALBANY (201) 322-4115 • ARIZ.PHOENIX (602) 278-6515 or 8516. TUCSON (602) 294-3139 • CAL. LOS ANGELES (213) 647-6350, SACRAMENTO (916) 383-4986, SAN FRANCISCO (415) 386-5525 • COL. DENVER (303) 226-3253 • CONN. SOUTHINGTON (203) 221-4599 • FLA. JACKSONVILLE (904) 731-6015, MIAMI (305) 696-6811 • GA. ATLANTA (404) 433-5463 • ILL. CHICAGO (312) 333-4500 or (312) 344-2994 • IND. INDIANAPOLIS (317) 639-1566 • KY. LOUISVILLE (502) 452-3311 • LA. NEW ORLEANS (504) 365-6528 • MD. BALTIMORE (301) 332-4115 • MASS. BOSTON (617) 396-9800 • MICH. DETROIT (313) 285-6700 • MINN. MINNEAPOLIS (612) 392-6199 • MD. BALTIMORE (301) 332-4115 • THE N.J. NEW JERSEY CLifton (201) 371-6550 • N.Y. BUFFALO (716) 876-1289, SCHENECTADY (518) 383-2165 • N.Y.C. NEW YORK (212) 682-6566 • N.C. CHARLOTTE (704) 525-6100 • OH. CINCINNATI (513) 874-8517, CLEVELAND (216) 441-4751,ledo (419) 481-3256 • OR. PORTLAND (503) 221-5101 • PA. PHILADELPHIA (215) 424-4450, PITTSBURGH (412) 462-7000 • S.C. GREENVILLE (864) 277-4093 • TENN. MEMPHIS (901) 327-3500 • TEX. HOUSTON (713) 677-3910, TULSA (918) 242-3080 • UTAH SALT LAKE CITY (801) 292-4411 • VA. RICHMOND (804) 332-4516 • WASH. SEATTLE (206) 577-2937 • W. VA. CHARLESTON (304) 345-0926 • WISC. MILWAUKEE (414) 744-0110 • PUERTO RICO PONCE (809) 462-4225 or 4625.
New products

Desktop computer sells for $2,850

Highly modular versatile system, built around the 8085A, can act as a stand-alone computer or as a terminal in a large system

by Pamela Hamilton, Boston bureau

Smaller is better, at least in the electronics industry, and Solid State Technology Inc. is driving the point home with its Athena Dt/C 8200 desktop computer [Electronics, Feb. 1, 1979, p. 35]. The neatly packaged unit, which can act as a stand-alone terminal or as part of a large system, was designed for easy adaptability.

“Our aim was to develop a product that isn’t limited to a specific marketplace and won’t dead-end quickly,” says Harry J. Grossman, vice president for research and engineering. “The Dt/C 8200 can be redefined and reconfigured at the customer level; all the software implementations are contained in the operating system.”

The strength of the system is its modularity, according to Grossman. The basic hardware includes a processor module, a video controller and display modules, a keyboard module, a motherboard module, a power supply, and a printer module. The processor board is based on a 3-MHz 8085A microcomputer (the 5-MHz version is available as an option) and also contains 2 kilobytes of read/write random-access memory (RAM), 12 kilobytes of read-only memory (ROM), and 256 by 4 bits of RAM with battery backup configured as 128 8-bit registers. The processor board provides 12 levels of vectored interrupts, a programmable real-time clock, programmable baud-rate generators, a keyboard interface, and an asynchronous communications interface. “The system organization is similar to Intel’s Multibus,” explains Grossman.

At the heart of the videocontroller module is a Motorola 6845 video controller chip, which provides programmable display features, the capability of generating custom fonts, and light-pen support for a 12-inch cathode-ray-tube display. The 25-line-by-80-character screen format displays up to 160 different characters: 32 control symbols and 32 graphics symbols in addition to 96 ASCII characters. A buffer allows one page to be displayed while another is waiting. The keyboard module has a full ASCII typewriter keyboard as well as a 15-key numerical keypad, a 12-key editing pad, and 14 special-function keys—four of which are programmable to eight levels of nesting.

The motherboard has nine non-dedicated slots for logic modules. A triple-output unit, the power supply delivers +5 v and ±12 v. Finally, the five-by-seven-dot matrix printer has an 80-column format and will print 150 characters per second.

Decentralized. “We’ve totally off-loaded any input/output handling,” says Grossman, “providing the ability to reconfigure the system at will without burden to the user.” Key to this is the use of microprocessor-based controller boards, housed within the Dt/C 8200 shell, for all the peripherals. The printer, CRT display, keyboard, minicassettes, and miniflופpies can be built into a single unit.

Much of the flexibility of the system comes from the automatic system generation software (Auto-SysGen), which allows automatic adaptation to any hardware configuration when the user simply shuts down the system, adds the needed controller board and peripheral, and turns the power back on. All the software needed to support the added peripherals is already included in the operating system, according to Grossman.

In addition to the multitasking operating system and Auto-SysGen, the system’s standard software includes a text editor. Basic, Cobol, Pascal, APL, and Fortran are offered as options.

A basic Dt/C 8200 system includes a processor, a keyboard, a display with its controller, 64 kilobytes of RAM, a power supply, the operating system, text editing, and Auto-SysGen as well as a diagnostic package and sells for $2,850. Full-scale production is scheduled to begin in late May or early June, at which time the company expects to ship about 350 units a month.

Solid State Technology, 17 Wheeling Ave., Woburn, Mass. 01801. Phone Roger Trudeau at (617) 935-3910 [399]
Visualizing complex data has been so critical to scientists and engineers that for years their computers have borne the overhead of condensing reams of alphanumeric-riddled printouts into a few charts or graphs. Now, however, the market in the graphic processing of nontechnical data is showing a 26% annual compound growth rate. Some analysts predict commercial computer graphics may bring in nearly $2 billion by 1983.

Past obstacles included the computational drain on the central processing unit, as well as need for extra memory and special programming and software. To slash the work-load placed on a host computer, Ramtek Corp. has placed dual parallel processors on separate buses inside their modular RM-9400 graphics display system. Furthermore, they have designed a system whose speed and resolution allow designers better use of the 1,000-line, wideband color monitors that are currently available, according to Jon Fowler, director of 9400 systems marketing for the company.

Placed between a computer and a cathode-ray-tube monitor, the RM-9400 accepts graphics data and instructions from the host, converts the generalized graphics coordinates (called “world coordinates”) into screen-specific coordinates, maps them into refresh memory, and scans the memory to form analog signals for the CRT monitor. Even where images are moved or rotated, or the screen’s picture is shifted left, right, up, or down, the intensive computations required to maintain coordinate integrity are performed by the RM-9400 instead of the host.

Data flows back and forth between host computer and graphics system via the display processor’s bus and a hardware computer interface subsystem. The 8-bit (Z80) microprocessor-based display processor (DP) interprets the host’s instructions, performs coordinate transformations, and passes processed data on to a memory control processor (MCP) based on a 16-bit bipolar microprocessor. The MCP performs high speed mathematical routines when needed and writes the image data into the refresh modules, which are composed of 16-k dynamic metal-oxide-semiconductor random-access memory chips.

The MCP then directs a video generator’s scan sequence and initiates conversion of the digital codes into analog color monitor signals. Some monitors can handle picture element signal times of 17 ns. Fowler says, and to squeeze maximum performance out of them takes digital-to-analog converters that can perform a conversion in 6 to 7 ns. The 8-bit d-a modules in the 9400 are rated 10 ns, which means they keep the monitor busy but allow room for future improvement.

Flexible. The system’s modular design lets it be tailored to specific applications. In a command and control system, for example, flicker-free appearance is important and requires refresh rates of 60 Hz. At that rate, a RM-9400 system with a resolution of 1,280 picture elements (pixels) per line by 512 lines can be configured. For computer-aided design systems, flicker is secondary to the need for higher resolution, Fowler explains. For these applications, Ramtek offers system setups with resolution of up to 1,280 pixels per line by 1,024 lines, but with refresh rates of 30 Hz.

“A typical system like the RM-9400/80 costs between $50,000 and $100,000 depending on the number of refresh memory planes and monitors serviced and on the computer interface,” Fowler says. The hardware computer interface is between $1,500 to $2,500 for most minicomputers, but an IBM-compatible module costs $5,000. A single refresh memory plane for the RM-9400/80 (for black and white) sells for $2,970, and a full 16-plane assembly (1-K by 1-K by 16 bit) shoots the price up to $37,520.

Ramtek offers three versions of the video generator system module. One, the RM-9400-V1, drives up to four color monitors, provides hardware “blink” (selective blinking of screen images), and mixes up to four cursors with any of its 12 output channels. Fowler sees this version as best suited for general-purpose color graphics. The V2 version drives only one color monitor but has a 2,048-by-13-bit video lookup table programmable for 4,096 colors at any of 2,048 input intensities. This version is tailored to image processing. A third generator, the V8 version, drives up to two color monitors and has a pair of 256-by-8-bit video lookup tables. This one is geared to command and control applications such as pilot flight simulation systems, according to Fowler. The RM-9400 is now in production and first units are being shipped.

Ramtek Corp., 585 North Mary Ave., Sunnyvale, Calif. 94086. Phone (408) 735-8400 [338]

New products

Video system unburdens host

Graphic display unit uses dual processors with dual buses to format data, do number crunching, and set up memory

by Robert Brownstein, San Francisco regional bureau

Electronics/March 15, 1979
And rugged quiet types too.

Take your pick of unique snap-action, snapless, industrial limit switches, and more.

Our line includes a wide range of both snappy and quiet ideas for your tough switching jobs. For example, take our subminiature Type 16 snap-action switch. It's only one of Licon's many small, rugged switches offering our unique Form Z double break switching. This means that two isolated circuits can be controlled simultaneously with one single pole Licon switch.

Double break switching offers other advantages, too. Twice the arc breaking and current interrupting ability. Better heat dissipation. Longer switch life. Improved resistance to shock and vibration. Superior wiping action. "Big Switch" ratings up to 20 Amps. It's why our small basics offer greater control, reliability and electrical ratings over most subminiatures.

We have other small things to talk about, too. Our Type 18 double break snap-action switches are sub-subminiature—ideal for your applications where space is at a premium. And subminiature snap-action switches are also an integral part of Licon's popular lighted pushbutton switches.

If you want a quiet switch, try our Type 17 basic snapless switch. Its non-snap action fits applications requiring minimum audible circuit transfer noise. And Type 17 provides the versatility of small size and the double control of double break switching. Recognized for its use in logic and low level switching applications along with the economy of non-gold contacts.

Licon switches meet a wide variety of uses, including computers, office machines, instrumentation, industrial controls, materials handling and transportation equipment. We offer an extensive variety of actuators and switch sizes. Amp versions to 20 Amps; up to 480 VAC and 125 VDC ratings.

For full details on all our switching ideas, contact your local Licon Salesman or Distributor, or call or write for literature: Licon, 6615 West Irving Park Road, Chicago, Illinois 60634. Phone (312) 282-4040. TWX: 910-221-0275.
It's no coincidence that Murata-Georgia provides unexcelled customer service nationwide

When a reputation as the fastest growing capacitor manufacturer in the U.S. is added to Murata-Georgia's already well known name for quality ceramic disc, monolithic and high voltage capacitors, it has to be backed by quality customer service. That's why we have named over 40 local manufacturer's representatives and distributors to provide Murata product service throughout the nation.

Murata-Georgia's Marietta office now has one of the most sophisticated data processing systems in the industry—we can tell you exactly what capacitors are on our shelf or where your capacitor order is and when it will be shipped on a minute-by-minute basis.

If you need high quality, competitively priced ceramic capacitors of any kind, give us a call and we'll let you sample our service.

Coincidence? No way. We've planned it that way.

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
**New products**

**Bit-slice mini boasts lower price**

Computer serves multiple users with floating-point processing and allows them to alter microcoding by plugging in their own PROMs

by William F. Arnold, San Francisco regional bureau manager

Although speedy bit-slice parts have been designed into some minicomputers, enabling them to emulate mainframes, the bit-slice approach to higher performance has not yet become popular for lower-priced systems. But the debut later this month of a multituser 16-bit minicomputer—one built with bit-slice power and priced with microcomputer savvy—should change all that.

Called the HEX-29, the bipolar minicomputer takes full advantage of microcoded bit-slice technology, according to Michael Simmons, head of Hex, a small Carmel Valley, Calif., design group. Consequently, the computer comes packed with a host of features, including floating-point processing and multituser time-sharing, at a reasonable price.

The systems will actually be manufactured and marketed by Digital Microsystems Inc. John Torode, president of the company, says that the basic minicomputer will come with cathode-ray display, 96 kilobytes of random-access memory, two floppy-disk drives, four serial input/output ports, and power supply. Housed in a 14-by-17½-by-20-in. cabinet, it will sell for a price just under $15,000.

The HEX-29 has a basic machine cycle time of 160 ns and a register-to-register cycle time of 320 ns, Simmons says. Pipeline instruction fetching also aids fast processing. Moreover, many instructions can be executed in as few as two machine cycles, he says.

Simmons and his team wanted to optimize HEX-29 for the complex numeric and string processing encountered by high-level language compilers and interpreters. To do so, they could "not emulate, not build yesterday's architecture," Simmons says. Rather, they had to design "a real new architecture from the bottom up."

Based on Advanced Micro Devices' 2901 bit-slice parts, the HEX-29's 64-bit-wide microinstructions are stored in programmable read-only memory, so a user can easily incorporate new machine-level instructions and complex routines by adding PROMs.

The architecture uses an extensive register set of 16 definable general-purpose registers, 16 memory management registers, and numerous special-purpose registers, including an extended-function condition register and an interrupt status and control register. The HEX-29 can handle a complete set of data formats from bit operations up to quad word and variable field operations. It also boasts a sophisticated interrupt structure with up to 256 interrupt levels under program control.

Hex and Digital Microsystems are eyeing potential sales to manufacturers of small business computers, educational systems, research laboratory and medical instrumentation—almost any system that can take advantage of the HEX-29's speed and features. Simmons points out that HEX comes with a great deal of system support. On the software side, its Timeshare operating system and macro-assembler will be followed by Super Basic, Fortran 77, and a Pascal compiler. In hardware, the programmable channel controllers for floppy disks and video graphics will be followed by ones for hard disks, magnetic tapes, and serial communications. And although the basic system has four I/O ports, it can handle up to 16 users and can plug into 1 megabyte of memory.

Digital Microsystems Inc., 4448 Piedmont Ave., Oakland, Calif. 94611 [340]

Key boards. Clockwise from top right: CPU, memory, disk controller, and program store.
New products international

60-mW display offers two rows of 16 characters

HITACHI DOT MATRIX LIQUID CRYSTAL DISPLAY DEVICE H2516. ELECTRON TUBE DISPLAY

HITACHI MATRIX LC DISPLAY H2518

Actual size
Eye-catching and fast-acting, Hitachi’s dot-matrix, liquid-crystal display devices are ready to dispense programmed information in an amazingly effective manner for an amazingly low cost.

They’re versatile enough to be used for anything from POP and POS displays to microcomputer, measurement equipment and small-size terminal applications.

The key to their performance is Hitachi’s special liquid crystal, featuring fast response, neutral color, high-contrast ratio, wide viewing angle, and temperature-compensating circuitry to allow continuous operation from a chilly 0° to a humid 50°C.

What’s more, power consumption is ultralow—a mere 60 to 100 mW, depending on the model.

So if you want to get your message across in a dynamic, exciting manner, check out Hitachi’s ultrasmart LCDs.

For more information, write to our head office or to the office nearest you.

### SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model No.</th>
<th>H2515</th>
<th>H2516</th>
<th>H2518</th>
<th>H2519</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characters x Line</td>
<td>40 x 1</td>
<td>40 x 2</td>
<td>16 x 2</td>
<td>16 x 1</td>
</tr>
<tr>
<td>Module Dimensions (w x h x d (max.) mm)</td>
<td>240 x 53 x 23</td>
<td>240 x 53 x 23</td>
<td>160 x 38 x 23</td>
<td>160 x 75 x 12</td>
</tr>
<tr>
<td>Power Supply (V)</td>
<td>(V_{dd}-V_{ss}) + 5±0.25 (V_{ee}-V_{ss}) - 5±0.5</td>
<td>(V_{dd}-V_{ss}) + 5±0.25 (V_{ee}-V_{ss}) - 7±0.7</td>
<td>(V_{dd}-V_{ss}) + 5±0.25 (V_{ee}-V_{ss}) - 5±0.5</td>
<td>(V_{dd}-V_{ss}) + 5±0.25 (V_{ee}-V_{ss}) - 5±0.5</td>
</tr>
<tr>
<td>Power Consumption (mW max.)</td>
<td>100</td>
<td>100</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

### FEATURES

- Excellent readability and high contrast ratio of twisted nematic display
- Alphanumeric display with 5 x 7 dot-matrix characters (with cursor in models H2515, H2516 and H2519)
- Character dimensions: 3.1 w x 4.4 h mm
- Easy to interface — only 8 connector pins
- C-MOS or TTL compatible
- Small-size, lightweight module
- Low operating voltage
- Ultralow power drain (60 to 100 mW) — portable and suitable for battery-driven operation
New products

Power supplies

Power-One gets into switchers

Linear-supply maker’s first switcher is a 5-V/40-A unit that sells for $250

To break into the highly competitive switching power-supply market, a manufacturer has to offer something special. In the case of Power-One Inc., a leading maker of linear supplies, the something special is a combination of the best of the various special features offered by its competitors.

“We looked at literally all our competitors and picked out what works,” says Steven Cole, vice president for marketing at the privately held firm. Individually, the features to which he refers are not uncommon, but taken together, he believes, they are indeed special.

The company’s first switcher is a 200-W single-output unit, the model SK5-40/OVP. Its payoff specification, as with any other switcher, is its efficiency. The basis upon which this is quoted is intentionally different from the ones used by competitors, states Cole.

“Efficiency is 70% minimum at full load over the entire ac input-voltage range,” he states. “This is a more realistic specification for a user,” he asserts, adding, “we can achieve efficiency numbers up in the 80s just like anybody else.” The ac input-voltage range is 90 to 130 V ac or 180 to 260 V ac at 47 to 63 Hz.

One truly unusual aspect of the new supply is its switching frequency—28 kHz. Most other supplies operate between 18 and 22 kHz, which Power-One engineers felt was less than optimum. They believe that they have maximized efficiency and eliminated the possibility of acoustical noise by going to 28 kHz. A major manufacturer of switchers, however, believes that the increased frequency is merely the result of the “usual design tradeoffs, and neither better nor worse than what we and others do.”

Among the more common features and specifications that Cole mentions is the SK5-40/OVP’s regulation to within 0.1% both over the full input-voltage range and for loads from no load to full load. He also
The Pick ‘N’ Choose Relay
972 variations of a 12 amp miracle from your Guardian Angel

PICK Series 1510 AC or 1515 DC.

PICK .187" or .205" quick connect/solder lug, or PC termination.

PICK push-to-test button versions.

PICK heat and shock resistant polycarbonate dust cover or open style (without cover).

PICK voltages from 6 to 240VAC, 6 to 110VDC.

PICK the 1510 that’s ideal for your application—and get it directly from Guardian... or from your Guardian Distributor.

Choose SPDT, DPDT or 3PDT.

Choose bracket, stud, stud-on-end or tapped core mount.

Choose indicator lamp versions.

Choose sockets with solder lug, .187" QC, PC or screw terminals.

Choose contact materials from silver-cadmium-oxide to tungsten and gold alloy silver and silver alloys for special applications.

Your Guardian Angel has a free technical application bulletin waiting for you. Send for your Series 1510 data today.
Notes its maximum transient deviation of 5% due to a sudden load change and its transient recovery time of 150 μs to within 1% of the nominal output voltage.

Cole singles out the supply’s direct-drive circuitry, which eliminates the base-drive transformers found in many other switchers, for special mention. Not only does the circuitry provide more positive control of the switching power transistors, he says, but it also improves line-noise rejection. According to Cole, it effectively regulates the voltage-second product applied to the power transformer, providing a form of preregulation. As a result, he says, “you can even plug in a soldering iron next to the supply and nothing will show up on the scope attached to the supply output.”

Other key specifications include 2,500-v-rms input-to-output isolation, input-to-chassis isolation of 1,500 V rms, and output-to-chassis isolation of 500 V dc. The unit has isolated terminals for remote on-off control of the dc output, with 5 mA required to cause shutdown. For further protection, the supply has a power-failure signal flag and current limiting to 105% to 125% of rated current. If a short occurs, the current is automatically reduced to 25% of rated current after 1 second.

The supply will deliver its full output from 0° to 50°C and can be derated for operation up to 70°C. It measures 4.88 in. high by 2 in. wide by 13 in. long for a total of 127 in³. In quantities of one to nine, the unit sells for $250; a 20% discount applies for lots of 100 or more. High-volume deliveries are planned to begin in early summer.

Power-One Inc., Power One Drive, Camarillo, Calif. 93010. Phone (805) 484-2806 [381]

DIP-packaged batteries last longer at 50°C

Designed as a power source for such applications as memory backup and single-chip microcomputers, the Goldtop DataSentry is a rechargeable nickel-cadmium battery that comes in a dual in-line package for direct wiring to a board. Unlike other such batteries with 50°C ratings, the Goldtop DataSentry is rated for up to 70°C. At 50°C, it will have an application life three times that of comparable units, according to the manufacturer.

The batteries have a capacity...
Before you choose a converter, be sure you get the facts you need.

DDD puts your data converter needs in perspective.

Matching the correct converter to your data conversion requirements isn’t always a simple matter. You need to look beyond speed and accuracy, to consider the full operating temperature range, all your environmental parameters, reliability, and size constraints. In short, the converter you buy should meet all your performance and quality requirements.

When you call DDC, you’ll get the answers you need to make a proper selection, and more. We’ll perform a complete analysis of your data conversion requirements. Prior to purchase, we match precisely a converter to your requirements.

Finally, DDC employs the industry’s highest quality disciplines, and insures that every converter delivered conforms in every detail to your design, fabrication and test specifications. To get all the information you’ll need to make an intelligent, cost-effective choice, call a DDC applications engineer, or write for a free copy of “Up-Front Facts About Data Converter Selection.”
Eliminate errors in your computer or instrument system with Deltec’s Super Isolation Transformer

Deltec DT series isolation transformers drastically reduce memory and transmission errors caused by transient noise on commercial power lines. Common Mode Rejection is 140dB and interwinding capacitance is less than 1 femtofarad (0.001 pf). Stock models are available from 250 VA to 5 KVA 1 Ø and 15 KVA 3 Ø, 50/60 Hz. For detailed specifications write or call Deltec.

UL LISTING PENDING.

High-voltage modules power photomultiplier tubes

The series PMT-10A and -20A, for powering photomultiplier tubes, provide outputs of 0 to 1,000 v dc at 4 ma and 0 to 2,000 v dc at 2 ma, respectively. Locally adjustable as well as remotely programmable, the output exhibits ripple of less than 2 mv peak to peak and is stable for the short term to within 0.005% of full scale.

The modules can operate from a variety of dc input voltages and may be ordered in versions that provide positive or negative voltages. They are protected against short circuits and arcing.

Available from stock, the units are priced at $185 in single quantities.

Stable voltage reference comes in single-cell version

A low-end addition to a series of voltage reference standards introduced last fall [Electronics, Oct. 26, 1978, p. 236], the model VTS 101-SC is a single-cell source. Like its
New improved 4K static RAMs: As low as 275 mW. As fast as 150 ns. Get 'em now. From Texas Instruments.

Just call your TI distributor. For TI's easy to use, economical family of 4K static RAMs. Which now includes higher performance versions. And the new, low power TMS 40L44 and TMS 40L45.

Low power match for microprocessors

Maximum power dissipations for the new low power RAMs range from 275 mW to 330 mW (operating). Access times from 200 ns to 450 ns.

Static design eliminates clocks, timing strobes, and refresh circuits.

These new high-density RAMs offer design flexibility—featuring both 4K by 1 and 1K by 4 organizations. They require only a ±5 volt power supply with a wide ±10% tolerance.

Improved standard RAMs

TI's standard 4K static RAMs are as fast as 150 ns. And power has been reduced to as low as 440 mW max.

All TI 4K static RAMs offer:

• Improved output drive: 1 mA high state; 3.2 mA low state.
• Improved input noise tolerance: −1 volt minimum.
• Improved address hold time: 0 ns minimum.

For 4K Static RAMs fast, make that call to your TI distributor now. Or for more information, write Texas Instruments Incorporated, P.O. Box 1443, M/S 669, Houston, Texas 77001.

<table>
<thead>
<tr>
<th>TI 4K Statics — Ready To Go</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Access Time</td>
<td>4K x 1</td>
</tr>
<tr>
<td>150 ns</td>
<td>TMS4044-15</td>
</tr>
<tr>
<td>250 ns</td>
<td>TMS40L44-20</td>
</tr>
<tr>
<td>400 ns</td>
<td>TMS4044-25</td>
</tr>
<tr>
<td>500 ns</td>
<td>TMS4044-45</td>
</tr>
</tbody>
</table>
Instant Access to All American and International

Data Communications Standards

1133 pages
Edited by Harold C. Foils,
Data Communications Standards Consultant
and
Harry R. Karp,
Editor-in-Chief
Data Communications Magazine

Presents all 89 relevant 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 Standards Committee (FTSC)

Plus... descriptions of the standards groups
And... relational charts of interfacing standards

Order today using this coupon!

Return coupon to:
Data Communications Standards
PO. Box 669
Hightstown, New Jersey 08520

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 $9.65 for each copy, plus applicable sales tax, shipping and handling charges.

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 #

Name ____________________________
Title ______________________________
Company __________________________
Address ___________________________
City __________________ State ______ Zip ______

This order subject to acceptance by McGraw-Hill

New products

multiple-cell relatives, the solid-state unit uses a 6.3-V zener diode that is stable to within 2 parts per million per year and has a typical short-term drift of 0.2 ppm/hr. The zener diode's voltage drop is accessible through terminals on the front panel, as is a 10.0-V output derived from it. The latter is stable to within better than 10 ppm/yr, with a typical drift of 0.5 ppm/hr.

The VTS 101-SC is priced at $1,695. Delivery takes 16 weeks.

Standard Reference Labs Inc., Pollitt Drive South, Fair Lawn, N.J. 07410. Phone John Haigren at (201) 797-3907 [385]

Triple-output supplies work at 50 Hz without derating

Providing full-rated output over the ambient range from 0° to 65°C, the MP series of triple-output supplies consists of six models. Users can choose outputs of ±12 or ±15 V and 5-V outputs at 3, 6, or 12 A, and all models operate from 115 or 230 V ac at 50 to 60 Hz with no derating for 50 Hz operation.

The units have a maximum output ripple of 1 mV rms, line and load regulation of 0.05% and 0.1% of nominal output, respectively, and efficiencies of 45%. Dual outputs track to within 0.05% of absolute value and all outputs are adjustable over a ±5% range by externally accessible potentiometers. In single quantities, prices range from $128 to $244 depending on output needed, and the delivery time is from one to four weeks.

Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021. Phone Gene Murphy at (617) 828-8000 [388]
THE WIDEBAND RMS VOLTMETER
ONLY FLUKE COULD CREATE.

You're probably accustomed to using analog meters for audio-to-rf measurements. Maybe you've given up hope of going digital at a reasonable price.

**Good news!**

Fluke's new 8920A wideband true rms DMM is loaded with features—some you can't buy anywhere at any price, and it sells at an analog price: $995!

For starters, 8920A bandwidth is 10 Hz to 20 MHz for sub-audio to video AC measurements. Mid-band accuracy is 0.5%, compliments of an exclusive Fluke designed (and built) micro-electronic rms chip. Accurately measuring noise and non-sinusoidal waveforms is easy since the chip responds only to the heating effect of the waveform. You can select the AC + DC function for non-symmetrical waveforms like pulses that have a DC component.

We gave the 8920A dynamic range from 180 µV to 700 volts, to measure from low noise levels to the output of powerful amplifiers. And, fast auto-ranging relieves you of the knob twisting chores!

Put the 8920A into dBV mode and measure from −75db to +57db (132db range), with 0.01db resolution. If you want your dBV reference somewhere else beside 1V, Fluke's exclusive relative reference lets you store any voltage as the 0-db point. Imagine how simple your gain measurements can be!

To make the 8920A all things to all people, we've included a “dial-an-ohm” feature for dbm measurements. Instead of laboriously correcting each of your readings from a 600 ohm reference, simply dial 50, 75, 300, or one of nine other impedances up to 1200 ohms, and be right on every reading. There are several selections for broadcast, telephone, TV and RF applications.

An analog meter is standard, for convenient peaking/dipping/nulling, as is a linear analog output for continuous recording. Optional are logarithmic analog output and an isolated output to drive a counter. Soon, IEEE 488 interface will be available for systems use.

If your prefer an isolated banana jack input with full floating capability, specify the 8921A (also only $995).

**U.S. Price**

For more information, contact one of the more than 100 Fluke offices or representatives, worldwide. In the U.S., CALL (602) 426-0361*, TOLL FREE. Residents of the U.S. and all countries outside of 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.

Price U.S. only.

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

FLUKE

Circle 153 for Literature
Circle 251 for Demonstration
Loch Katrine in the Trossachs — where Glasgow draws much of its exceptionally pure water

Glasgow's unique industrial resource — unfailing supplies of the purest water in Europe

The lochs which ring the city do much more than make Glasgow an attractive centre for the tourist. They make it an attractive base for industries that need pure and abundant water.

From these lochs comes the purest piped water in Europe — and some of the purest in the world. Certainly the purest in any major conurbation.

And the supply never fails. Even in the U.K. droughts of 1976, industry in Glasgow could still use water without restriction.

Inexpensive water

There is another reason why Glasgow is so attractive to industries heavily dependent on fresh water. Because Glasgow's water is so available, so close at hand, it is inexpensive water.

There is yet a third reason, too. In Glasgow, there is no charge for disposal of industrial effluents. That, in itself, can make a big difference to costs in many industries.

So if your processes need pure water, get in touch. We'll help fill in the facts and figures for you. And we'll show you the other resources Glasgow offers industry.

Room for you

First and foremost, Glasgow has room for new industry. Nearly five million square feet of factory space, in units to suit any size of company, are immediately available. And there are over 500 acres of industrial building land, offering sites of five acres up.

So you won't be cramped for space. Nor will you be isolated in some remote industrial estate. All these sites are well inside the city — making it easy to recruit and keep staff.

Glasgow's other resources

Glasgow has other resources, too. A well-educated workforce, traditionally orientated towards sophisticated industrial processes. The service and sub-contracting resources of a major industrial centre — tool-making, packaging, printing, maintenance. Excellent links to the rest of the U.K., and to foreign markets, by road, rail, sea and air. And the leisure facilities of a great city, surrounded by some of the finest countryside in the world.

But, for the full story, contact D. S. Logan, Industrial Development Officer, City of Glasgow District Council, Sun Life House, 116 West Regent Street, Glasgow G2 2RW. Telephone 041-332 9700.
NOW FROM MACRODATA
THE NEW M-1
The Industry's First 25-MHz Memory Test System

From the company that was first to introduce 10-MHz LSI test systems comes the industry's first all-new 25-MHz memory tester – the Macrodata M-1.

With the advent of high-speed MOS Static RAM's and 16K/64K Dynamic RAM's with complex timing requirements, the need for a new high-speed memory tester is obvious and urgent. Looking ahead, Macrodata foresaw that need and developed its new 25-MHz M-1 Memory Test System.

But there's more to the new M-1 than just speed. Here is a brief run-down of some of the outstanding features:

**True 25-MHz Device Testing Speed**
- tests 4K (and larger) fast Static MOS RAM's up to 25-MHz (40 nanosecond period) speeds
- tests 16K and 64K Dynamic MOS RAM's up to 20-MHz (50 nanosecond period) speeds with full split-cycle timing
- tests both bipolar and ECL RAM's at speeds up to 25-MHz

**Unique Device Interface**
- special hybrid comparator packaging allows measurement and error processing at end of cable
- small lightweight test head provides easy interface to commercial probers and handlers

**Full Computer Control**
- full stand-alone software capability based upon DEC LSI-11 system, providing program generation, datalog, shmoo plot, edit, bin summaries, etc.
- standard video terminal plus hard-copy print-out

**System Timing Accuracy**
- skew specification guaranteed over 20% to 80% of waveforms, not restricted to a single midpoint measurement
- fully automatic software calibration without the use of pots – many times faster than any other system

**Designed for Reliability**
- efficiently designed with advanced IC technology to reduce hardware complexity and parts count
- design rule of 10 watts per double board maximum allowable power dissipation to eliminate heat problems
- maintenance by card replacement with guaranteed interchangeability to eliminate pots and minimize downtime

**Cost Advantages**
- provides the highest performance per dollar investment, resulting in the “lowest-cost-per-hertz” in the industry
- single rack console minimizes floor space
- simplicity of design maximizes system utilization

**Get the Facts**
The new Macrodata M-1 is not only the industry's fastest memory tester, but it is the precursor of a whole new generation of test systems. For more information on this advanced new system, send for a copy of the M-1 brochure or call us directly. Also ask about Macrodata's complete family of memory board and other LSI device testers.

MACRODATA
A CUTLER-HAMMER COMPANY

Macrodata Corporation, P.O. Box 1900, Woodland Hills, California 91365, Phone: (213) 887-5550, Telex: 69-8489

Circle 155 on reader service card
New products

Computers & peripherals
4-pen plotter sells for $16-k

Three microprocessors allow intelligent unit to plot at 15 inches per second

I Corp.’s chief designer, Victor Kley, did not set out to design a plotter when he went looking for one to hook up with his company’s line of low-cost computer-aided design systems [Electronics, Nov. 23, 1978, p. 196]. He found, however, that available plotters were either too slow or too costly. So he solved the problem by taking a bare-bones plotter and designing a three-microprocessor front end to make it fast, flexible, and very competitive on a price/performance basis.

Compared with a competitor’s one-pen 2-inch-per-second plotter that sells for $12,500, Kley feels I Corp.’s four-pen 15-in./s model 3700 at $16,000 is a real breakthrough. Made to complement I Corp.’s equipment, it nevertheless interfaces easily with any IEEE-488- or RS-232-C-compatible terminal or computer. “It will hook up to Tektronix’ 4051, HP’s 9835 and 9845, and DEC’s LSI/11 and PDP/11 and makes these systems faster than with any other plotter now available,” he claims.

Inside the 3700 are three 3870 8-bit microprocessors: one is a master chip that orchestrates the 3700’s hardware arithmetic section, another processes X-axis data, and the third handles Y-axis information. With intelligence built in, the plotter relieves its attached system’s processor of data-intensive arithmetic tasks each time a drawing is zoomed (scaled up or down), for example.

“That is what really slows a system down,” states Kley. “A line-intersect equation needs to be solved for all the points every time a drawing is partitioned, causing throughput to sag. Now a user can load the plotter with raw data and let the machine do the calculations.”

Instead of using vector approximations for curved sections as do many plotter systems, the 3700 has an integral curve-generation routine that produces smooth curves with much less data than the vector-approximation technique requires, according to Kley. Users have, in addition to the built-in printing character set, provisions for creating virtually any other symbols by downloading patterns to the plotter and configuring the 225 (15-by-15 stroke character points, he adds.

When manipulating a variety of pens and drawing media, users need dynamic control of pen velocity, and the 3700 provides for such control via software. Page sizes can be
TEKTRONIX thinks your logic analyzer should be as versatile as you are

So ours let you see analog and digital displays at the same time.

Digital troubleshooting usually involves two steps: First, logic analysis to find where the problem is located. Then analog measurement to pinpoint the source. Tektronix 7000-Series Plug-Ins give you both steps. Presented together on the same display: a complete picture of the analog/digital relationship.

Many Tektronix 7000-Series Mainframes allow the 7D01 Logic Analyzer plus vertical amplifier and time base plug-ins to all be housed in a single mainframe. The same configuration gives you full analog and digital capability.

First, locate a logic problem with the 7D01's timing display and retain it on the screen through memory. Next, make the analog measurement and put it up on the same display. Both sides of the problem are now revealed in a single image.

Simultaneous analog/digital display: it helps make our Logic Analyzer versatile. So you can do today's job and tomorrow's. So you can change applications without changing your logic analyzer.

Contact Tektronix Inc., P.O. Box 500, Beaverton, OR 97077. In Europe, Tektronix Ltd., P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.

Verify logic and analog relationships at a glance

TEKTRONIX LOGIC ANALYZERS THE VERSATILE ONES

For Technology Data circle #157 on Reader Service Card
For Demonstration circle #252 on Reader Service Card
For immediate action dial our toll free automatic answering service 1-800-547-1512
MEASURE ANY ELECTRICAL LOAD

simultaneous amps/volts/watts readout
with display hold
fast · easy · precise

Even an inexperienced operator can set this instrument up—simple line plug-in, two simple input and output connections, pin connectors supplied.

Nonblinking four-digit readouts with automatic location of decimal points.

Pushbutton range selection with protection from overload or incorrect selection.

Illuminated pushbutton display hold for three-function manual recording at a glance.

Portable all-in-one unit—only 15" wide, goes anywhere, needs no hard wiring.

Here is a rugged, versatile instrument that easily and accurately performs countless test and analysis operations on anything that uses electrical power: motors, transformers, appliances, resistance units, even light bulbs.

By simultaneously displaying amps, volts, and watts, it does the work of three conventional power-measuring units; and with its easy-to-read digits and pushbutton display it minimizes chances for operator error—almost anyone can handle its simple setup and equally simple operation.

True RMS readouts, high surge capability; no need for burden compensation or other correction, many other advanced features. Ranges 0-50 amps, 0-600 volts, 0, 30,000 watts. Typical accuracy better than ±1 percent. Analog and digital outputs optionally available. The unit can also be used as a secondary standard for testing other instruments.

Request information today.

70 GARDENVILLE PARKWAY WEST BUFFALO, NEW YORK 14224 716-668-5555

Circle 158 on reader service card

New products

varied up to a maximum of 34 by 150 inches, with folding wings provided for working on sheet material. Users can continuously vary pen pressure and the plotter's carriage has an ink reservoir for use with technical pens on Mylar, Kley points out. Delivery time for the new plotter is 30 days.

I Corp., 735 Addison St., Berkeley, Calif. 94710. Phone (415) 848-6600 [361]

Microcomputer opens door to minicomputer systems

Most computer manufacturers add to the low end of their lines so that potential users can gain entry to the family at less cost, but Texas Instruments has done so with added flair. Additions to the DS990 series of minicomputers, models 1 and 2 let users enter the minicomputer world through a microcomputer portal.

A multiuser system, the model 2 is based on a new single-board microcomputer, the 990/5, that contains the central processing unit, 64 kilobytes of random-access memory, and input/output ports. Available in either a desktop housing or a 30-in.-high cabinet, the model 2 offers such choices as a video display or printer terminal as a work station and two to four double-sided double-diskette drives.

The model 2's system software includes the 990 assembly language as well as TX Basic, an enhanced version of ANSI-standard Basic for business applications. TX Basic runs under the TX5 operating system, which is completely file-compatible with the TX10 system used on larger DS990 systems.

Software for the model 1, a single-user desktop system based on the TMS 9900 16-bit microprocessor, also includes TX Basic operating under the TX5 system, as well as Terminal Programming Language, or TPL. The latter runs under the TPL operating system used on 700 series distributed-processing systems, and thus the model 1 forms a bridge between those systems and the DS990 series. The model 1's main

The magazine you're reading now, could be your own.

Drop off the routing list. Get your own fresh, unclipped copy mailed to your home or office. Turn to the subscription card in the back of the magazine. If somebody has beat you to it, write: Electronics, P.O. Box 430, Hightstown, N.J. 08520.
This switch doesn’t need an umbrella

If your product must work outdoors this sealed Cherry switch will work!

We built an umbrella around a switch ... by putting our subminiature snap-action switch inside a sturdy housing and injection molding epoxy plastic that encapsulates the switch and leads to seal out dirt and moisture.

It’s watertight and weatherproof. Making it the ideal switch for use in autos, trucks, boats, snowmobiles, power mowers, outdoor vending machines ... just about any product subjected to extreme weather, dust, dirt, grease, grime or spray.

The watertight, weatherproof “inside switch” is our reliable E62 subminiature, proven over more than a decade in millions of demanding applications. In this new sealed switch design, its stainless steel coil spring mechanism and reliable rock-wipe contact action are protected by a double enclosure plus a rubber boot on the actuator. So that when it rains ... it works!

TEST A FREE SAMPLE OF THIS NEW SEALED SWITCH. Just PHONE (312) 689-7700 or TWX (910) 235-1572, or write on your letterhead.

CHERRY ELECTRICAL PRODUCTS CORP.
3608 Sunset Avenue, Waukegan, Illinois 60085

SWITCHES and KEYBOARDS — Available locally from authorized distributors.
Our New Spectrum Analyzer MS62C/D does only what it's told.

Some spectrum analyzers give you a pretty picture of their own noise and internally generated spurious signals. Not ours. With a dynamic range of 70 dB and noise of less than 

\[-122 \text{ dBm}, \] 

our new MS62C and MS62D come pretty close to showing you only what you put in to it. Even with a 

\[-30 \text{ dBm input signal, spurious components are kept to} \] 

\[-100 \text{ dBm or less. A wide frequency range from 50 Hz all the way to 1.7 GHz means this is one spectrum analyzer you can use for a wide range of applications: base band, video, radio, or mobile. Controls have been simplified for quick pushbutton operation, and overall size and weight have been reduced for ease in carrying. Operate on a.c., d.c., or battery power. MS62C comes with long persistence-type CRT (P7 phosphor), while MS62D comes with a storage-type (P31 phosphor) display screen.} \]
Want to test the long life, high output of these GE optoelectronic devices?

Try one. Free.

The best way to test the high reliability and performance in General Electric's full line of optoelectronic components is to try one—ask, and we'll send one free.

What do you need—Interrupter Modules? Choose from 30 types, including new H21/22 modules, available in transistor and darlington models. They're compatible with popular logic systems and operate at higher speeds because of an optimized light path through a 1mm aperture. Couplers? GE offers 81 types, with the highest available CTR... interchangeable with all popular types. Emitters? Beam-on axis, radiant intensity guaranteed for accuracy. Detectors? Available with transistor and darlington outputs at low cost.

Every GE optoelectronic component gives you better value. All GE infrared emitting diodes (IREDs) are processed with premium liquid epitaxial material for optimized reliability and performance. This process, commercially pioneered by GE, has been refined over 15 years for the best characteristics available. Results: high light output, high efficiency, minimum degradation, long life.

For optoelectronic components, come to the source—General Electric.

We optimized the infrared emitting diode, introduced the first commercially successful opto SCR, and offer you industry's broadest line. For a free sample and copy of our 190-pg. Optoelectronics manual, contact your nearest authorized GE distributor, or write General Electric Co., Box 44A, West Genesee Street, Auburn, N.Y. 13021.

In Europe, contact International General Electric of New York, Dundalk, Ireland, (042) 32371, telex: 33816.

There's more to GE semiconductors than meets the eye

GENERAL ELECTRIC
The Indicator
With a Memory

New!
The P35 panel mount memorizing indicator from Ferranti-Packard.

The P35 features:
• Long life (100 million operations minimum)
• Excellent visibility (light reflecting disc)
• Choice of 5 fluorescent disc colors
• Enclosed housing
• Simple mounting

A 1 millisecond, 250 mA current pulse sets or resets the disc, status is retained indefinitely by remanent magnetism.

Uses include:
Transient recorders, Industrial process displays, Contact status indicators, Field equipment.

Discover how you can use the P35 indicator—Fill out the reader service card or write direct today.

When clear displays count, specify:

Ferranti-Packard Limited
Electronics Division
8030 Ambler Drive
Mississauga, Ontario
Canada L4W 2P1
Telephone: (416) 624-3020
Telex: 06-961437

Network family interfaces with variety of hosts

Another contender has entered the networking arena: Raytheon Data Systems Co., Norwood, Mass., is now offering a five-member family of upgradable single and multiple processor configurations—Raynet—which can interface with a variety of major host machines. As David B. Levi, executive vice president points out, “our computers live in networks and we want networks that are easier to use.”

The family consists of line concentrators (Raynet I, II, and III), message switchers (Raynet IV), and network nodes (Raynet V). Raynet I is an RDS-500 minicomputer-based network that allows 60 terminal lines to be added without adding host hardware. The Raynet I also allows mixed line speeds of up to 9,600 bits per second.

New products

record deletion and modification, screen formatting, and menu selection. With Symple, source code has a standard internal format that eases integration and maintenance of programs by making them appear as though they were all coded by the same programmer.

For NM4 Fortran IV compiler: Naked Mini Division, Computer Automation Inc., 18651 Von Karman, Irvine, Calif. 92713 [368]
The newest member of the Neff System 620 family, the Series 500 Measurement and Control I/O System provides a single, computer-controlled interface for various types of I/O signals commonly used in measurement and control applications. It accepts contact closures, TTL or other voltage levels, frequency inputs and low-level analog voltages. Its outputs include contact closures, voltage levels and analog. In addition, the Series 500 provides the interface to the controlling computer and a serial data link to remote systems.

The Series 500 includes a 4K RAM in which the computer can store scan lists, instructions and control words to operate peripheral devices. Data is returned to the computer over a single DMA channel. Completely integrated and cabled standard interfaces are available for most computers and software drivers are available for most popular operating systems.

Configuring the system for any combination of I/O signals is a simple matter. It’s done with plug-in function cards selected for the types of signals to be handled - up to 16 function cards per assembly, expandable to 256 function cards per site. Series 500 supports any of the Neff 620 systems for low-level analog data acquisition.

Let us show you how the Series 500 can simplify the instrumentation of your measurement/control application.
FOR REGULATORY LASER COMPLIANCE*

UDT's Model 60 is designed specifically for precise regulatory measurement of class 1, 2 and 3 CW HeNe lasers to Bureau of Radiological Health standards. This compact, rechargeable, NiCad battery-operated power meter provides rapid, precise measurement of HeNe lasers in the field, on production lines or whenever a direct reading or go/no go meter is needed.


- Calibration accuracy ±5% traceable to NBS
- 1% reading accuracy

UNITED DETECTOR TECHNOLOGY, INC.
2644 30th Street, Santa Monica, California 90405 (213) 450-8585 Telex: 65-2413

Circle 164 on reader service card

From Electronics Magazine Book Series.
Zero-risk trial offer.

New Product Trends in Electronics, Number One
From "New Products," state-of-the-art materials and equipment arranged according to function. $14.95 per copy

Name__________________________ Title__________________________
Company________________________
Street__________________________
City__________________________ State____ Zip____

Electronics Book Series
P.O. Box 689, Hightstown, N.J. 08520

Send me ______ copies of “New Product Trends in Electronics, Number One” at $14.95 per copy.

Discount of 40% on orders of 10 or more copies.
I must be fully satisfied or you will refund full payment if the book is returned after ten-day trial examination.

☐ Payment enclosed ☐ Bill firm ☐ Bill me
Charge to my credit card:
☐ American Express ☐ Diners Club
☐ Visa ☐ Master Charge

A/C No.________________________ Date exp.________

On Master Charge only, first numbers above name.

See us at the Paris Composants Electroniques '79 in the U.S. Pavilion.

New products

per second and an application-dependent throughput rate of 50 to 60 messages per second.

Raynet II is also an RDS-500 based system with all the features of the Raynet I, but also offers a choice of line disciplines and allows communications with up to eight different hosts from a single terminal, using automatic protocol conversion for "host transparency" in mixed-protocol environments. Raynet III, RDS-500 based as well, differs from the II system in that it will support multiple protocols. This will allow the user to integrate systems with multiple communications line disciplines. Raynet currently supports Binary Synchronous, Synchronous Data Link Control, Univac U-100, and Pars airline industry protocols.

The next upgrade step in the family is Raynet IV, which has up to one billion bytes of local disk storage for store-and-forward message switching. Raynet V, as the largest configuration in the group, functions as a network processor, with the capabilities of Raynet III and IV, plus data switching between nodes for distributed mainframes and virtual terminals. Up to five Raynet Vs can be strung together within a single network.

Immediate applications for Raynet I include airline reservation/ticket services or for users with IBM 3270s. These applications would hold for the Raynet II systems, which also include users with remote-job-entry functions. Raynet III users would have multihost access requirements, while Raynet IV users would also have teletype networks. Raynet V would be used for large corporations in need of switching networks. All Raynet systems can be expanded with additional peripherals. Raytheon Data Systems' communications operating system is standard for all configurations.

A single Raynet I with CRT display/keyboard and software will sell for about $60,000. Deliveries will begin in March.

Raytheon Data Systems Co., 1415 Boston-Providence Turnpike, Norwood, Mass. 02062. Phone (617) 762-6000 [362]
The inside story of Cambion cage jack superiority.

The inside story is a simple one.

Three beryllium copper spring surfaces in Cambion's unique "cage" insure superior contact redundancy. The cage is captivated to insure proper insertion/extraction forces and long life (up to 50,000 cycles of use).

Use cage jacks to mount components and for function switching. They facilitate plug-ability of fuses, crystals, relays, A/D converters, oscillators, trimmers, what-have-you. No soldering, unsoldering. When you want to change components, snap 'em out of cages, and snap in replacements. Quick. Saves costly service, downtime. As switches, when mated with Cambion jumpers, they have extraordinary life, are easy to handle, and position is always evident.

The simple story has a very happy ending. Cambion cage jacks and mating jumpers and plugs come in a wide range of sizes from .014 to .080" for almost any component lead size. They are priced right. You can get fast delivery. Order Cambion cage jacks from 54 Cambion distributor locations across the country, or directly.

That's the story. You can have a FREE technical brochure for all the details, with engineering specs you'll appreciate. Send for it. Cambridge Thermionic Corporation, 445 Concord Avenue, Cambridge, MA 02138.
Best by test after test.

You're doubly sure of quality with twice tested Buss® fuses.

This small dimension glass tube fuse may look good to you. And to us. But looks aren't enough at Bussmann.

That's why Bussmann quality control involves more than a quick visual inspection. Or testing a random sample from our production line.

Instead, Bussmann tests every one of these fuses twice. Once for resistance, to measure electrical performance. Then again for dimensions, to make sure the length and diameter are right.

Few manufacturers test each and every small dimension glass tube fuse they make. Even fewer test each fuse both physically and electronically.

Our tougher testing assures that the Buss fuses you buy will perform exactly the way you want them to. When you want them to.

It also explains why Buss fuse quality is in a class by itself.

Bussmann Manufacturing Division
McGraw-Edison Company
P.O. Box 14460
St. Louis, Missouri 63178

McGRAW-EDISON
Bussmann. The Protection Experts.
Conrac's variety show won't win an Emmy. But OEM's think it's great just the same. Where else could they find such a variety of reliable color and monochrome CRT monitors to meet their system needs? Screen sizes range from a compact 9" to a dramatic 25". Resolution capabilities go up to 4,500,000 individual picture elements. Rack, cabinet, or even ceiling mount options are offered. Models are available for every signal input: NTSC, PAL, SECAM and separate signals for RGB. Also composite, non-composite or external syncing pulses. Whether your requirement is for simple alphanumeric or complex graphics and computer-generated imagery, you can depend on Conrac's experience and depth of technology. And since Conrac monitors are made in the U.S., we're always here to supply first-hand technical assistance and parts.

Call or write for more information today. We'll also send you a "tv guide" for OEM's — the Conrac CRT Monitor Guide.

Conrac Division, Conrac Corporation, 600 North Rimsdale Ave., Covina, CA 91722, Tel. (213) 966-3511 Telex 67-0437.

Conrac's variety show won't win an Emmy. But OEM's think it's great just the same. Where else could they find such a variety of reliable color and monochrome CRT monitors to meet their system needs? Screen sizes range from a compact 9" to a dramatic 25". Resolution capabilities go up to 4,500,000 individual picture elements. Rack, cabinet, or even ceiling mount options are offered. Models are available for every signal input: NTSC, PAL, SECAM and separate signals for RGB. Also composite, non-composite or external syncing pulses. Whether your requirement is for simple alphanumeric or complex graphics and computer-generated imagery, you can depend on Conrac's experience and depth of technology. And since Conrac monitors are made in the U.S., we're always here to supply first-hand technical assistance and parts.

Call or write for more information today. We'll also send you a "tv guide" for OEM's — the Conrac CRT Monitor Guide.

Conrac Division, Conrac Corporation, 600 North Rimsdale Ave., Covina, CA 91722, Tel. (213) 966-3511 Telex 67-0437.

Variety show.
Incredible, but true!

10 Watts
1 to 1000 MHz

ULTRA-WIDEBAND AMPLIFIER

Amplifier Research again leads the way with its new Model 10W1000, an ultra-wideband amplifier that delivers 10 watts of linear power from 1 to 1000 MHz—more power and bandwidth than any other amplifier of its kind. In fact, as the "next generation" in ultra-wideband amplifiers, Model 10W1000 offers you 2 1/2 times the power of its predecessor, the Model 4W1000.

Versatile and unconditionally stable, this high-performance amplifier can be used with frequency synthesizers or swept signal sources to provide high-level outputs for RFI susceptibility testing, NMR spectroscopy, antenna and component testing, general lab applications, and other uses.

For complete information on our 10W1000 and other W Series amplifiers, write or call:

Amplifier Research
160 School House Road
Souderton, PA 18964
Phone: 215-723-8181
TWX 510-661-6094

New products

Instruments

Hand-held meter reads true rms

One of a 3 1/2-digit series, it, too, measures to 10 A, checks continuity

Beckman Instruments has entered the 3 1/2-digit, hand-held multimeter market with a series of three meters that offer several features never before found in instruments of their type. Further, the top-of-the-line unit, the RMS 3030, earns its letters by being the only true rms meter of this type available today.

The $130 model 3010, the $170 model 3020, and the $190 RMS 3030 all can measure ac and dc current up to 10 A. All three feature a continuity test indicator and a semiconductor test function. Powered by a 9-V battery of the type used in portable radios, each unit can operate for up to 2,000 hr. Should it fail to operate properly, even because of mistreatment, it can be returned to the factory for free repair or replacement under a one-year "no-fault" warranty.

All models measure across the same ranges: five dc voltage ranges, from 200 mV to 1,500 V full scale; five ac voltage ranges spanning 200 mV to 1,000 V full scale; five ac and dc current ranges, 200 µA to 2 A full scale (a separate input extends the range to 10 A); and six resistance ranges with full-scale values from 200 Ω to 2 MΩ.

The low-power resistance ranges permit users to make in-circuit resistance measurements without turning on semiconductors, which would affect those measurements. To verify the operation of a semiconductor junction, the units provide a 5-mA test-current range. In all resistance ranges, the instruments provide a quick continuity check by flashing the Greek letter omega in the upper left portion of the display.

Both the model 3010 and the 3020 provide ac voltage measurements of signals with frequencies of up to 10 kHz, and they have input impedances of 22 MΩ. The 3010 is accurate to within 0.25% of reading + 1 digit on all dc voltage ranges and the 3020 is accurate to within 0.1% + 1 digit.

The RMS 3030, which has the same dc voltage accuracy as the 3020, makes true-rms measurements of both ac voltage and current for accurate measurement of nonsinusoidal waveforms. All ac voltage ranges have guaranteed accuracy specified out to 20 kHz for signals with crest factors (peak value...
Our new 64K ROM packs an on-time guarantee:

We'll deliver 64K, 32K or 16K ROMs in 8 weeks — or you'll get 100 parts free.

Everybody promises on-time delivery. Only Signetics guarantees it. In writing.
That means you'll get the first 100 pieces of our new 64K high-density MOS ROMs within eight weeks. After your written code verification, of course. If we slip delivery, you'll get 100 additional devices free. No questions asked.

Same offer goes for our industry standard 16K and 32K static ROMs.
We'll deliver those as promised. Or we'll add 100 free to your order for 1000 parts or more.
Signetics has a strong commitment to high-density ROMs. And we've packed that into our new 64K part. Higher circuit density means fewer parts to meet storage requirements.
That translates to cost savings in assembly time and board space.
Our 64K ROM is also a snap to interface. And it's available in 16K X 4 as well as 8K X 8. Since it's static, no clocking is needed. Couple that with ROM codes that work the first time out, and you'll cut the time lag from design to working hardware.

Compare the features of our 64K with other ROMs on the market. You'll see why it should be your first choice for design-ins.
And then try to find another supplier who'll guarantee delivery. You won't.
While we're meeting your ROM delivery schedule, Signetics will even program your mask codes free. That goes for every 16K, 32K, and 64K ROM on orders of 1000 up.

Whatever your design objectives are, Signetics will help you meet them. On time.
To get your on-time ROM guarantee certificate and technical literature, call us today on Signetics special ROMLINE: (408) 746-1756.
Or if another supplier has tied you up your phone making delivery promises he won't keep, send us the coupon below.

Signetics
a subsidiary of U.S. Philips Corporation

Signetics Corporation
P.O. Box 9052
811 East Arques Avenue
Sunnyvale, California 94086
Telephone 408/739-7700

Memories On Schedule

To: Signetics Information Services, 811 East Arques Ave
P.O. Box 9052, Sunnyvale, CA 94086

☐ Please send me complete details on miniMOS-4™
static ROMs and guarantee certificate.

Name ____________________________ Title ____________________________
Company ____________________________ Division ____________________________
Address ____________________________ MS ____________________________
City ____________________________ State __________ Zip ____________________________

☐ I'm tired of promises other suppliers won't back up. Please have a MOS Memory specialist phone me today at:

( ) ____________________________
For the best performance from your CRT display terminals — specify Thordarson. Thordarson is the leader in the design and development of CRT high voltage transformers and deflection yokes. Products that are unsurpassed in construction, safety and reliability. All designed to meet your physical and electrical requirements.

Whether your needs are large or small, we want to discuss your CRT applications with you. Our R&D facility is devoted to prototype custom products. Samples can be produced fast. Let us help make your display terminals function better and last longer. Send us your specifications today.

THORDARSON MEISSNER, INC.
Electronic Center
Mt. Carmel, Illinois 62863
(618) 262-5121
In Canada—GTE Sylvania Canada Corporation

Circle 170 on reader service card

New products

divided by rms value) of up to 3:1 at full scale.

The three instruments' inputs are protected against overload conditions that result from the measurement of unknown signals or from operator error. Voltage ranges are protected from inputs in excess of 1,500 V dc or 1,000 V rms ac. Resistance ranges are protected to 300 V dc or rms ac. The current inputs are protected with a 2-A fuse. (A replacement fuse is included inside each instrument case.) The 10-A range is rated for 20 A for 30 s.

The multimeters' liquid-crystal display and complementary-metal-oxide-semiconductor custom-designed integrated circuitry minimize battery drain. A single 9-V battery provides up to 2,000 hours of continuous instrument usage. During the final 200 hours of battery life, a decimal point blinks on the display to warn the user to change the battery.

Calibration of the instruments requires only one adjustment on the 3010 and 3020—four on the RMS 3030—and is guaranteed for a full year. Each instrument is shipped with a battery, a spare fuse, test leads, and an operator's manual.

Accessories for the multimeters include two carrying cases, a radio-frequency probe for voltage measurements up to frequencies of 200 MHz, a current clamp for measurements up to 200 A, and a deluxe test-lead kit with test leads and 10 screw-in probe tips.

Advanced Electro-Products Division, Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634 [401]

Variable filter offers choice of four attenuation slopes

An extremely versatile filter, the model 3750 not only offers low-pass, high-pass, band-pass, and band-reject modes, it also offers a choice of four attenuation slopes: 6, 12, 18, and 24 dB per octave. The filter, which is tunable over the range from 0.02 Hz to 20 kHz, has a Butterworth response and a switch-selecta-
Meet Super Grip II, the great new test clip from A P Products.

New narrow-nose design makes it easy to attach on high-density boards. And now you can test ICs with only .040" between opposing legs.

New "duck bill" contacts are flat, won't roll off IC leads.

Open-nose construction enables probe at IC leg.

Pin rows are offset for easy attachment of probes.

Contacts are gold-plated phosphor bronze. "Contact comb" construction separates contacts with precision. No shorts.

Heavy-duty, industrial-grade springs for firm contact pressure—and a good grip when pulling ICs. They'll keep their spring indefinitely. No intermittents.

Steel pivot pin. Engineering-grade thermoplastic body molded around contact pins. Made to last.

New button-head pins keep probes from sliding off. (Straight pin models for logical connections.)

The new A P Super Grip II is, without question, the best way there is to troubleshoot DIP ICs.

You get positive contacts. No intermittents. No shorts. Ever.

So it's endlessly useful to you—and it's built to stay useful indefinitely. Try one. Your local A P distributor has 8, 14, 16, 18 LSI, 18, 20, 22, 24, 28, 36 and 40-pin models. (Be sure it's the A P distributor.) Need the number? Phone (toll-free) 800-321-9668. And ask for our complete A P catalog, The Faster and Easier Book.

Faster and Easier is what we're all about.
DPM’S that light up your life... and for less.

Now, an AC Line Powered DPM with:
- Bright, 0.6 in. high efficiency LED’s
- Differential inputs
- NEMA case interchangeability
- LSI reliability
- Low cost BCD output option

Bright Meters For Less!

Gralex Industries
Division Of General Microwave Corporation

Model 38-2

155 Marine St
Farmingdale, N.Y. 11735
Tel 516-694-3607
TWX 510-224-6406

Now, an AC Line Powered DPM with:
- Bright, 0.6 in. high efficiency LED’s
- Differential inputs
- NEMA case interchangeability
- LSI reliability
- Low cost BCD output option

Bright Meters For Less!

Gralex Industries
Division Of General Microwave Corporation

Model 38-2

155 Marine St
Farmingdale, N.Y. 11735
Tel 516-694-3607
TWX 510-224-6406

New products

Module lets HP1611A analyze almost any microprocessor

Hewlett-Packard's model 1611A logic-state analyzer for microprocessor-based systems is a plug-in system that requires different personality modules for different microprocessors. The company's latest such module, the 10264A, differs from its predecessors in that it is flexible enough to monitor activity on virtually any microprocessor, albeit with certain limitations. For example, the general-purpose module can display code lists in octal or hexadecimal, but not in mnemonic code, because the mnemonic code is different for each microprocessor. When the 10264A is plugged into the
Harris shatters the Op Amp speed barrier:

The first true Op Amp with performance compatible with high-speed Data Acquisition and Display systems.

Harris sets a new benchmark for high-speed amplifiers.

The Harris HA-5190 wideband, fast-settling Op Amps provide the high-speed performance of costly hybrids—with the economy of monolithic bipolar construction.

Result: The industry's highest performing true Op Amps for as little as $8.60 (100-up).

You get the advantages of Harris' unique Dielectric Isolation technology—6.5 MHz full power bandwidth, ±200 V/µs slew rate and settling time of 70 ns (0.1%, 5 V output step). Plus excellent input characteristics of 5 mV offset voltage and 15 nV/√Hz input voltage noise at 1 kHz, and the facility of inverting and non-inverting mode operation.

Now you have an economical, true Op Amp to match the performance of high-speed DACs. The natural choice for data acquisition, pulse and wideband video amplifiers, avionic and military equipment, and a variety of graphic displays.

For fast facts, check the specs below ... then call the Harris Hot Line. Or write: Harris Semiconductor Products Division, Box 883, Melbourne, Florida 32901.

HARRIS HOT LINE! 1-800-528-6050, Ext. 455

HARRIS SEMICONDUCTOR PRODUCTS DIVISION
A DIVISION OF HARRIS CORPORATION

PERFORMANCE PARAMETERS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PNL OFFSET VOLTAGE</td>
<td>5 mV</td>
</tr>
<tr>
<td>BIAS CURRENT</td>
<td>5 µA</td>
</tr>
<tr>
<td>FULL POWER BANDWIDTH</td>
<td>65 MHz</td>
</tr>
<tr>
<td>RISE TIME</td>
<td>11 ns</td>
</tr>
<tr>
<td>SLEW RATE</td>
<td>±200 V/µs</td>
</tr>
<tr>
<td>SETTLING TIME</td>
<td>5 V to 0.1%: 70 ns, 5 V to 0.01%: 120 ns</td>
</tr>
<tr>
<td>POWER DISSIPATION</td>
<td>600 mW</td>
</tr>
</tbody>
</table>

Harris Technology ... Your Competitive Edge
1611A, therefore, the latter's mnemonic key is disabled.

With a display up to 36 bits wide, the user can watch activity on several buses simultaneously, for both 8- and 16-bit microprocessors. Seven clocks allow multiplexed data on common bus structures to be latched into the 1611A as necessary for proper display. Each half of a multiplexed 16-bit address bus and a 16-bit data bus can be clocked into the 1611A separately, allowing an additional 4-bit bus to be interrogated by a different clock at a different time.

A model 1611A analyzer with the general-purpose module installed sells for $6,000; the model 10264A plug-in is priced at $2,000. Deliveries are beginning this month.

Hewlett-Packard Co., 1507 Page Mill Rd., Palo Alto, Calif. 94304 [404]

20-MHz portable scope is priced at $950

The model LBO-308 dual-trace oscilloscope is a portable instrument with a bandwidth of 20 MHz, a sensitivity of 2 mV per division, and a price tag of $950. Designed for field and laboratory applications, the scope may be powered by the ac line, by a dc power supply, or by an optional rechargeable battery pack. Its 3-inch screen is divided into an 8-by-10-division grid. Two probes with switches for direct or 10× operation are included with the scope. A carrying case is optional.

Leader Instrument Corp., 151 Dupont St., Plainview, N.Y. 11803. Phone George W. Zachmann at (516) 822-9300 [406]

Substitution box provides resistance and capacitance

The model RCS-500 digital resistance-capacitance substitution box uses one set of side-by-side thumb-wheel switches for setting the desired resistance value and another, similar set of switches for selecting the desired capacitance. This permits
THE SUCCESS OF OUR MODEL NINETY-SIX GOES TO OUR HEADS.

Quite frankly, a tape system's performance depends on the quality of its heads. And that's why Honeywell developed the advanced technology needed to produce the heads for the Model Ninety Six.

They are made of solid ferrite, a material so long-wearing that we warrant the heads for 3000 hours of operation. These heads also have such uniform gap azimuth, and such minimal gap scatter, that they can be counted on to produce stable, solid data whatever your record or reproduce application.

But the Model Ninety-Six offers more than the long-lasting ferrite heads. Its adjustment-free tape path features a highly efficient combination of vacuum-column isolation, dynamic inertial damping and high-performance capstan servo that keeps skew, flutter, and TBE to absolute minimums.

So if you need a system that offers consistent, gentle tape handling, up to 28 data channels, and a variety of tape widths and recording formats, call Ed Haines at (303) 771-4700. He will be happy to give you a no-nonsense explanation of the features and options of the Model Ninety-Six.

Or write for technical data sheets on the Model Ninety-Six and a free illustrated brochure that describes all of Honeywell's magnetic tape systems, oscillographic recorders and signal conditioning modules. Honeywell Test Instruments Division, Box 5227, Denver, CO 80217.

WE'LL SHOW YOU A BETTER WAY.

Honeywell

Circle 175 on reader service card
You know Hamlin reed switches
Now get to know
Hamlin reed relays.

Hamlin has long been Number One in reed switches. Now make Hamlin your Number One choice for PCB and dual in-line packaged reed relays.

Hamlin reed relays are hermetically sealed in epoxy with a choice of Form A, B or C contacts; diode or electrostatic shielding optional. These are available as dry reed or mercury-wetted, no-bounce operation. One mercury model permits operation in any position — a Hamlin first!

All Hamlin reed relays can be driven directly with TTL and CMOS logic and provide total isolation between input and output circuits. The epoxy encapsulation provides high vibration and shock immunity and gives total protection to the coil and contacts in hazardous environments.

For more information, write or call:
Hamlin, Inc.
Lake & Grove Streets
Lake Mills, WI 53551
Phone: 414/648-2361
TWX 910/260-3740

New products

the user to choose any resistance from 1 to 9,999,999 Ω in 1-Ω increments and a capacitance value between 100 pF and 99,999 µF in 100-pF increments.

The selected resistance and capacitance may be used independently, in series, or in parallel. All of the resistors are 1% devices with a power rating of 0.5 W. The capacitors are 100-V units with tolerances of 4%.

The 14.5-oz box measures 4.72 by 3.16 by 2.17 inches and sells for $185.95. Delivery is from stock.

IET Labs Inc., 761 Old Country Rd., Westbury, N.Y. 11590. Phone S. Sheena at (516) 334-6959 (405)

Portable gauss/fluxmeter takes wide range of probes

A portable 3%-digit gaussmeter and fluxmeter, the model 906 measures flux density in two ranges, 1 and 10 kilogauss full scale, using any of nine different Hall-effect probes. It also has two magnetic-flux ranges, 10⁻² and 10⁻¹ Maxwell turns, over which inputs from four standard search coils or custom probes are integrated and displayed.

The instrument has an internal reference magnet of 600 G ±2%. When used as a gaussmeter, its readings are accurate to within ±(0.4% of full scale + error of reference magnet) ±1 digit for static fields and ±3% for dynamic fields to 10 kHz. Used as fluxmeters, they are accurate to within ±(0.4% of full scale + 0.5% of reading) ±1 digit.

The 906 provides a maximum analog control output of 0.5 V dc and costs $665 without probe.

RFL Industries Inc., Instrumentation Division, Boonton, N.J. 07005 (407)
Litronix is turning out LED lamps by the millions in four different colors. Six different sizes. Nine different arrays. And we're continuing to develop innovative products like our flashing lamps and lamps that maintain a constant brightness over a 4.5 to 16 volt range.

Our super brights include a powerful green lamp which puts out a dazzling 20 millicandellas.

And our broad product line comes in all popular sizes, from general purpose T13/4 down to lamps of one millimeter. See the sampling below.

Whether you need 100 lamps or 100,000, we're the high volume producer who can get you product fast. Our huge distributor network is everywhere.

Write for samples on your letterhead. And light up with Litronix, 19000 Homestead Road, Cupertino, CA 95014. (415) 257-7910.

<table>
<thead>
<tr>
<th>Part Number (Series)</th>
<th>Color</th>
<th>Package Size &amp; Description</th>
<th>Minimum Light Output MCD</th>
<th>Output mA</th>
</tr>
</thead>
<tbody>
<tr>
<td>LD52 Red T1%</td>
<td></td>
<td>High Brightness</td>
<td>1.2 to 15</td>
<td>10</td>
</tr>
<tr>
<td>FRL4403 Red T1%</td>
<td></td>
<td>Flashing</td>
<td>.5</td>
<td>20</td>
</tr>
<tr>
<td>RL4403 Red T1%</td>
<td></td>
<td>Wide Angle</td>
<td>.8</td>
<td>20</td>
</tr>
<tr>
<td>RL5054 Red T1%</td>
<td></td>
<td>Narrow Angle</td>
<td>.5 to 1.0</td>
<td>10</td>
</tr>
<tr>
<td>RLC200 Red T1%</td>
<td></td>
<td>Constant Current</td>
<td>0.4 to 0.8</td>
<td>10 to 20</td>
</tr>
<tr>
<td>LD32 Red T1</td>
<td></td>
<td>High Brightness</td>
<td>1.2 to 2.0</td>
<td>10</td>
</tr>
<tr>
<td>RL209 Red T1</td>
<td></td>
<td>75 mil lead spacing</td>
<td>.3 to 2.0</td>
<td>20</td>
</tr>
<tr>
<td>RL4480 Red T1</td>
<td></td>
<td>100 mil lead spacing</td>
<td>.3 to 2.0</td>
<td>20</td>
</tr>
<tr>
<td>RLC210 Red T1</td>
<td></td>
<td>Constant Current</td>
<td>0.1</td>
<td>10</td>
</tr>
<tr>
<td>RL50 Red Sub Min</td>
<td></td>
<td>Radial Lead</td>
<td>.3 to 2.0</td>
<td>20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part Number (Series)</th>
<th>Color</th>
<th>Package Size &amp; Description</th>
<th>Minimum Light Output MCD</th>
<th>Output mA</th>
</tr>
</thead>
<tbody>
<tr>
<td>LD56 Yellow T1%</td>
<td></td>
<td>High Brightness</td>
<td>1.6 to 10</td>
<td>10</td>
</tr>
<tr>
<td>YL4550 Yellow T1%</td>
<td></td>
<td>General Purpose</td>
<td>1.0</td>
<td>10</td>
</tr>
<tr>
<td>LD36 Yellow T1</td>
<td></td>
<td>High Brightness</td>
<td>1.6 to 2.0</td>
<td>10</td>
</tr>
<tr>
<td>YL212 Yellow T1</td>
<td></td>
<td>General Purpose</td>
<td>1.0</td>
<td>10</td>
</tr>
<tr>
<td>YL56 Yellow</td>
<td></td>
<td>Sub Min Radial Lead</td>
<td>2.0 (typical)</td>
<td>20</td>
</tr>
<tr>
<td>LD57 Green T1%</td>
<td></td>
<td>High Brightness</td>
<td>2.5 to 20</td>
<td>10 and 20</td>
</tr>
<tr>
<td>GL4950 Green T1%</td>
<td></td>
<td>General Purpose</td>
<td>1.0</td>
<td>20</td>
</tr>
<tr>
<td>LD37 Green T1</td>
<td></td>
<td>High Brightness</td>
<td>2.0 to 4.0</td>
<td>20</td>
</tr>
<tr>
<td>GL211 Green T1</td>
<td></td>
<td>General Purpose</td>
<td>.8</td>
<td>20</td>
</tr>
<tr>
<td>GL56 Green Sub Min</td>
<td></td>
<td>Radial Lead</td>
<td>1.0 (typical)</td>
<td>20</td>
</tr>
</tbody>
</table>
16 bits and then some... and Datawest packs it all together

DATAWEST will cut your data acquisition system and digital signal processing system cost by applying time proven techniques to your application. Putting together a successful analog-to-digital data acquisition system requires more than just a good A/D converter. Expertise is needed in signal conditioning, front end multiplexing and digital techniques. DATAWEST has been designing and manufacturing systems for sophisticated applications for over a decade. DATAWEST-designed systems, installed all over the world, are being used in a wide variety of applications including geophysical studies, vibration analysis, nuclear system monitoring and bio-medical research. DATAWEST supplies complete analog-to-digital data acquisition systems from input amplifier to computer interface, including the DATAWEST line of array processors. Field proven standard modules (plus custom interface circuits if needed) can be assembled to provide reliable, cost-effective systems to meet specific needs.

The 390 system offers high resolution and high speed utilizing the DATAWEST 16-bit, 150 kHz A/D converter.

Other DATAWEST products:
- Array Processors
- Channel Simulators for IBM 360/370
- Digital Audio Delay Systems
- 12, 15 and 16 bit A/D Converters
- 12, 15 and 16 bit D/A Converters
- Complete Scientific Signal Processing Systems

For information regarding DATAWEST products, contact David Long, Director of Technical Marketing
7333 East Helm Drive • Scottsdale, Arizona • (602) 948-3280
TWX 910-950-1289 DATAWEST SCOT
Manufacturers of computers and computer peripherals throughout the world use C&K switches. Producers and designers of test instrumentation, panel boards, word processing, and telecommunication equipment are switching our way too.

And here's why. Our line of mini, submini, and microminiature switches is literally hundreds of thousands of models long. Quality is incredibly high because we specialize exclusively in switches and have developed our own specialized engineering techniques. C&K switches are readily available, at highly competitive prices and with no minimum order requirements.

If you're not with us yet, start switching. Send for our complete new catalog and see for yourself. We give you more to switch about than anyone in the world.
Components

**V-I converters are accurate**

Modules convert voltages between 0 and +10 V into currents from 4 to 20 mA.

Voltage-to-current converter modules that can maintain tight accuracy specifications over a broad temperature range are hardly common. They're a little easier to come by now, however, with the introduction of two new ones by Analog Devices Inc. The converters—the nonisolated model 2B20 and the isolated model 2B22—are expected to find wide application in a variety of industrial areas.

“The 2B20 is completely self-contained,” notes Janusz S. Kobel, marketing manager for signal conditioner components. “No external components are needed for this nonisolated model.” Voltage inputs for the 2B20 may range from 0 to +10 V and will produce outputs between 4 and 20 mA. Nonlinearity, as a percentage of span, is ±0.2% for the 2B22, ±0.1% for the 2B22K, and 0.05% for the L. Settling time to within 0.1% of full scale for a 10-V step is 300 μs for all three devices. Nominal supply voltage is +15 V, although the units will work off voltages between +14 and +32 V.

The 2B22 will meet its specifications from 0° to 70°C, but it can be used with reduced accuracy from −25° to +75°C. The maximum offset error at 25°C is ±0.25% of span for the J and K versions and 0.1% of span for the L. The offset temperature coefficients for the three versions are: ±0.01%, 0.005%, and 0.0025% per °C for the J, K, and L, respectively.

The isolated units are housed in modules that measure 2.2 by 3 by 0.6 in. In hundreds, the prices are $59 (J), $74 (K), and $92 (L). Applications for both models include industrial instrumentation and process control, principally digital-to-analog conversion and data monitoring and logging. “The live zero (non-zero output for zero input) is especially useful to the process-control industry,” says Kobel. The
Now you can get your favorite programs in color.

Heeeeeeeerrrrresss Xerox!

With the new 6500 Color Graphics Printer. The first printer that can put full-color reproductions of computer generated graphics in your hands in seconds.

So now, for the first time, you can quickly get a permanent record in full color.

A permanent record to hand out after presentations, or as part of a report on an ongoing project.

Process industries, for example, can use the 6500 CGP for prints of process variables such as temperature, pressure, flow, valve settings and to record alarm conditions for analysis. It can help railroads keep track of their train routes. Graphics data processing centers can now print graphic data in color.

And when the 6500 CGP isn't working off a computer, it becomes a great way to make full-color copies from regular hard-copy originals. Or even 35mm slides.

So ask about the 6500 Color Graphics Printer.

It'll not only make your programs look better.

It'll do wonders for your ratings.

XEROX

Circle 181 on reader service card

XEROX® and 6500 CGP are trademarks of XEROX CORPORATION.
New products

isolated 2B22 can be used in current-to-current isolators, "where isolation from one loop to another is needed," he adds.

Both products are available from stock.

Analog Devices Inc., Route 1 Industrial Park, Norwood, Mass. 02062. Phone Janusz Kobel at (617) 329-4700 [341]

400-V/800-mA triac is controlled by less than 10 mA

A small, sensitive-gate triac, designed to be compatible with integrated logic circuits, requires less than 10 mA of input current to control its 800-mA rms output. The SC92 withstands 400 V, allowing it to control small motors, solenoids, lamps, and similar devices directly.

The triac is protected against nonrepetitive voltage transients by a breakover-triggered mechanism, which guarantees that if the triac is hit with a high-voltage transient, it will turn on and protect itself. Furthermore, its glass-passivated pellet enhances its blocking life while its gold eutectic mountdown provides virtual immunity to thermal fatigue.

The SC92 is priced in the vicinity of 30 cents. For detailed specifications, along with a free sample kit, write to George Sawchuck at the following address.

General Electric Co., West Genesee St., Auburn, N. Y. 13021 [342]

Keyboards withstand high-pressure selling

A series of sealed keyboards designed for severe environments, Thinswitches can withstand not only the rigors of military aircraft and industrial control applications but even the punishment inflicted on them in vending machines.

The high-reliability keypads come in three-by-four and four-by-four arrays as well as in custom configurations. They have been designed to meet the requirements of MIL-E-16400 and -5400, and can be

AO STEREOSTAR® Microscope. It has everything from A to Zoom.

ALL ESSENTIAL FEATURES FOR AN OUTSTANDING INDUSTRIAL MICROSCOPE

Auxiliary Lenses: .5x, 2x
Body Rotation: 360°
Eyepieces: 10x, 15x, 25x
Field Size Range (inches): .13-2.25
Magnification: Standard 7-30x; Range 3.5-150x
UL listed Illuminator
Working Distance: Standard, 4.0 inches; Range, 1.4-5.7 inches
Zoom Range: .7-3x; Zoom Control: Dual Side Mounted; Zoom Ratio: 4.3-1

These are all features you want and need for efficient assembly or inspection of microcomponents. The AO STEREOSTAR ZOOM Microscope was specifically designed for production-line applications. It's easy to use, with plenty of working distance plus coupled zoom control conveniently located on both sides. And traditional AO quality optics give very high resolution for crisp, sharp images. Send for a detailed brochure. American Optical, Scientific Instrument Division, Buffalo, NY 14215.
When you want the world’s most accurate multimeters... you want Data Precision multimeters.

The Model 935
the world’s most accurate hand-held 3½ digit portable $149.

The Model 3400
the world’s most accurate 4½ digit lab and systems multimeter $795.

The Model 7500
the world’s most accurate high speed 5½ digit systems multimeter $2995, base

For a demonstration or a copy of our comprehensive Digital Instrumentation catalog contact Data Precision Corporation, Electronics Avenue, Danvers, MA 01923, USA
Phone (617) 246-1600 Telex (0650) 921819

For Additional Information circle 183
For Demonstration circle 257

VISIT US AT ELECTRO, BOOTH 1814-16-18
The true Touch Screen has finally become a reality—no more light pens or cumbersome input devices, just touch the screen with a finger to access data.

Consisting of a glass screen and a separate controller board, the Touch Screen “Digitizer” can easily be incorporated in your terminal or CRT system during the manufacturing process. It provides a new dimension in man/machine interaction, and it provides your system with greater operational simplicity and flexibility.

As to special features—here are just a few!

- Operator uses a finger to select data directly on the display
- No operator training required
- Fewer operator errors—the operator’s eyes never leave the screen
- Extremely high stability, resolution, and reliability
- Screen matches the curvature of many CRT’s
- Eliminates the keyboard in many data retrieval applications

Touch base with us about improving the competitive edge of your terminal and CRT system. And why not also inquire about our extensive line of Display Monitors.

*Shaded area indicates location of electronics (covers removed). **Optional

** TSD DISPLAY PRODUCTS, INC.
Sales/Service
35 Orville Drive • Bohemia, New York 11716/Tel. 516-589-6652 • Telex 14-4659
Manufacturing
302 Legget Drive • Kanata, Ontario K2K 1Y5, Canada/Tel. 613-592-1774

College dollars need time to grow.

Take stock in America.
With higher paying U.S. Savings Bonds.

New products

purchased with or without plastic bubbles that provide tactile feedback. Each key has a rated life at load of 10^6 operations.

The switches are constructed with gold-plated beryllium copper contacts. A high-temperature transparent polyester laminate allows lights at the edge of the panel to illuminate the switch legends, which can be produced to the purchaser’s specifications by photographic means. The units work without springs, buttons, or other mechanical linkage and are only 0.13 in. thick.

Within an array, each single-pole, single-throw key provides momentary contact between a row and a column element when pushed. At 25°C, it has a contact rating of 50 mA at 28 V dc and maximum contact bounce duration is 5 ms.

A standard four-by-four array Thinswitch with tactile feedback costs $95 in lots of 100. Delivery of standard models takes four to six weeks.

Industrial Electronic Engineers Inc., 7740 Lemona Ave., Van Nuys, Calif. 91405. [343]

Light-emitting diodes shine brightly from pc boards

Available in red, green, or yellow, the 5300 series of light-emitting diodes have a high-intensity output.
NEC’s new series of silicon power transistors lets you tailor a power chain to suit your power output requirements. Maybe it’s a hand-held transceiver or land mobile radio. Whatever the application, you can count on up to 35 watts at the antenna, through 900 MHz.

Gain and reliability are extraordinary—the result of proprietary fabrication techniques.

Pricing is competitive and, better yet, they’re available. Contact California Eastern Labs, One Edwards Court, Burlingame, CA 94010. (415) 342-7744.

### NEC microwave semiconductors

<table>
<thead>
<tr>
<th>SERIES</th>
<th>TYPICAL APPLICATION</th>
<th>TYPICAL OPERATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vcc (V)</td>
<td>Pcc (Watts)</td>
</tr>
<tr>
<td>NE0202</td>
<td>2 watt device for a</td>
<td>7.2</td>
</tr>
<tr>
<td></td>
<td>hand-held transceiver or mobile radio</td>
<td>13.5</td>
</tr>
<tr>
<td>NE0203</td>
<td>3 watt driver for mobile radio</td>
<td>13.5</td>
</tr>
<tr>
<td>NE0206</td>
<td>6 watt device for a</td>
<td>7.2</td>
</tr>
<tr>
<td></td>
<td>hand-held transceiver</td>
<td>13.5</td>
</tr>
<tr>
<td>NE0207</td>
<td>7 watt device for a</td>
<td>7.2</td>
</tr>
<tr>
<td></td>
<td>hand-held transceiver</td>
<td>13.5</td>
</tr>
<tr>
<td>NE0210</td>
<td>8 watt device for a</td>
<td>13.5</td>
</tr>
<tr>
<td></td>
<td>mobile radio</td>
<td>13.5</td>
</tr>
<tr>
<td>NE0220</td>
<td>20 watt device for a</td>
<td>13.5</td>
</tr>
<tr>
<td></td>
<td>mobile radio</td>
<td>13.5</td>
</tr>
<tr>
<td>NE0235</td>
<td>35 watt device for a</td>
<td>13.5</td>
</tr>
<tr>
<td></td>
<td>mobile radio</td>
<td>13.5</td>
</tr>
<tr>
<td>NE0502</td>
<td>1 watt device for a</td>
<td>7.2</td>
</tr>
<tr>
<td></td>
<td>hand-held transceiver</td>
<td>7.2</td>
</tr>
<tr>
<td>NE0503</td>
<td>3 watt driver for NE0510</td>
<td>12.6</td>
</tr>
<tr>
<td>NE0504</td>
<td>4 watt device for a</td>
<td>7.2</td>
</tr>
<tr>
<td></td>
<td>hand-held transceiver</td>
<td>13.5</td>
</tr>
<tr>
<td>NE0510</td>
<td>9 watt device for a</td>
<td>12.6</td>
</tr>
<tr>
<td></td>
<td>mobile radio</td>
<td>12.6</td>
</tr>
<tr>
<td>NE0520</td>
<td>18 watt device for a</td>
<td>12.6</td>
</tr>
<tr>
<td></td>
<td>mobile radio</td>
<td>12.6</td>
</tr>
<tr>
<td>NE0801</td>
<td>1 watt driver for NE0804</td>
<td>13.5</td>
</tr>
<tr>
<td>NE0804</td>
<td>4 watt driver for NE0810</td>
<td>13.5</td>
</tr>
<tr>
<td>NE0810</td>
<td>10 watt device for a</td>
<td>13.5</td>
</tr>
<tr>
<td></td>
<td>mobile radio</td>
<td>13.5</td>
</tr>
</tbody>
</table>
If you look ahead: The only L-R-C decision.

The ESI Model 296 Automatic LRC Meter offers remarkable versatility and future flexibility through the logic power of a 6800 microprocessor. You get wide ranges (2F), % and units deviation readout, multiple limits and high speed. Plus the flexibility of dual displays for your choice of function combinations...C or L combined with D, Q, R, or G...in either deviation or in units. And options for future expansion: Calculator control, teletype terminal, parts handler interface, dc resistance measurement. Everything you need for today, a superb investment for tomorrow, at $4700 (U.S.A. only).

Electro Scientific Industries
13900 N.W. Science Park Drive
Portland, Oregon 97229
Phone: 503-641-4141

New products

Depending on color, the LEDs have a luminous intensity of 6 to 7.5 milli-candelas with a current of 20 mA.

The units can be mounted on circuit boards where they can act as pilot lights or illuminate back panels. A channel on the bottom of the housing permits flux cleaning solutions to circulate beneath them.

In quantities of 1,000, each unit costs 45¢. Delivery is from stock.

Industrial Devices Inc., 7 Hudson Ave., Edgewater, N.J. 07020. Phone (201) 224-4700

Digital delay line withstands harsh production processes

Designed to withstand manufacturing processes such as wave soldering and freon degreasing, the HY-5001 digital delay lines are housed in hermetically sealed, 14-pin, dual inline packages. Delay times can be selected in 20% increments by five taps, maximum values being 25 ns to 250 ns. Accuracy is to within ±5% of maximum delay time or ±2 ns, whichever is larger. In quantity, the HY-5001 sells for $14.80 and is available from stock.

Hytek Microsystems Inc., 16780 Lark Ave., Los Gatos, Calif. 95030. Phone Dick Fryoff at (408) 358-1991

Gas-discharge display looks bright 50 ft away

A seven-segment, six-digit gas-discharge display, the SP-491 has a brightness of 210 foot-lamberts. The neon-orange display is 0.7 in. high, can be read at distances up to 50 ft, and is visible at an angle of up to
Today's management techniques are not new to him.

Kieran Fitzpatrick has learned to work with cost control, quality control, flexible production schedules, and increased employee responsibility. Many international companies have shown that innovative management can be very successful in Northern Ireland. It works for Du Pont, Goodyear, ITT, for Grundig, Michelin, Telefunken—for firms of all sizes in a range of industries.

The Northern Ireland work force fits new methods into a manufacturing tradition as old as the industrial revolution. We combine innovation with positive attitudes toward company loyalty, productivity, and labor relations. We apply to the task skills from the basic to the sophisticated.

And to help put all this to work for you, we offer the best overall package of economic incentives in the EEC.

Find out how well we fit your business style. Get the facts from Reg Browne or George McLaren at the Northern Ireland Industrial Development Office in New York. They will 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. He's building a career in electronics at Grundig.

Northern Ireland works.
Electronics Magazine Books Offers You:

1. Microprocessors What you must know about available microprocessor technology, devices, information, 4th printing. $8.95

2. Applying Microprocessors 2nd and 3rd generation technology. 26 detailed applications from data networks to video games. $9.95

3. Large Scale Integration Covers the basic technology, new LSI devices, LSI testing procedures, plus system design and applications. $9.95

4. Basics of Data Communications Includes 47 articles from Data Communications magazine covering more than 11 key areas. $12.95

5. Circuits for Electronics Engineers Contains 306 circuits arranged by 51 functions from Amplifiers to Voltage Regulating Circuits. Saves design drudgery. $15.95

6. Design Techniques for Electronics Engineers Nearly 300 articles drawn from "Engineer's Notebook." A storehouse of design problem solutions. $15.95

7. Memory Design: Microcomputers to Mainframes The technology, devices, and applications that link memory components and system design. $12.95

8. Personal Computing: Hardware and Software Basics More than 50 articles from leading publications, including specifications, helpful hints, subject index. $11.95

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 1. Microprocessors @ $8.95
___ copies of 2. Applying Microprocessors @ $9.95
___ copies of 3. Large Scale Integration @ $9.95
___ copies of 4. Basics of Data Communications @ $12.95
___ copies of 5. Circuits for Electronics Engineers @ $15.95
___ copies of 6. Design Techniques for Electronics Engineers @ $15.95
___ copies of 7. Memory Design: Microcomputers to Mainframes @ $12.95
___ copies of 8. 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 __ VISA __ Master Charge

Acct. No. __________________ Date Exp. ______

On Master Charge only, first numbers above name

Name __________________________ Title __________________________

Company __________________________

Street __________________________

City __________________ State ______ Zip __________

Signature __________________________

130° even at that distance.

Designed for multiplexed operation, it is well suited for use in point-of-sale terminals. The SP-491 is priced at $13.80 in quantities of 1,000 and is deliverable from stock.

Display Systems Division, Beckman Instruments Inc., 350 N. Hayden Rd., Scottsdale, Ariz. 85257. Phone (602) 947-8371 [347]

Photoelectric reader lamp beams with higher power

For photoelectric card and tape readers that require a higher-wattage light source, a T-2-1/2 model incandescent lamp has been added to the CM8 Thin-Line series. The 3/4-in. diameter lamp contains a 4-in.-long filament that radiates 3.16 \text{ watt} \text{ at} 12 \text{ V}.

Like other members of the CM8 series, the 10,000-hr lamp is con-
your ultra precision resistors will also be ultra stable if you profit from our advanced technology

our unique NiCROCE® processes* give you extra advantages

* Worldwide Patents

CHIP TECHNOLOGY, METAL FOIL ON ALUMINA SUBSTRATE
TOLERANCES: up to ± 0.005 %
TYPICAL TEMPERATURE COEFFICIENT ± 1 ppm/°C between 0°C and +60°C
T.C. TRACKING AVAILABLE TO: 0.5 ppm/°C
STABILITY: 25 ppm/year or 50 ppm/3 years
CLIMATIC CATEGORY: – 55°C/+ 175°C/56 days

CONFORM TO MIL-R-55182/9 - CECC 40300 style RS 92 N
(RCK02 for sales in Europe)

RCK 02/RCK 02 A
Dimensions
8 x 7,5 x 2,5 mm
0,33 W at 125°C
2,5 Ω to 150 kΩ

RCK 04
Dimensions
10,5 x 15 x 3,5 mm
0,6 W at 125°C
5 Ω to 300 kΩ

RCK 05
Dimensions
10,5 x 22,6 x 3,5 mm
0,9 W at 125°C
7,5 Ω to 450 kΩ

MATCHED SETS AND CUSTOM NETWORKS

TRY US! our service is part of our success

* RESISTOR RESEARCH IS A WHOLLY-OWNED SUBSIDIARY OF SFERNICE

Circle 188 on reader service card
CEDAR RAPIDS — Rockwell International is anticipating another year of growth and new developments for its avionics and telecommunications businesses, according to sources in Cedar Rapids where Rockwell's Avionics and Missiles Group is headquartered. Rockwell's Collins Divisions have helped place the company among the largest electronic firms in the world. The company is now gearing up for development of the next generation of electronics products. Among the systems produced in Cedar Rapids are the Rockwell-Collins Pro Line and Micro Line avionics for general aviation aircraft, and a complete line of air transport avionics. Government avionics products and systems include the U.S. Air Force standard tactical air navigation system, and the complete avionics system for the new U.S. Coast Guard Medium Range Search Aircraft.

Rockwell-Collins digital flight control systems to guide new generation of commercial aircraft through the turn of the century.

CEDAR RAPIDS — A new multimillion-dollar contract awarded to Rockwell International's Collins Air Transport Division is expected to provide a baseline business for the Division through the turn of the century. The contract is for digital flight control systems to guide a new generation of commercial aircraft. It's the firm's largest single avionics project ever, surpassing even their work on the U.S. space program. The Division has immediate openings for additional engineers to help handle the increased work load.

General Aviations' new product introductions help provide continued market leadership.

CEDAR RAPIDS — The availability of exciting new technology, combined with healthy sales projections for general aviation aircraft, has helped stimulate a wave of new product introductions by Rockwell International's Collins General Aviation Division. Typical of the energetic product development efforts of the Division was the introduction this year of six new general avionics products. Among them: the first Rockwell-Collins Pro Line color weather radar and a Pro Line navigation processor which displays checklist and map information of the radar indicator; and the new Micro Line DCE-400 distance computing equipment which uses the bearing information from two VOR stations to compute distance and groundspeed. (The engineer who developed the latter product was named Engineer of the Year for the Division.) The thrust of the new product development work for both product lines will be to further increase the momentum that has propelled the Division to market leadership.

New products and systems under intensive development at Rockwell's Collins Government Avionics Division.

CEDAR RAPIDS — The GPS generalized development model user equipment being developed by Rockwell's Collins Government Avionics Division continues to perform well beyond expectations in USAF Avionics Lab tests. Meanwhile, the Division continues work on the USAF standard TACAN, standard AM/FM comm transceiver, the avionics system for the USCG HU-25A and an entire new family of cockpit control and display systems. The Division is also engaged in a series of major new product and system development programs for the government avionics market, creating a requirement for engineering and technical personnel to help the Division expand its share of this growing market. Professional Rockwell employees enjoy a wide range of benefits, including life, medical, dental and accident insurance; income protection; paid vacations/holidays; liberal reimbursement for relocation; and generous savings and retirement plans.

For full details, write Loren Wells, Mgr., Professional Employment, Avionics and Missiles Group, 400 Collins Road NE, M/S 120-145, Cedar Rapids, IA 52406.

Equal Opportunity Employer M/F
Once a year, you have the opportunity to see the latest product developments across the entire electrical engineering industry - all in one place - at the Hanover Fair.

Electric Power Transmission
Electrical Energy Supply
Telecommunications
Measuring, Testing, Control and Automation Equipment
Electronic Components and Subassemblies
Electrical Installation
Electric Lighting
Specialized Areas and Processes in Electrical Engineering

Information for Your Visit to the Fair
The Fair Planner and technical brochures will be available from February onwards. You can order the documents you need with this coupon.

Please send me the technical brochure
☐ Electric Power Transmission
☐ Electrical Energy Supply
☐ Telecommunications
☐ Measuring, Testing, Control and Automation Equipment
☐ Electronic Components and Subassemblies
☐ Electrical Installation
☐ Electric Lighting
☐ Specialized Areas and Processes in Electrical Engineering
☐ Fair Planner with the complete programme of all the specialist markets at the 1979 Hanover Fair

Deutsche Messe- und Ausstellungs-AG
Messegelande, D-3000 Hannover 82
Tel.: (0511) 891, Telex: 0922728

Name: ___________________________
Company: _______________________
Street: __________________________
Town/Postal Code:_________________

All the decisive innovations - in one place at one time.

Wednesday, 18th - Thursday, 26th April

Hanover Fair '79
New products

Microcomputers & systems

System develops C-MOS computers

CRT instrument supports 8080A and Z80 and also accepts 1802 overtures

Playing second fiddle does not give second sources much of the limelight. So, to demonstrate its own virtuosity, Hughes Solid State Products division, which manufactures 1800-family devices under license from RCA, has decided to introduce a noteworthy product itself. Called HMDS, it is a microprocessor development system that supports the complementary-metal-oxide-semiconductor 1802, as well as n-MOS processors like the 8080A and the Z80.

"It shows that Hughes is more than a second source, that we bring something more to the 1802," notes Gary DesRochers, manager of microprocessor applications for the division. In his view, RCA's use of a teletypewriter (rather than the cathode-ray tube found in most n-MOS support systems) presented an opportunity in the C-MOS MDS field. "Our customers are used to CRT systems for real-time visual feedback," DesRochers underscores.

The system, which uses personality modules to orchestrate the various types of processors, is being offered in two configurations: one with floppy-disk storage for loading and maintaining programs and data files, and a lower-priced cassette version.

The disk-storage HMDS sells for under $11,000, the exact price varying according to whether 630 or 1,018 kilobytes of storage are required. It includes a 40-by-24-character display, an ASCII keyboard, 16 kilobytes of static random-access memory, an in-circuit debugger board for the 1802, power supplies, and a chassis. Also provided are editor, assembler, and monitor-debugger software. Similarly equipped, the cassette-storage MDS sells for under $7,000. In the disk-based version, programs and data files are loaded by programmable read-only memories. The PROM programs include commands for reading object code and for comparing and changing data.

The HMDS assembly language is compatible with RCA's Cosmac, says DesRochers. At present, the system uses Basic as its high-level language, and Hughes is considering offering Pascal as an option.

In addition to its monitoring and debugging capabilities, the in-circuit debugger board can select either the internal or an external clock. It can also enable or disable direct memory access or interrupts.

Optional hardware and software
Plug all your measurement needs into one recorder.

Gould plug-in signal conditioners give you all the versatility you need so you don't have to buy new recorders as your measurement needs change. This modular approach allows you complete latitude of measurement capabilities. Measure microvolts to kilovolts; microstrain to 10,000 microstrains; temperature from —250°C to 2500°C; frequencies from 10 Hz to 50KHz. Simply plug in the appropriate signal conditioner. And you get all this versatility without sacrificing any of the features you expect from your Gould instrument — calibrated zero suppression, low pass filtering to eliminate high frequency interference, full floating inputs for operation up to 500 volts off ground at any sensitivity setting.

Find out how one recorder can satisfy all your measurement needs. Contact Gould Inc., Instruments Division, 3631 Perkins Ave., Cleveland, OH 44114. Or Gould Alco S.A., 57 rue St. Sauveur, 91160 Ballainvilliers, France.

Selectivity: The ability to accept signals within a specified frequency band while rejecting all others. Formerly a problem. See monolithic crystal filter.

Monolithic crystal filter: The solution to most selectivity problems in radio communication. See PTI. Their filters define the best and most economical in the field. Dozens of standard models, or custom production models from 5 to 180 MHz. Write for their catalog. The standard in monolithic crystal filters.

WE WROTE THE BOOK.

Plezo Technology Inc.
2525 Shader Rd., Orlando, Fl. 32804
(305) 298-2000

IT'S NEW and SMARTER THAN EVER

TP-3150 Thermal Printer
All you need for full Alphanumeric Thermal Printing!
• Serial or Parallel ASCII Input
• Power Supply • Bowmar's TP-3150 Printer
and it's only $269.00 in unit quantity

Bowmar

New products

at present offered include additional static RAM boards priced at $550 for 8-K, $1,000 for 16-K, and $1,750 for 32-K. Personality modules for n-mos processors and the associated software are priced at $500 and $50, respectively. Also offered is a PROM programmer. Delivery of prototypes began in February and Hughes expects delivery times of 8 to 12 weeks for all subsequent system orders.

Hughes Aircraft Co., Solid State Products Division, 500 Superior Ave., Newport Beach, Calif. 92660. Phone (714) 759-2907 or 2678 [371]

System supports development of 12-bit processors, too

Original-equipment manufacturers working with a number of different microprocessors or anticipating future change can now purchase a single system to handle all development needs. The UDS, or Universal Development System, unites a 5-in. cathode-ray-tube display, keyboard, and open card cage in a portable (shown) or bench-top package.

According to their needs, system developers can purchase boards tailored to specific processors, as well as support and memory modules. All popular 8-, 12-, and 16-bit central processing units, like the Z80, 8085, 8080A, IM6100, 6800, 9900, Z8000, and 68000, are supported by boards and software, and bipolar processors can be accommodated on special order.

With power supplies, a boardless portable unit sells for $3,195. An 8-bit CPU board, a 4-kilobyte memory module, an erasable program-
We sell insurance. 100% insurance against faults in your bare P.C. boards.

The Series 50 Circuit Verifier line is a low-cost, high-speed test system that once programmed, will test up to 8,000 points on bare printed circuit boards in less than 4 seconds. Quickly, accurately, simply.

Insure that only fault-free boards enter your assembly cycle. The Series 50 can provide 100% electrical inspection to minimize assembly rework due to faulty P.C. boards.

Quick and simple to operate, the Series 50 features easy self-programming from a known good board, extensive self-diagnostics, rapid "go-no-go" inspection, complete numeric or alpha numeric hard copy error messages and full memory storage on magnetic tape or diskettes.

The associated fixture system features interchangeable test heads to accept bare boards up to 20" x 24", and the "Bed of Nails" uses our own reliable probes.

We sell fast, accurate testing. We sell no fault insurance. Think about it. The Series 50 Circuit Verifier Line. By ATEC, an Everett/Charles Company.

ATEC
ASSEMBLY AND TEST EQUIPMENT CORPORATION
2806 METROPOLITAN PLACE
POMONA, CALIFORNIA 91767

SEE US AT NEPCON WEST-BOOTH #563
You are Invited!!!
to Examine the Prestigious, Portable Voltsmeter Collection.

- Greatest selection.
- Smallest size.
- Low prices.
- Greatest portability.
- Excellent performance.
- Dependability.
- Reliable.
- Most modern design.
- More optional features.

- Measures VDC, VAC, Ohms, DCmA & ACmA.
- Full four digits.
- Automatic zero.
- Automatic polarity.
- Battery powered with charger unit included.

Circle 196 on reader service card

LM-4A
With LED Readout

- Measures VDC, VAC, Ohms, DCmA & ACmA.
- Three & one-half digits.
- Automatic zero.
- Automatic polarity.
- Battery or AC line operation.※

Circle 223 on reader service card

LM-350
With LCD Readout

- VDC, DCmA, Ohms and RMS VAC & ACmA.
- Three & one-half digits.
- Automatic zero.
- Automatic polarity.
- Battery or AC line operation.※

Circle 222 on reader service card

RMS-350
With LCD Readout

<table>
<thead>
<tr>
<th>MODEL</th>
<th>RANGES</th>
<th>DC ACCURACY</th>
<th>RESOLUTION</th>
<th>DIGITS</th>
<th>PRICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM-3A</td>
<td></td>
<td>±0.1% Rdg</td>
<td>1 mV</td>
<td>3</td>
<td>$124</td>
</tr>
<tr>
<td>LM-300</td>
<td>VDC, VAC, DCmA &amp; ACmA</td>
<td>±0.1% Rdg</td>
<td>1 mV</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>LM-3.5A</td>
<td>1, 10, 100, &amp; 1000Ω, 1000Ω</td>
<td>±0.1% Rdg</td>
<td>1 mV</td>
<td>3-1/2</td>
<td></td>
</tr>
<tr>
<td>LM-350</td>
<td>RMS-350 displays true RMS in VAC and ACmA modes.</td>
<td>±0.1% Rdg</td>
<td>1 mV</td>
<td>3-1/2</td>
<td></td>
</tr>
<tr>
<td>RMS-350*</td>
<td></td>
<td>±0.1% Rdg</td>
<td>1 mV</td>
<td>3-1/2</td>
<td></td>
</tr>
<tr>
<td>LM-40A</td>
<td>1MΩ, 10MΩ, 100MΩ, 1 MD &amp; 10 MD</td>
<td>±0.05% Rdg</td>
<td>100 μV</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>LM-4A</td>
<td></td>
<td>±0.05% Rdg</td>
<td>100 μV</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

※LED-display models—NiCad batteries and charger unit included. LCD-display models—batteries and charger unit not included but available at extra cost.

NLS products are available from Nationwide Electronic Distributors. Send for our brochure today!

Non-Linear Systems, Inc.
Originator of the digital voltmeter.
Box N, Del Mar, California 92014 Telephone (714) 755-1134

New products

mable read-only memory module, and an E-PROM programmer are priced at $599, $350, $140, and $350, respectively. Source tape or floppy disk for the Editor costs $500, as do those for the Universal Assembler. Compatible floppy disk and line printer systems are also offered.

Micro Specialists Inc., 1431 E. St. Andrews Pt., Santa Ana, Calif. 92705. Phone (714) 549-0391 [397]

Fast worker hires on
for $7,700 or less

Intended for tasks best handled in Basic, the SDS 420 microcomputer system sits neatly atop a desk and goes to work for only $7,700. The 6502A-based system has a maximum instruction time of only 3.5 μs.

The unit’s 32-kilobyte memory, expandable to 56 kilobytes, fits on a single board, and mass storage of from 1½ to 10 megabytes is provided by up to four single- or double-density floppy-disk drives. A 71-character detachable keyboard and a 12-in. cathode-ray tube that can display up to 25 lines of 80 characters allows transactions under the guidance of the operating system and 12-K Basic interpreter.

Delivery time for the SDS 420 is 90 days and substantial discounts are available for large orders.

Scientific Data Systems Inc., 12640 Beatrice St., Los Angeles, Calif. 90066. Phone (213) 390-8673 [398]

Computer processes

English and data

Blending a high-speed, Z80-based microcomputer, a video terminal, dual floppy-disk drives, and a printer, the Memoret 2 meets the computing needs of many small businesses or departments within larger companies. In building the computer, Vector Graphic Inc. used its own MZ microcomputer and Mindless Terminal as well as Qume Corp.’s Sprint 5 printer and dual Micropolis
Once you compare our new 191 digital multimeter to ordinary 5½-digit DMMs, we think you'll readily agree that it outclasses its class. For good reason.

The 191 is a ±200,000-count DMM capable of 0.004% accuracy and 1µV/1mΩ sensitivity. It delivers unsurpassed accuracy, faster, because firmware in the 6802-based µcomputer has replaced slower, less precise analog circuitry.

Displayed data is updated at the fastest rate of digit change readable by the human eye—4 conversions per second. Settling time of 0.5 seconds is easily half that of the 191’s nearest competitor.

The µP combines both charge-balance and single-slope conversion techniques. Every displayed reading is automatically corrected for zero and gain drift.

If you’ve ever had to contend with the frustration of potentiometer zeroing, you’ll appreciate the 191’s null function. Automatic arithmetical correction of residual error is standard. With a touch of the button you can buck out any in-range signal, large or small.

You don’t need low-level noise either. So the 191 automatically suppresses it. The 191’s non-linear digital filter is entirely free of dielectric absorption and leakage problems associated with analog techniques. On the 200mV and 200Ω ranges, the filter effectively attenuates noise by displaying a running average of the 8 previous readings. Yet it instantly displays input changes of 10 digits or more.

Another exclusive of the 191 is 2 and 4-terminal measurement from 1mΩ to 20MΩ across six ranges. Simply adding two more sense leads automatically enables Kelvin measurements. No changing input terminal links or even pushbutton settings.

And, finally, since µP design reduces component count, the 191 requires less servicing and calibration, increasing reliability and stability.

At $499 without plug-in ACV, the 191 is today’s performance/value leader in 5½-digit DMMs. A year from now most people will agree. But you probably don’t need that much time to make up your mind. And we’re ready to help you with a demonstration or additional information. Call 800-321-0560. In Ohio, 216-248-0400.

Next year you’ll be glad you did.

A year from now you’ll own one or wish you did.
DON'T LET MOISTURE UNDERMINE YOUR PRODUCT RELIABILITY.

Moisture trapped inside an IC package can seriously affect its long term stability and reliability. This problem becomes critical with hi-rel hybrids used in military or commercial systems.

The Mini-Mod-A sensor provides an accurate, nondestructive method of testing hybrids for moisture content. It is a miniature device designed to be mounted inside the package with the other components, using conventional bonding techniques. With the Mini-Mod-A sensor and the Model 771 Moisture Analyzer, it is possible to measure moisture levels from less than 25 ppm to greater than 15,000 ppm. This method is simple to use, and is a cost-effective alternative to destructive sample testing. It will also continue to provide information on the moisture content of the hybrid for its entire life.

Call or write us today for free literature and technical papers describing the Mini-Mod-A and its applications in the microcircuits industry. Panametrics, Inc., Thin Film Sensor Operations, 221 Crescent St., Waltham, MA 02154, 617-899-2719.

Name ___________________________ Function ___________________________
Company ___________________________ Division ___________________________
Address ___________________________ City ___________________________
State ___________ Zip ___________ Phone ___________ Ext. ___________

Circle 198 on reader service card

New products

floppy-disk drives. The MZ can manage up to 630 kilobytes of disk memory and the printer can operate at speeds up to 55 characters per second.

For word processing, Memorite 2 has edit and delete capabilities for advanced text preparation. The system will automatically type letters from memory with underlining, indentation, automatic margins, and variable line and character spacing. Moreover, letters and address lists may be merged for mass mailings.

As a data processor, Memorite 2 can perform not only accounting tasks and custom calculations using the Business Basic language, but also scientific calculations. Price of the Memorite 2 system is $8,950. Vector Graphic Inc., 31864 Via Collinas, Westlake Village, Calif. 91361. Phone (213) 991-2302 [394]

Disk operating system executes faster than most

Index, which stands for interrupt-driven executive, is a disk operating system for the 6800 microprocessor. It is faster than most disk operating systems because the keyboard console and other input/output devices are serviced by interrupts rather than polling. Also, because the I/O devices are treated as disk files, new devices can be added without altering the operating system.

A user can expand Index by adding utility commands and driver routines, which reside on diskette and are loaded into memory only when needed. Thus software can be enhanced without changing the entire program or adding memory.

Index handles both ASCII and binary files, and these disk files are

If this magazine is worth your time, it's worth 65¢.

Drop off the routing list. Avoid the Perils of Passalong. Get your own fresh, unclipped copy mailed to your home or office $17 (65¢ per issue) for a one-year U.S. subscription. ($19 in Canada.) Turn to the subscription card in the back of the magazine. If somebody beat you to it, write: Electronics, P.O. Box 430, Hightstown, N.J. 08520.
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 Corporation
Chandler, Arizona 85224

For immediate need circle #224

For Information only circle #199
When you need illuminated switches, or more than illuminated switches...

Dialight is the first place to look. We make just about any kind of illuminated push button switch that anyone could want... Single lamp, dual lamp, neon, incandescent, LED lighted, you name it.

Perhaps you're looking for snap action switches with silver or gold contacts, or wiping action switches with gold contacts for low level application.

And if you're looking for rear panel or front bezel mounting switches, switches with momentary or alternate actions, or high quality switches for computer applications, we have them.

You'll find that Dialight switches are not only available at a reasonable price, they're also available with some very attractive features. Lamp removal is from the front so you don't have to remove an entire switch just to change a lamp. And you never have to use anything more complicated than your fingers for replacement or installation.

Along with outstanding variety and design, you get superior Dialight quality. Most Dialight switches are Underwriter's Laboratory listed and CSA approved.

And Dialight distributors are widely located throughout the United States, Canada and worldwide.

Call or write Dialight today. We'll send you our free switch catalogs so you can select a quality switch that's American made and Dialight guaranteed.

Dialight meets your needs.

Dialight, 203 Harrison Place, Brooklyn, N.Y. 11237 (212) 497-7600

Circle 228 on reader service card
New products

automatically created, allocated, and de-allocated storage. Files are given names up to eight characters long to which parameters are appended to indicate drive number, directory level, protection status, and activity value. With the activity value, the user may list or display only the file entries at or above this level.

Versions of Index are available for the PerCom LFD-400, Southwest Technical Products' MF-68, Smoke Signal Broadcasting Co.'s BFD-68, and Motorola's EXORciser development system. Index is supplied on two minidiskettes for $99.95.

Percom Data Co., 318 Barnes, Garland, Texas 75042. Phone (214) 272-3421 [395]

Simulator takes place of RAMs or ROMs

The ED-6000 simulator is used in place of read-only or read/write random-access memories while code is being developed for them. This allows a user to design and test machine-code software for microprocessors, as well as bit-slice and minicomputer systems. Because of the unit's short access time (65 ns), user programs can be executed and diagnosed at full speed without wasting programmable ROMs.

The simulator will support words up to 128 bits in length. Its memory is contained on cards holding 16 kilobits each. Data can be entered into the high-speed simulator through an optional terminal, through the use of a paper-tape reader, or by a computer.

The basic ED-6000, with 16 kilobits of memory, sells for $4,500.

Eldyne Inc., 7364 Convoy Court, San Diego, Calif. 92111. Phone (714) 277-2471 [396]
1. Microprocessors
What you must know about available microprocessor technology, devices, information, 4th printing. $8.95

2. Applying Microprocessors
2nd and 3rd generation technology. 26 detailed applications from data networks to video games. $9.95

3. Large Scale Integration
Covers the basic technology, new LSI devices, LSI testing procedures, plus system design and applications. $9.95

4. Basics of Data Communications
Includes 47 articles from Data Communications magazine covering more than 11 key areas. $12.95

5. Circuits for Electronics Engineers
Contains 306 circuits arranged by 51 functions from Amplifiers to Voltage Regulating Circuits. Saves design drudgery. $15.95

6. Design Techniques for Electronics Engineers
Nearly 300 articles drawn from "Engineer's Notebook." A storehouse of design problem solutions. $15.95

7. Memory Design: Microcomputers to Mainframes
The technology, devices, and applications that link memory components and system design. $12.95

8. Personal Computing: Hardware and Software Basics
More than 50 articles from leading publications, including specifications, helpful hints, subject index. $11.95

---

Electronics Magazine Books
P.O. Box 669, Hightstown, NJ 08520
(609) 481-1700, ext. 5494

<table>
<thead>
<tr>
<th>No. of Copies</th>
<th>Title</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Microprocessors</td>
<td>$8.95</td>
</tr>
<tr>
<td>2</td>
<td>Applying Microprocessors</td>
<td>$9.95</td>
</tr>
<tr>
<td>3</td>
<td>Large Scale Integration</td>
<td>$9.95</td>
</tr>
<tr>
<td>4</td>
<td>Basics of Data Communications</td>
<td>$12.95</td>
</tr>
<tr>
<td>5</td>
<td>Circuits for Electronics Engineers</td>
<td>$15.95</td>
</tr>
<tr>
<td>6</td>
<td>Design Techniques for Electronics Engineers</td>
<td>$15.95</td>
</tr>
<tr>
<td>7</td>
<td>Memory Design: Microcomputers to Mainframes</td>
<td>$12.95</td>
</tr>
<tr>
<td>8</td>
<td>Personal Computing: Hardware and Software Basics</td>
<td>$11.95</td>
</tr>
</tbody>
</table>

Discounts of 40% on orders of 10 or more copies of each book.

If after my 10-day free-trial examination I am not fully satisfied I understand that my payment will be refunded.

Charge to my credit card:
- American Express
- Visa
- Master Charge

Bill to:
- Firm
- Me

Acct. No.          Date Exp.

*On Master Charge only, first numbers above name

Name
Company
Street
City State Zip

Signature

Electronics/March 15, 1979
Zeiss Optics...Precision...Durability...for Production, QC, and R&D.

130 interchangeable objectives—No eyestrain—Greatest operator comfort.

Standard 20 T—the workhorse
Compact, rugged semiconductor microscope with 4x4" traveling stage for the production line, inspection. Removable specimen holders for easy loading of masks and wafers.

The Universal—the most universal microscope
Time-proven in R&D, quality control, and failure analysis. Full interchangeability for the most sophisticated techniques, use of 35mm and large-format cameras, TV, automatic scanning stages, and photometer lend true universality to the UNIVERSAL.

Epi-Microscope—the best buy on the market
A small and versatile upright incident-light microscope for production, QC, and R&D. Can be mounted on various stands or attached to any machinery. With special objective, working distance up to 18mm for up to 300x magnification. Circle 203

Ultraflat—camera microscope
The only, all-enclosed system for micro- and macrophotography at continuous magnification from 2.5x to 3,200x in brightfield, darkfield.

Stereomicroscopes DR and DV 4
High resolution at economical prices
2 fixed magnifications or 1:1 finest zoom optics with widefield eyepieces give exceptionally brilliant, flat, and sharp images. Precise binocular alignment is easy on operator's eyes.

Write for 10-page catalog:
"From Slice to Circuit." Circle 127

Carl Zeiss, Inc., 444 5th Avenue, New York, New York 10018 • (212) 730-4400
Branches in: Atlanta, Boston, Chicago, Houston, Los Angeles, San Francisco, Washington, D. C.

Nationwide Service
For multiple choice in alphanumeric displays...

LOOK TO IEE FOR SIZE, COLOR, QUALITY AND ECONOMY!

LRT1784/85 is a dual .54" 14-segment LED display; it is low power, low cost, end-stackable and available in red, green, and orange.

LRT1704 is a .3" 5x7 LED array available in the high brightness colors of red, yellow and orange.

LRT1057 is a 1.16" 5x7 dot matrix, side-stackable LED capable of creating a "marqueeing" type of display effect; available in red, green, yellow and orange.

Please request additional information on your business letterhead, or call your local sales representative listed below:

<table>
<thead>
<tr>
<th>UNITED STATES</th>
<th>CANADA</th>
<th>INTERNATIONAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL (205) 883-7893</td>
<td>MI (313) 353-8210</td>
<td>AL (205) 883-7893</td>
</tr>
<tr>
<td>AZ (602) 995-9455</td>
<td>MN (612) 927-4361</td>
<td>BC (604) 591-7611</td>
</tr>
<tr>
<td>CA (213) 541-2515</td>
<td>MO (314) 569-1220</td>
<td>ON (416) 838-6511</td>
</tr>
<tr>
<td>CO (303) 965-9321</td>
<td>NC (704) 527-3070</td>
<td>PE (514) 487-3434</td>
</tr>
<tr>
<td>CT (203) 239-0212</td>
<td>NY (518) 489-7408</td>
<td></td>
</tr>
<tr>
<td>FL (305) 857-3760</td>
<td>NY (607) 729-8743</td>
<td></td>
</tr>
<tr>
<td>FL (305) 942-0774</td>
<td>NY (716) 271-2330</td>
<td></td>
</tr>
<tr>
<td>IA (319) 362-9177</td>
<td>NY (315) 732-3775</td>
<td></td>
</tr>
<tr>
<td>IL (312) 433-2375</td>
<td>NY (516) 222-8980</td>
<td></td>
</tr>
<tr>
<td>IN (317) 844-8462</td>
<td>OH (216) 520-2535</td>
<td></td>
</tr>
<tr>
<td>IN (219) 432-5553</td>
<td>OH (614) 457-8472</td>
<td></td>
</tr>
<tr>
<td>KS (913) 381-0004</td>
<td>OR (503) 245-2342</td>
<td></td>
</tr>
<tr>
<td>KS (316) 264-2662</td>
<td>PA (215) 265-5211</td>
<td></td>
</tr>
<tr>
<td>MA (617) 862-8230</td>
<td>TX (214) 349-9940</td>
<td></td>
</tr>
<tr>
<td>MD (301) 460-6100</td>
<td>UT (801) 262-0000</td>
<td></td>
</tr>
<tr>
<td>MD (301) 252-7111</td>
<td>VA (504) 973-5674</td>
<td></td>
</tr>
<tr>
<td>MI (313) 353-8210</td>
<td>WA (206) 983-6690</td>
<td></td>
</tr>
</tbody>
</table>

INDUSTRIAL ELECTRONIC ENGINEERS, INC. • 7740 Lemona Ave., Van Nuys, CA 91405 • Telephone (213) 787-0311 • TWX: 910-495-1753

Circle 204 on reader service card
LOW COST PROTECTION FOR MICROPROCESSORS, MEMORIES OR ANY SYSTEM LOAD.

Lambda semiconductor overvoltage protectors
2 AMPS to 35 AMPS from $1.70.

Lambda staffed sales and service offices
OVERVOLTAGE PROTECTION

ORDERING INFORMATION

**MONOLITHIC**

**L-6-OV**

**HYBRID OVERVOLTAGE PROTECTOR SCHEMATIC DIAGRAM**

**LAMBDA L-2-OV USED TO BUILD HIGHER CURRENT LEVEL OV PROTECTOR.**

**ORDERING INFORMATION**

<table>
<thead>
<tr>
<th>NOM SUPPLY VOLTAGE (VOLTS)</th>
<th>TRIP POINT VOLTAGE A</th>
<th>2 AMP MODELS</th>
<th>QTY</th>
<th>100</th>
<th>250</th>
<th>1000</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>6.5 - 2</td>
<td>L-2-OV 5</td>
<td>10</td>
<td>5</td>
<td>8</td>
<td></td>
<td>5.65</td>
</tr>
<tr>
<td>6</td>
<td>7.5 - 2</td>
<td>L-2-OV 6</td>
<td>10</td>
<td>5</td>
<td>8</td>
<td></td>
<td>6.55</td>
</tr>
<tr>
<td>9</td>
<td>10.5 - 4</td>
<td>L-2-OV 9</td>
<td>10</td>
<td>5</td>
<td>8</td>
<td></td>
<td>10.50</td>
</tr>
<tr>
<td>10</td>
<td>11.0 - 5</td>
<td>L-2-OV 10</td>
<td>10</td>
<td>5</td>
<td>8</td>
<td></td>
<td>11.00</td>
</tr>
<tr>
<td>12</td>
<td>13.7 - 4</td>
<td>L-2-OV 12</td>
<td>10</td>
<td>5</td>
<td>8</td>
<td></td>
<td>13.70</td>
</tr>
<tr>
<td>14</td>
<td>16.0 - 5</td>
<td>L-2-OV 14</td>
<td>10</td>
<td>5</td>
<td>8</td>
<td></td>
<td>16.00</td>
</tr>
<tr>
<td>15</td>
<td>17.0 - 5</td>
<td>L-2-OV 15</td>
<td>10</td>
<td>5</td>
<td>8</td>
<td></td>
<td>17.00</td>
</tr>
<tr>
<td>16</td>
<td>20.3 - 10</td>
<td>L-2-OV 18</td>
<td>10</td>
<td>5</td>
<td>8</td>
<td></td>
<td>20.30</td>
</tr>
<tr>
<td>20</td>
<td>28.1 - 10</td>
<td>L-2-OV 24</td>
<td>10</td>
<td>5</td>
<td>8</td>
<td></td>
<td>28.10</td>
</tr>
<tr>
<td>24</td>
<td>31.9 - 10</td>
<td>L-2-OV 28</td>
<td>10</td>
<td>5</td>
<td>8</td>
<td></td>
<td>31.90</td>
</tr>
</tbody>
</table>

**8 AMP MODELS**

<table>
<thead>
<tr>
<th>QTY</th>
<th>100</th>
<th>250</th>
<th>1000</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>8</td>
<td></td>
<td>5.75</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>15</td>
<td></td>
<td>5.75</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>30</td>
<td></td>
<td>5.75</td>
</tr>
<tr>
<td>20</td>
<td>40</td>
<td>60</td>
<td></td>
<td>5.75</td>
</tr>
</tbody>
</table>

**PRICE**

<table>
<thead>
<tr>
<th>QTY</th>
<th>100</th>
<th>250</th>
<th>1000</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.65</td>
<td>8.00</td>
<td></td>
<td>5.65</td>
</tr>
<tr>
<td>5</td>
<td>8.00</td>
<td>10.50</td>
<td></td>
<td>8.00</td>
</tr>
<tr>
<td>10</td>
<td>10.50</td>
<td>13.00</td>
<td></td>
<td>10.50</td>
</tr>
<tr>
<td>20</td>
<td>13.00</td>
<td>15.50</td>
<td></td>
<td>13.00</td>
</tr>
</tbody>
</table>

**35 AMP MODELS**

<table>
<thead>
<tr>
<th>QTY</th>
<th>100</th>
<th>250</th>
<th>1000</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.65</td>
<td>8.00</td>
<td></td>
<td>5.65</td>
</tr>
<tr>
<td>5</td>
<td>8.00</td>
<td>10.50</td>
<td></td>
<td>8.00</td>
</tr>
<tr>
<td>10</td>
<td>10.50</td>
<td>13.00</td>
<td></td>
<td>10.50</td>
</tr>
<tr>
<td>20</td>
<td>13.00</td>
<td>15.50</td>
<td></td>
<td>13.00</td>
</tr>
</tbody>
</table>

**VOLTAGE TOLERANCE MAINTAINED OVER 0.7°C DUE TO POWER DESIGN**

*Lambda's 5-year-guaranteed power supplies.*
The Lambda overvoltage protector prevents damage to the load caused by excessive power supply output voltage due to improper adjustment, improper connection, a disconnected sense lead, or failure of the power supply. Load protection is accomplished by effectively short circuiting the output terminals of the power supply when a preset limit voltage has been exceeded. The trip-point limit voltage cannot be adjusted. To reset overvoltage protector, remove AC input to power supply, allow overvoltage protector to cool, and reapply power.

### True Temperature-Compensated

#### 2A, 6A, 12A

#### General Description

The same semiconductor overvoltage protectors used in the output terminals of the power supply when a preset limit voltage has been exceeded. The trip-point limit voltage cannot be adjusted. To reset overvoltage protector, remove AC input to power supply, allow overvoltage protector to cool, and reapply power.

#### Overvoltage Protector Absolute Maximum Rating

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>L-2-OV SERIES</th>
<th>L-6-OV SERIES</th>
<th>L-12-OV SERIES</th>
<th>L-20-OV SERIES</th>
<th>L-35-OV SERIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>On State Current</td>
<td>I dc</td>
<td>2A</td>
<td>6A</td>
<td>12A</td>
<td>20A</td>
</tr>
<tr>
<td>On State Voltage</td>
<td>V dc</td>
<td>2.6V</td>
<td>2.6V</td>
<td>1.2V</td>
<td>1.4V</td>
</tr>
<tr>
<td>Non-Repetitive Peak Surge Current</td>
<td>I p</td>
<td>20A</td>
<td>70A</td>
<td>200A</td>
<td>260A</td>
</tr>
<tr>
<td>Standby Current</td>
<td>I s</td>
<td>35mA</td>
<td>25mA</td>
<td>30mA</td>
<td>30mA</td>
</tr>
<tr>
<td>Operating Temperature (Blocking)**</td>
<td>T CB</td>
<td>-40°C +100°C</td>
<td>-40°C +100°C</td>
<td>-40°C +100°C</td>
<td>-40°C +100°C</td>
</tr>
<tr>
<td>Operating Temperature (Conducting)**</td>
<td>T CC</td>
<td>-40°C +150°C</td>
<td>-40°C +150°C</td>
<td>-40°C +150°C</td>
<td>-40°C +150°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>T s</td>
<td>-40°C +150°C</td>
<td>-40°C +150°C</td>
<td>-40°C +150°C</td>
<td>-40°C +150°C</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>P O</td>
<td>30 Watts</td>
<td>150 Watts</td>
<td>30 Watts</td>
<td>150 Watts</td>
</tr>
<tr>
<td>Derate above 50°C</td>
<td>P O</td>
<td>30 Watts</td>
<td>150 Watts</td>
<td>30 Watts</td>
<td>150 Watts</td>
</tr>
<tr>
<td>Thermal Resistance</td>
<td>P1 (JAC)</td>
<td>5.0°C/W</td>
<td>10°C/W</td>
<td>5.0°C/W</td>
<td>10°C/W</td>
</tr>
</tbody>
</table>

*For sinusoidal current duration of 8.3 milliseconds max.*

**Case temperature for overvoltage protector in non-conducting or OFF state.

**Case temperature for overvoltage protector in conducting or ON state. Power must be removed and case temperature allowed to drop to 40°C before application of output voltage.

The overvoltage protector requires an external heat sink to maintain case temperature below rated limit. When the overvoltage protector is used with a Lambda power supply, the power supply chassis acts as the heat sink. The L-12-OV, L-20-OV, L-35-OV overvoltage protector is supplied with mating connectors for pins on overvoltage protector (+V and -V engraved on unit).
LOW COST PROTECTION FOR MICROPROCESSORS, MEMORIES OR ANY SYSTEM LOAD.

Lambda semiconductor overvoltage protection from $1.70*

DC REGULATED OUTPUTS

SEMICONDUCTOR OVERVOLTAGE PROTECTORS

Lambda semiconductor overvoltage protection from $1.70*

$1.70 IN QUANTITIES OF 1000
fabulous
and revolutionary

**Microtest Mod. 80**
The smallest, thin and lightweight precision meter in the world!
(90 x 70 x 18 mm - 120 gr. only) with a very wide mirror scale meter (90 mm).
- **8 MEASUREMENT FUNCTIONS AND 40 RANGES**
- **NO ROTARY SWITCH - NO POTENTIOMETER-METALLIC FILM AND WIRE RESISTORS OF HIGH PRECISION (0.5%)**
- **OVERLOAD PROTECTIONS SENSITIVITY 20 KΩ/V.**

Not bigger than a packet of cigarettes!

---

**Supertester 680 R**
10 MEASUREMENT FUNCTIONS
AND 80 RANGES

---

**300 NANOSECONDS VOLTAGE DAC**

True 12-Bit D To A Conversion

... is achieved by combining our 4065 current DAC and our 1430 fett operational amplifier. The result is a 12-bit hybrid voltage DAC system with a voltage settling of under 300 nsec to 0.01%.

In addition, these units offer operation from -55°C to +125°C and the high reliability that is inherent in MIL-STD-883 screening.

Just one more reason why....
No One Does It Better Than Philbrick

---

**TELEDYNE PHILBRICK**
DATA CONVERTERS, V/F/V CONVERTERS, LINEARS, NONLINEARS, POWER SUPPLIES
Allied Drive at Route 128, Dedham, Massachusetts 02026
Tel: (617) 329-1600  TWX: (710) 348-6726  Telex: 92-4439
Triggering is the single most important feature of your logic analyzer.

Now BPI brings you expanded triggering.

Introducing our new Trigger/Data Probe. Coupled with our versatile logic analyzer (as pictured), it's the most powerful way to tackle your microprocessor, mini, or mainframe problems. Here's why.
1. You can parallel trigger up to 38 bits wide.
2. And record and analyze up to 16 digital signals while triggering from up to 22 additional locations.
3. Or use the probes in series for double or triple word triggering.

Compare feature for feature, dollar for dollar. The new BPI Trigger/Data Probe brings you more versatility, portability and performance at a low, low price.

Call us today for a demonstration of how our expanded triggering can make troubleshooting easier in your applications.

BP Instruments • 10601 S. DeAnza Blvd., Cupertino, CA 95014 • (408) 446-4322

The biggest problem with your IEEE bus...

So your new equipment conforms to IEEE standards. Great. But your system doesn't work. Not so great. Either your interface or your software isn't compatible. But which one?

Look no further. This is Model 488. The IEEE Bus Monitor/Analyzer from Interface Technology.

It records, analyzes, and controls. It stimulates, calibrates, tests, and verifies. In short, it does the thinking — and the searching — for you.

Call today for a demonstration of this remarkable time saver. Now that you're on the bus, you don't want to miss the boat.

interface TECHNOLOGY

852 North Cummings Road • Covina, California • (213) 966-1718

Circle 211 on reader service card
### Products newsletter

<table>
<thead>
<tr>
<th>4-bit quantizer has 10-ns conversion time, $45 price</th>
<th>Watch for Advanced Micro Devices Inc., Sunnyvale, Calif., to speed up the analog-to-digital conversion market with a 100-MHz 4-bit quantizer that performs a complete conversion in 10 ns. Available as samples, the Am6688 is a parallel converter that obtains its high speed by operating 16 emitter-coupled-logic comparators in parallel, instead of using a series technique like successive approximation. Although it only resolves four bits, the device has 8-bit accuracy, so 16 of them can be stacked to make an 8-bit converter. The part will sell for $45 each in hundreds. A 6-bit version is expected by the end of the year.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe enhances logic analyzer Users of E-H International Inc.'s model LA 1850 logic analyzer should be glad to hear that the Oakland, Calif., firm is enhancing the instrument's capability with a new data-probe accessory, the model DP11. The probe, which sells for $525, features 11 channels—8 regular data bits plus 3 qualifier lines—according to product manager Richard L. Newsome. Units may be connected to provide more bits for complex combinational triggering, Newsome says.</td>
<td></td>
</tr>
<tr>
<td>Monolithic 8-bit a-d converter sells for $14.50 Analog Devices Inc.'s Semiconductor division in Wilmington, Mass., has applied integrated injection logic to an 8-bit analog-to-digital converter with a conversion time of 25 µs. The single chip contains a clock, a comparator, a successive-approximation register, a buried zener reference, a d-a converter, and three-state output circuitry. It requires no external components to operate at full accuracy (±½ least significant bit uncertainty) and is priced at $14.50 in hundreds.</td>
<td></td>
</tr>
<tr>
<td>Floppy-disk systems offered for PDP-8 users There are still plenty of PDP-8 computer systems around and Xebec Systems Inc. of Santa Clara, Calif., hopes to supply many of them with its two new flexible-disk systems. The first is the model 1252A, a double-density system capable of storing 1.56 million 12-bit words. The second, the 1252AS, is compatible with DEC media and can store 788,000 12-bit words. Both units sell for $3,950 and come complete with computer interface, formatter, two drives, cables, and manuals.</td>
<td></td>
</tr>
<tr>
<td>Price reductions Mupro Inc., Sunnyvale, Calif., has reduced prices on its line of 16-kilobyte Multibus-compatible memory boards. The basic MBC-016 has been reduced by $190 from $985 to $795, while the cost of top-of-the-line MBC-016C with its error checking and correction capability has been lowered $220 from $1,395 to $1,175. General Electric Co.'s Electronic Components Business division, Auburn, N. Y., has cut the prices of 27 of its optocouplers. The reduction averages 16% on the 4N types and 22% on the H11A and B devices. Analog Devices Inc., Norwood, Mass., has slashed prices across its entire line of synchro-to-digital converters. Prices for the SDC1702511 (10-bit), 1700511 (12-bit), and 1704511 (14-bit) converters, in single quantities, are now $215 (down from $325), $255 (from $345), and $385 (from $440), respectively. “Other resolutions and reference frequencies have similar price reductions,” says Edward H. Friedman, product line manager for synchro converters.</td>
<td></td>
</tr>
</tbody>
</table>

---

*Electronics* / March 15, 1979
REPRINTS AVAILABLE FROM ELECTRONICS

Books

R-903 Personal Computing: Hardware and Software Basics—Electronics Book Series 266 pp $11.95
R-819 McGraw-Hill's Compilation of Data Communications Standards—99 standards from 5 organizations 1133 pp $165.00
R-732 Memory Design: Microcomputers to Mainframes—Electronics Book Series 180 pp $12.95
R-726 Design Techniques for Electronics Engineers: 293 time-saving ideas in 48 chapters—Electronics Book Series 370 pp $15.95
R-711 Circuits for Electronics Engineers: 306 circuits in 51 functional groups—Electronics Book Series 396 pp $15.95
R-31D Designer's Casebook Number 1 106 pp $5.50
R-704 Thermal Design in Electronics 52 pp $5.00
R-701 Applying Microprocessors—Electronics Book Series 191 pp $9.95
R-608 Basics of Data Communications—Electronics Book Series 303 pp $12.95
R-602 Large Scale Integration—Electronics Book Series 208 pp $9.95
R-520 Microprocessors—Electronics Book Series 154 pp $8.95
R-011 Computer-aided Design 135 pp $4.00

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' dominance 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

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.

USE THIS PAGE AS YOUR ORDER FORM

Cost of orders $ __________
Plus 10% handling charge $ __________
TOTAL AMOUNT ENCLOSED $ __________

SEND REPRINTS TO

Name: ____________
Company: ____________
Street: ____________
City: ____________ State: ____________ Zip: ____________

Mail your order to:
Janice Austin
ELECTRONICS REPRINTS
P.O. Box 689
Hightstown, N.J. 08520

New products/materials

A cover film of polyimide coated with azelate adhesive for forming flexible circuits does not require the high processing temperature and pressure needed for acrylic adhesives. R/flex 7000 absorbs less than 0.2% of its weight in water after being immersed for 30 minutes at 25°C. It has a bond strength of 8 lb/in. at 25°C when laminated to treated copper, a tensile-strength rating of 23,000 lb/in², and the capability to withstand a 60-second dip in a 260°C solder bath with no degradation of these specifications. The material is available in thicknesses of 1.2, 3, and 5 mils, coated on one or both sides with the azelate adhesive. The thickness of the adhesive may be 0.5, 1.0, or 1.5 mils.

Rogers Corp., Circuit Systems Division, P. O. Box 700, Chandler, Ariz. [476]

Thick-film thermistor pastes may be used to replace conventional discrete thermistor chips. Four different pastes are available in the NTC 100 series, with resistivities ranging from 500 Ω square to 10 kΩ per square, and maximum betas from −1,500 to −2,350 (comparable to a −7,000 to −8,500 temperature coefficient of resistance). These materials can be blended prior to use to achieve intermediate resistivities, or they can be custom-blended to customer specification. In evaluation quantities they sell for $4 per gram, and in production lots for about $2.50 per gram.

Cerma-Dip, Cerma-Dip Division of Bala Electronics Corp., Union Hill Industrial Park, West Conshohocken, Penn. 19428 [477]

A ceramic coating insulates electrical and electronic components at temperatures up to 3,200°F. Cerma-Dip 538, a single-component material, comes in paste form with a liquid thinner that gives the thixotropic coating a souplike consistency. The material can then be brushed onto a component, or the component can be dipped in the mixture. After air-drying for one hour, followed by baking at 180°F for 3 to 4 hours, the coating hardens into a dense ceramic surface. Cerma-Dip 538 has a dielectric strength of 150 V/mil at
LAST YEAR, AN IMPRESSIVE 389 NEW OEMs JOINED DATA GENERAL.

HERE'S WHY.

1. Because we've got an aggressive new product introduction policy that produces goods, not excuses.

2. Because we've got a broad line of compatible products to get them in more doors.

3. Because we get our products delivered before they become ancient history.

4. Because we offer an enticing discount schedule and extended start-up contract.

5. Because we'll go right to their customer with them to help close a big sale.

6. Because they know that success breeds success.

HERE'S HOW.

☐ I'm impressed, tell me how I can become a Data General OEM.
☐ I'm a business systems supplier ☐ OEM
☐ an end user.

Name: __________________________ Title: __________________________

Company: __________________________ Tel. No. __________________________

Address: __________________________

City: __________________________ State: __________ Zip: __________

Mail to: Data General Corp.
        Attn: OEM Marketing
        MS 83180, Westboro, MA 01581

Data General
We make computers that make sense


The Data General Computer Express — A live product presentation and demonstration — is coming to your area. Call your local Data General sales office. Or call direct (617) 366-8911, ext. 4722 for details.
For maximum warning and minimum size, you can't buy a better audio indicator than our new Series AI-250. Features include Piezo transducer, P.C. PIN or flange mounting, low power consumption, and a 4 KHz, 89 dB sound pressure rating at one foot. Get full details on the AI-250 and our entire line of Audio Indicators by contacting Projects Unlimited, Inc., 3680 Wyse Road, Dayton, Ohio 45414. Phone (513) 890-1918. TWX 810-450-2523.

**OUR NEWEST WARNING**

**Exclusive Sheldahl FLEXSWITCH® kit**

Only $10.00

With scissors, modify this 0.30 thick, non-tactile panel into a 9-16 key, water and dust-resistant switching module. Prototype kit includes: design guidelines, complete instructions, a Sheldahl FLEXSWITCH®, flexcircuit connector, press-on nomenclature and RFQ check-sheet. Available in production quantities at reduced prices. Pressure sensitive back.

Mail to: Sheldahl Electrical Products Division P.O. Box 170, Northfield, MN 55057

Please send me____ FLEXSWITCH kit(s). For each ordered I enclosed check or money order for $10.00.

Name____________________ Title____________________________

Company________________

Address__________________

City________________ State____ Zip_______________

Specify Switch type: [ ] Short to ground [ ] Crosspoint

---

**New products/materials**

Foam microwave absorbers are backed with an electrically conductive coating, allowing application to both nonconductive and conductive surfaces. The three types of Eccosorb absorbers, ANP-ML-73, -74, and -75, display a maximum power reflectivity of −17 dB. Depending on the type of material, the frequency range is 2.5 GHz to 12 GHz, weight is from 0.16 lb/ft² to 0.50 lb/ft², and thickness is from 1/8 to 1/4 in. Standard sheets of the material are 2 ft².

The absorbers can be bonded to metallic or nonmetallic surfaces with Eccobond 87-H and can be easily cut with an electric carving knife or scissors. Delivery is from stock Emerson & Cuming Inc., Microwave Products Division, 59 Walpole St., Canton, Mass. 02021 [480]

A cyanoacrylate adhesive fuses to almost any combination of materials in 10 to 12 seconds, forming a permanent bond. Developed for industrial use, AR-1776 is useful for production assembly, prototype assembly, and field repairs. The one-component transparent material does not require any surface preparation and is resistant to most chemicals, weather, and temperature. Shelf life is six months.

AR-1776 has a viscosity of 75 centipoises, a specific gravity of 1.06 at 25°C, and a melting point of 350°F. Tensile strength depends strongly on the substrate to which the material is bonded.

In quantities of 1 to 24, the material sells for $6.40 in 1-oz bottles and $63 in 1-lb bottles. For 25 bottles or more, the price is $5.80 per 1-oz bottle and $59.50 per 1-lb bottle.

Formulated Resins Inc., P.O. Box 508, Greenville, R.I. 02828 [475]
672,000 BYTE TAPE DRIVE FOR 3M DC100A DATA CARTRIDGE

MODEL 200 MINIDRIVE™...
The most compact tape drive ever...
Large, up to 672,000 bytes capacity...
Recording on one or two tracks...
Read-after-write capability...
3M DC100A or ITC TC-150 Data Cartridge...
High transfer rate, up to 48,000 bits-per-second...
Low power requirements, +5 and +12 Volts DC only...
High electrical and mechanical reliability...
Flexible configurations range from basic OEM building blocks to complete tape memory systems...
Optional electronics and mounting hardware...
From $250 in single unit quantities...
Contact us today for complete details...

Qantex Division of North Atlantic Industries
60 Plant Avenue, Hauppauge, NY 11787
(516) 582-6060 TWX 510-227-9660

SEE US AT INTERFACE '79 - BOOTH #349
New literature

Rfi filters. "Corcom RFI Power Line Filters," a 24-page catalog, provides a flow chart that shows how to choose the correct filter for an application. Several series of filters are presented in the catalog, each with complete electrical and mechanical specifications. Six pages discuss such subjects as what radio-frequency interference is, choosing an effective filter, and testing for rfi susceptibility, rf emissions, and insertion loss. International specifications are also provided. Corcom Inc., 2635 North Kildare Ave., Chicago, Ill. 60639. Circle reader service number 421.

Miniature systems. A 112-page booklet gives information on SMA, SMB, SMC, radio-frequency coaxial connectors, miniature semirigid cable, coaxial-cable assemblies, and hermetically sealed SMA MIC launchers, plus a line of fiber-optic connectors and assemblies. Two additional sections contain instructions for assembling connectors and engineering data that include detailed line drawings. The devices are indexed by product type. Cablewave Systems Inc., 60 Dodge Ave., North Haven, Conn. 06473 [422]

Winchester disk drives. "Who's Selling Rifles to the Indians?" describes the evolution of the Winchester disk

The new way to do Prom Programming

Software Personality™. E-H's contribution to the science of prom programming, makes it possible for one smart machine to handle all types of EPROM's, current and contemplated, without the hassle (and expense) of extra sockets and personality boards. No hardware. No hassles!

If you are working with NMOS EPROMS—either in development work or production—our new Software Personality technique for doing the programming will save you money. And time. And hassle.

Two keystrokes tells our programmer which Software Personality you want, 4K to 32K... up to 128K.
No personality boards. No new sockets.
Our Flex-Pin Matrix™ lets us control all device programming environments with software. When you change manufacturer or device density, all you have to change is the Software Personality.
At no extra cost!
Also, features that are expensive options on some systems are included in ours. At no extra cost. 2K x 8 RAM, for instance. Extensive move, list, and alter address operations. Fully buffered and powered-down (cold) sockets. And an easy-to-use serial I/O port to talk to other systems.

Save up to $1500!
Hardware Personality (Theirs) Prom Programmer (plus accessories required) ... about $4,000
Software Personality (Ours) E-H Model 4 Prom Programmer (no accessories needed) ... $2,495*

Use coupon for free Cost Comparison booklet.
Get all the facts on the new E-H Software Personality Programmers. Return the coupon for the data sheets and a very informative price comparison of hardware and software personalities in prom programming. For immediate information, please use our hotline, (415) 834-3030. Ask for Tina Bilhorn.

*U.S. domestic price only

Circle 217 on reader service card
drive. Subtitled "A Winchester Disk Drive Technology Primer," the booklet also explains the differences between Winchester disk-drive technology and the earlier disk-drive technologies from which Winchester evolved. A brief history traces the development from IBM's Ramac 305 with 50 disks and 5 megabytes of data storage. Improvements in track and bit density and in disk-drive reliability are discussed. Priam Corp., 20730 Valley Green Dr., Cupertino, Calif. 95014 [423]

Microcomputer products. The series 80 family of microcomputer products is discussed in a Databook from National Semiconductor. It includes descriptions, photographs, and diagrams for six board-level computers, three rack-mounted computer systems, and three prototyping systems, all based on the 8080A microprocessor. More than 30 support products are also described, including boards with random-access memory, read-only memory or programmable ROM, input/output expansion boards, combination memory and I/O boards, analog I/O boards, peripheral controllers, and system chassis and power supplies. National Semiconductor Corp., C.P.G. Marketing Services, MS/10A190, 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [424]

Telecommunication statistics. The sixth edition of "The Yearbook of Common Carrier Telecommunication Statistics" is a compilation of telecommunications information gathered from 163 countries. Covering the years 1968 to 1977, this 351-page yearbook includes such information as the number of automatic main telephone stations, number of Telex connections, annual investments in telecommunication facilities, the gross domestic product, and the ratio of investment to gross domestic product. It sells for 42 Swiss francs and is available from Sales Service, International Telecommunication Union, CH-1211 Geneva 20, Switzerland.

Ceramic capacitors. A 32-page catalog covers a wide range of monolithic ceramic capacitors, including radio-frequency ceramic-chip capacitors, multilayer ceramic capacitors, glass-sealed multilayer ceramic capacitors, and special products. Technical information and test and performance specifications are also given, as are detailed drawings with dimensions in both English and metric units. The catalog can be obtained from Centre Engineering Inc., 2820 East College Ave., State College, Pa. 16801 [426]

The Model 16B, the only programmer capable of doing data manipulation and volume production. It programs 16 EPROMs in one operation. Before it programs the devices, it checks them for proper insertion, continuity, shorts, and opens.

E-H International, Inc., 515 Eleventh Street, Oakland, CA 94607. TWX (910) 266 7258
Please send data sheets on Model 4 and the Model 16B Prom Programmers—the new way to go. Also send your FREE booklet. "Cost Comparison of Prom Programmers."

Name: ________________________________
Title: ________________________________
Company: ____________________________
Address: ______________________________
City, State/Zip: __________________________
I'm in something of a hurry. Please have one of your sales offices phone me at (______) ___________________________.

Stocked at Weatherford.

The Model 4, with its device flexibility, low cost and small size, make it ideal for both software development and field service applications. It includes in-circuit emulation (ICE), an important feature to enhance your software development and check-out capabilities.
Keep a step ahead of the market place with a truly full-function microcomputer

- Z80 CPU
- 64K bytes RAM
- 350KB/700KB mini-floppy disk drives expandable to 1.4M bytes
- Two RS232C ports built-in
- Extended BASIC Interpreter

Options:
- Extended BASIC Compiler
- FORTRAN-IV Compiler
- COBOL Compiler

Visit us at Halle 18, Stand 1304 at the Hannover Messe, April 18–26, 1979.
Visit us at Stand 907 at the EQUIPORAMA in Aartselaar, Belgium March 16–22, 1979.

Interested distributors and OEM's please contact our office.

SORD COMPUTER SYSTEMS, INC.
Isoma No. 2 Bldg., 42-12 Nishi-Shinkawa-4-chome, Katatsuhika-ku, Tokyo, Japan 124
Phone: (03)696-6611
Telex: 2622393(SORD J)
Cable: SORDCOMPSYS TOKYO

SORD U.S.A., INC.
International Trade Center, 8300 NE Underground Drive, Kansas City, Missouri 64161, U.S.A.
Phone: 1-816-454-6300
Telex: 42204 ISORDUSAINC

Distributors

Europe: COMPTRONIX AG
Morgen, Switzerland
Phone: 0221/545070
Telex: 58198/CPTX CH

Europe:

Asia and Oceania: WITSU & CO. (AUSTRALIA) LTD
Melbourne, Australia
Phone: 60-148183
Telex: 302155/MEILMM AA

Europe:

Asia and Oceania:

Free Yourself

with our New Data Acquisition and Control System

Free yourself from the normal drudgery of data logging, collection, reduction, report preparation and control.

The NEW Fi Electronics Data Acquisition and Control System is a complete system that can do it all. It can accept any kind of signal, reduce the data immediately, generate a concise report on the spot, and control the process or experiment, all from one location. And it will even do 3 color X-Y plotting.

For more information on our new system call Ed Bollet. COLLECT at (707) 527-0410.

Fi ELECTRONICS, 968 Piner Rd., Santa Rosa, CA 95401
Try one on for size

Weston Trimmers.

The Weston cermet trimmer family can meet a variety of demanding applications with top performance and unmatched versatility. Our newest model is the 860 . . . the first reasonably-priced ¼” square multiturn cermet trimmer. It features 16 turns of adjustability, operating temperature range from −55°C to +150°C and ¼ watt power rating at 85°C.

The 860 relies on the same superior Weston technology that produced our well-known 830, 840 and 850 trimmers. The 830, a ¾” rectilinear model, offers you 15 turns, while the 840 gives you one-turn adjustability in a ¾” square trimmer for smaller-size, single-turn applications. The 850 combines the best of both models with 22 turns and a higher operating temperature capability in a ¾” format. All Weston trimmers offer a choice of pin configurations.

Whatever your need in trimmers . . . . insist on the Weston family of quality trimming potentiometers.
The consequent pursuit of the principle of proximity focusing in image converters lead to unique optoelectronic components offering new possibilities to research and development:

**PROXIFIER®**

converts UV- and IR-images brilliantly sharp and free of distortion into the visible range of the spectrum.

- high quantum efficiency in the range 160 nm ... 950 nm by the use of S 20-photocathodes on fused silica windows and by field-enhanced emission in the IR
- 1:1 imaging with high contrast and absolutely free of distortion
- high resolution and gain, both equal over the entire useful area
- adjustable gain, in a single stage up to 300, in two stages up to 30000
- low noise
- axial dimension 10 mm (single stage, unpotted)

More information about single- or two-stage PROXIFlERs, with or without integrated power supply, is obtainable from

PROXITRONIC FUNK GmbH & Co. KG
D-6100 Darmstadt - Kasinistra. 24 - Tel. 06151/89 4209 - Telex 419589
West-Germany

---

**OMSI PASCAL**

Reliable, efficient, production Pascal compiler for the DEC PDP-11 family, including the LS-11.

**Full Language**

All elements of Standard Pascal, including the capabilities not found in student Pascal. Extensions for complete low-level control with direct memory and I/O device access, embedded assembler code, FORTRAN procedure interface.

**Production**

Integrated with DEC operating systems (RSTS/E, RTI 1, RXI, IAS). Compatible with existing file structures, editors, and utilities. Interactive symbolic Debugger with breakpoints and full trace.

**Performance**

Fast one-pass compiler runs in 16k words (32kB), translates thousands of lines per minute. Produces compact PDP-11 code that runs circles around interpretive or threaded languages.

**Proof**

In production use since 1975 - now at more than 300 customer sites. Warranted for 1 year after purchase.

Write for information, demonstration, manuals, and benchmark.

---

**220** Circle 270 on reader service card

---

**Volume Erasing in 6.7 Minutes!**

Introducing two new members in UV P's growing family of MEMORASE® Erase Systems. Both offer speed, reliability and outstanding performance.

For large capacity requirements, the C-90 will erase 600 chip batch in under 7 minutes. No preoperative adjustments or tuning are needed. Simply load it, set the timer, and forget it. It's that easy.

Model C-91 is geared for small systems users and delivers fast, efficient operation at an affordable price. It provides complete, thorough erase of up to 96 chips in one cycle in less than 7 minutes.

Like all UV products, each MEMORASE System is quality built, and backed by nearly 50 years of UV experience and technology.

Why settle for less? Call or write today for more information.

*New ... from the research labs at UVP*

**Ultra-Violet Products, Inc.**
5100 Walnut Grove Avenue, San Gabriel, CA 91776 U.S.A.

---

**226** Circle 271 on reader service card
NO ONE EVER PRODUCED A FULLY INTEGRATED DTMF RECEIVER ON A MONOLITHIC CHIP...
UNTIL NOW.

Sticky one-of-a-kind problems are routine at SSi. Although no one else had ever completely integrated a DTMF receiver on a single monolithic chip—that's what the task called for, so that's what we did. Employing state-of-the-art technology, we not only combined analog and digital functions but also—for the first time—fully integrated the necessary filters on the same CMOS chip. We thereby produced a unique tone decoding IC that can detect 12 or 16 standard digits without the need for prefilters and a host of other external components.*

At SSi, we offer all the capabilities required to produce a custom IC circuit for your application. Working from your design, our design, or in design collaboration with you—we can deliver the custom circuits you require in small runs or in large volume. What's more, we help you select the most cost effective technology for your application—TTL, Schottky TTL, ECL, PL, Bipolar Linear, PMOS, CMOS, NMOS, etc. We are not technology limited in our design thinking or in our production.

If you are using hybrids or have avoided custom circuits in your application because you think that custom ICs cannot be made to replace your complex circuitry, are not as reliable as your proven circuits, are too expensive, or require massive follow-on production orders—call SSi for a consulting discussion. Remember when you switch to full integration it almost always means lower power, lighter weight, smaller size, cheaper system costs, and greater reliability and accuracy.

If you haven't taken the custom IC step yet but have been thinking about it, call Jim Meyer for a personal discussion of your application. Or send for our capabilities brochure today.

Silicon Systems Incorporated, 16692 Hale Avenue, Irvine, California 92714. Phone (714) 979-0941. TWX 910-595-2809

*(Described in the paper "A Monolithic Dual-Tone Multifrequency Receiver—WAM26" presented by SSi at the February 1979 International Solid State Circuits Conference.)

Binnen de Berkel organisatie, welke is opgesplitst in produktgroepen is de afdeling Research and Development verantwoordelijk voor de ontwikkeling van produkten en technologieën. Deze ontwikkelingswerkzaamheden worden uitgevoerd in een projectgerichte, recentelijk ingevoerde matrix-organisatie.

Voor de centrale R&D afdeling te Leidschendam, voorstad van Den Haag, Nederland, zoeken wij thans

**ervaren project managers**

welke voor de produktgroepen,
- elektronische toonbankschalen & etiketteerapparatuur
- industriële weegapparatuur en -systemen,
de verantwoording dragen van alle "design".  
Zij zullen daarbij rechtstreeks aan de directeur R&D rapporteren en samenwerken met afdelingshoofden met wie zij in de organisatie op één lijn staan.

Een ingenieursopleiding (TH) elektronika, alsmede een zeer ruime ervaring in projectmanagement in een vergelijkbare industrie zijn voor deze functie vereist. Een goede beheersing van de Engelse taal is noodzakelijk, terwijl ook de Duitse taal geen problemen mag opleveren.

Kandidaten moeten in staat zijn ontwikkelingswerkzaamheden in verschillende landen op efficiënte wijze te coördineren. Zij moeten daartoe tevens bereid zijn in voorkomende gevallen buitenlandse vestigingen te bezoeken.

Uw schriftelijke sollicitatie met curriculum vitae en met opgave van huidig salaris kunt u richten aan de directeur R & D, postbus 20, 2260 AA Leidschendam, Nederland. Interviews kunnen worden gehouden op onze vestiging in Laporte, Indiana, USA. Reiskosten worden vanzelfsprekend vergoed, evenals verhuiskosten bij indiensttreding.

**BERKEL M & D B.V.**
The ITT LSI Systems Support Center is working on some very exciting projects. In fact, the work is so proprietary and advanced we can't give you specifics.

We can, however, tell you that our small, high-caliber staff is tackling the more complex LSI design problems for telecommunications, space, defense, commercial, industrial, and automotive product areas throughout International Telephone and Telegraph Corporation.

We can also tell you that you'll work in an informal, stimulating atmosphere. Enjoy direct exposure to every phase of LSI design and development. And have the opportunity to make the most of your versatility, creativity and imagination.

This spring we'll be moving into new quarters in Milford, Connecticut, where we'll have 20,000 square feet all to ourselves and the latest resources at our command — including digital and linear test systems, SEM for failure analysis, environmental test equipment, computer and graphics systems... and state-of-the-art wafer fabrication facilities at ITT's nearby Corporate Technology Center.

Off-the-job, you'll enjoy the best in Connecticut living, in a location close to Long Island Sound and New Haven, and almost midway between New York and Boston.

So let's hear from you. Particularly if you're unusually talented. And can keep a secret.

We have opportunities at various levels for:

- Process & Device Specialists
- LSI and VLSI Design Engineers
- Linear Designers
- LSI Layout Designers
- LSI Applications Engineers
- Digital & Linear Test Engineers
- Reliability & Quality Engineers

Call collect to arrange interview: (203) 348-8855, Monroe Weiant, Assistant Director — Operations.

Or send resume including salary history in confidence to Mr. Eugene Edwards, Caller Service 1-14, Milford, Conn. 06460

ITT LSI SYSTEMS SUPPORT CENTER

An Equal Opportunity Employer, M/F
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**

**DESIGN**

**SOFTWARE ENGINEERS**

**ANALYSTS**

**PROGRAMMERS**

**SYSTEMS**

**SENIOR ENGINEERS**

**PROJECT ENGINEERS**

**ENGINEERS**

**PRODUCT ASSURANCE**

**RELIABILITY MAINTAINABILITY**

**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 active 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 E379
NORTHROP CORPORATION
Defense Systems Division
600 Hicks Rd., Rolling Meadows, IL 60008

An equal opportunity employer m/f

---

**Positions Vacant**

Electrical Engineer/Instructor – Qualifications: Electrical Engineer, Bachelor’s Degree, Master’s Degree preferred. Three years of applied experience in the design or application of engineering principles on electronic equipment or equal. Solid state and computer background as well as training in the communications field is desirable. Salary range: depending upon training and experience. To apply send resume, transcripts and salary requirements in confidence to: Edward R. Maclosky, Springfield Technical Community College, One Armory Square, Springfield, MA 01105. An equal opportunity employer.

Applicants are invited for a faculty position in the Electrical Engineering Dept. at South Dakota State University, Brookings, SD, to begin Aug. 16, 1979. Rank and salary are commensurate with background and ability. Acceptance of applications is being extended until position is filled. Contact Dr. V. Ellerbruch, Head, or call 605-688-4526. An equal opportunity affirmative action employer.

Anticipated faculty position in Bachelor of Technology Program Fall 1979. Teach courses in areas of digital electronics, microprocessors and computer interfacing. Ph.D. required for assistant professor appointment; industrial and teaching experience desired. Send resumes to: Dr. George DePuy, Director of Technology Programs, School of General Studies, SUNY-Binghamton, Binghamton, New York 13901. An equal opportunity employer.

Electronics / March 15, 1979
You’ll make the right connections at GTE LENKURT

San Francisco Peninsula

Join a people-oriented TELECOMMUNICATIONS Company that is not only stable, but also growing rapidly to meet the expanding demand for a variety of communications systems.

Our customers depend on us for excellence in design, manufacture, and service of sophisticated video, voice and data communication systems. We offer a rewarding career, excellent advancement potential, interface with knowledgeable professionals.

DEVELOPMENT ENGINEERS

Electrical Engineers at all levels for projects in subscriber carriers, signaling and RF equipment design, PCM carrier and switching as well as digital microwave radio. Experience in either linear, digital or microprocessor control circuit design.

PCM DEVELOPMENT ENGINEER

As a key member of a product development team, you will have significant responsibilities for system and circuit design of high bit rate PCM equipment. This equipment will utilize State-of-the-Art techniques including high speed digital circuits and microprocessors, and will be used with fiber optic and microwave radio systems. Applicants should have a minimum of 4 years digital design experience, preferably including ECL and a BSEE degree. A background in PCM telecommunications equipment design is desirable.

PCM TERMINALS ENGINEERS

Responsible for circuit design of PCM voice/data channel bank equipment from concept to factory production. Position requires BSEE degree and experience in analog design. Prefer some digital experience or desire to learn digital design. Openings at all skill levels.

MICROPROCESSOR SOFTWARE ENGINEERING

For a Stored Program Digital Telecommunications Switching System. Should have a BS or MS degree in one or more of the following areas: Telephone Call Processing, Structured Software Design, Real Time Systems Design, Systems Diagnostics, PLM.

APPLICATION ENGINEER

Responsible for analyzing customer orders and determining exact detailed requirements. This requires performing varying amounts of System Engineering, scheduling, contract interpretation and direct customer or sales contact plus factory support. Must have prior technical experience in 1 or more of the following areas: microwave radio, multiplex, supervisory and control and switching systems.

MICROWAVE TRANSMISSION ENGINEER

Utilize topographic and other maps to select radio repeater sites, determine tower heights and antenna equipment needed to meet customers communications requirements. You will also calculate system noise performance, predict radio propagation reliability and analyze potential microwave interference situations. BSEE or equivalent degree and experience required.

POWER ELECTRONICS ENGINEER

Position requires a BSEE with 25 years experience in power electronics and power processing. Knowledge of solid state components, power electronic circuits and power magnetics is required.

CUSTOM IC DEVELOPMENT ENGINEERS & DESIGNERS

BS/MS or PhD in Electrical Engineering to develop custom integrated circuits in Bipolar and N-Mos technologies. Analog and/or digital design and computer simulation desirable. Willing to train Engineer with solid experience in discrete circuit design. You will have full responsibility for the development of your telecommunication circuit. Need Electrical Engineer to generate IC modeling test pattern and to develop automatic programs for high speed test systems. Solid background in linear or digital circuit analysis and aptitude in programming required. Programmer/IC Designer to develop and maintain IC layout design rules and to generate software programs for digitizing and mask design.

EQUIPMENT MECHANICAL/PC DESIGNERS

Must have knowledge of electromechanical packaging and/or printed circuit board layout for proprietary products. No degree necessary.

GTE Lenkurt offers excellent salaries and a comprehensive benefits package including Paid Vacations and 11 Paid Holidays; Medical/Dental/Life/Disability Insurance; Stock Purchase; Savings & Investment Program; 100% Tuition Refund; Pension Plan; Employee Store and Credit Union and Relocation Assistance. We are an Equal Opportunity/Affirmative Action Employer.

Please send your resume or a brief letter outlining your qualifications to DICK NELSON, Employment Manager, GTE Lenkurt, 1105 County Road, San Carlos, CA 94070. (415) 595-3000.

GTE LENKURT
A Part of General Telephone & Electronics Corporation

Electronics / March 15, 1979
FRESH IDEAS IN DIGITAL COMMUNICATIONS ARE WHAT WE'RE ALL ABOUT...

If you are a digital engineer with a desire to work with other innovative and imaginative professionals in advanced digital technology, you should investigate opportunities of uncommon potential with us. We’re Digital Communications Corporation, a worldwide leader in digital communications, and we seek engineers who want to expand their professional horizons working in the most advanced digital technology available anywhere.

DIGITAL LOGIC DESIGNERS
You need experience in complex logic design including mini-computer interfaces.
Experience with PDP 11/35 required (MS preferred).

COMMUNICATIONS SYSTEMS ENGINEERS
You need at least 3 years experience in communications systems analysis and design of terrestrial and satellite networks with familiarity in at least two of these areas: network design and organization; traffic engineering; switching; modulation & multiple access techniques and system engineering; electronic tradeoffs. Your work will involve design, analysis and specification of new communications networks, performing systems studies, computer simulations and field evaluation to optimize system parameters. MSEE desired.

RESEARCH SR. MEMBER TECHNICAL STAFF
You will perform analysis of communications systems and techniques and direct programs leading to new products. You will report to the V.P., Research, Ph.D.
required, major in EE, physics or mathematics with a minimum of 10 years experience in these areas.

RESEARCH MEMBER, TECHNICAL STAFF
You will implement and analyze new signal processing techniques leading to new product development. You need a MS (Ph.D. preferred) with experience and educational background in signal processing techniques, communications theory and communications systems analysis.

MODEM ENGINEERS
You need a knowledge of design, implementation and test of coherent PSK modems, and your background should include IF and RF design, 1-3 years experience and a BSEE.

We are located in a pleasant Maryland suburb close to the Nation's Capital with five major universities, and your choice of city, suburban, mountain or water living.
If any of these positions sounds like the fresh opportunity you seek in digital communications, please send your resume including salary history in confidence or call COLLECT to:

J.E. GLAZE
(301) 840-3487

DIGITAL COMMUNICATIONS CORPORATION
19 Firstfield Road, Gaithersburg, Maryland 20760
Excellence in telecommunications Engineering
A MA/COM Company
An Equal Opportunity Employer M/F

POSITION VACANT

Electrical Engineer/Instructor—Qualifications: Electrical Engineer, Bachelor's Degree, Master's Degree preferred. Three years of applied experience in the application, design or maintenance of electrical power, Control equipment, motor controls, or similar current consuming devices is required. Good state and logic systems as they apply to electrical controls are desirable. Salary range: depending upon training and experience. To apply send resume, transcripts and salary requirements in confidence to: Edward R. Maclosky, Springfield Technical Community College, One Armory Square, Springfield, MA 01105. An Equal Opportunity Employer.

EMPLOYMENT SERVICES

Electronic engineering growth positions with clients located nationally. Our service is enhanced by the fact that I am an EE with 20 years in industry and over 10 years in placing professionals on an employer fee paid basis. Send your resume to Joe Torcassi, Director, J. Anthony & Associates, PO Drawer AD. Lynchburg, OH 45142 513/364-2305.

POSITIONS WANTED


SCHOOLS

World Open University—A Non-Resident Graduate School—Division of Electronics & Computer Engineering offers full graduate courses in areas: Applied Mathematics & Physics; Electronics Engineering; Electrical Circuits; Computers & Advanced Programming; Communications Systems; Power Systems; Energy-Power Systems; Nondestructive Testing—leading to M.S., Ph.D., Sc.D., Eng.D., Tech.D.—guided by full professors having a series of original contributions to international learned societies. Request complete information to WOU, PO Box 5505, Orange, CA 92667. USA, enclosing $5 in US or US $7 outside of US, for airmailing. Self-authored original paper reprints from national learned societies may get proper credits. WOU is racially nondiscriminatory. To mention Electronics in request.

BUSINESS OPPORTUNITIES

“Norden Systems continues to lead the field in winning major long-term military contracts. For instance, RGWS and AEWS for the Navy and TAWDS for the Air Force. And we were selected to modify and update radar systems for the B-52—which is bringing involvement with the latest technological developments including ‘side-looking’ radar. We’re also implementing advanced concepts in such fields as synthetic aperture radar and high-speed programmable digital signal and data processors. And several of our projects are integral parts of a larger program focusing on next-generation electronic countermeasures.

“Our impressive record in radar development is matched by our extensive contract performance in other military areas involving data, display, and navigation systems. We offer engineers the chance to make a personal impact on every phase of a project—from concept and proposal through delivery. Personal and professional development is further enhanced by our association with United Technologies—a corporation whose R&D investment exceeds $1 million per day. And our own expansion, of course, will continue to open up higher level positions for ambitious engineers.”

- Radar Systems Engineers
- Radar Signal Processing Design Engineers
- Microwave Design Engineers
- Receiver Design Engineers
- Command & Control System Engineers
- Fire Control System Engineers
- Ship Combat Systems Engineers
- Real Time Software System Designers
- Real Time Software Programmers
- Sr. Mechanical Design Engineers
- Power Supply Design Engineers
- Sonar Systems Engineers
- ECM/Radar Engineers
- Test Equipment Design Engineers
- Hybrid Development Engineers
- Digital Design Engineers
- EMI Engineers
- Computer Architects & Designers
- Display Systems Engineers

If you are interested in the kind of opportunity we offer, and would like more details, you can reach me or an appropriate member of my staff by calling James E. Fitzgerald COLLECT at (203) 852-5408.”

Or you may send your resume including salary history to Mr. James E. Fitzgerald, Norden Systems, Inc., United Technologies Corporation, 308 Norden Place, Norwalk, Connecticut 06856.

The military systems house.

An Equal Opportunity Employer
ENGINES:

AMECOM Challenges You!

Put Your Ideas Up Against Our Best in EW/ECM Systems.

We work on the leading edge of EW and ECM systems, and our success is measured by the major programs in house with production follow-on to provide systems operating capability through the year 2000. If you are an innovative Microprocessor or EW Software Engineer we challenge you to work in the development of multifunction distributed microprocessors.

These positions range from Member of the Technical Staff to Senior Scientist with salaries to $35,000. Find out more about the challenges waiting for you at AMECOM. Please send your resume including salary history, or better yet, call COLLECT to:

Philip T. Foster
(301) 864-5600

AMECOM also has openings for Telecommunications and RF Engineers at our College Park headquarters. We are located in a pleasant Maryland suburb close to the Nation's capital with your choice of city, suburban, waterfront or country living.

LITTON SYSTEMS, INC.
5115 Calvert Rd., College Park, Md. 20740
An Equal Opportunity Employer M/F/H

FLIGHT TEST DATA SYSTEMS

McDonnell Aircraft Company has immediate openings in Flight Test Data Systems associated with the collection processing and presentation of Flight Test Data.

- Technical Specialist – To direct the software development of minicomputer systems. M.S. in computer science with E/E. basis. Familiarity with minicomputer operating systems, assemblers, and source file management, and the ability to deal with system hardware as well as software are required.

- Senior Programmer and Programmer – To write or direct the writing of minicomputer applications for Raytheon RDS-500, Data General Nova and H.P. Scientific Minicomputers. Experience with aforementioned systems is desirable but not required. M.S. or B.S. in E.E., Computer Science major. 3-5 years experience in minicomputer programming preferred.

Please send your resume in confidence to:

W. B. Kellenberger
Section Manager,
Professional Employment (62-2A)
Department E-03
P.O. Box 516
St. Louis, Missouri 63166

McDONNELL DOUGLAS

DESIGN ENG.

New Products. E/M Devices. $25K.
Pathfinder
P.O. Box 447
Commack, NY 11725
Engineering Recruitment Nationwide

Electronics/March 15, 1979
Electronics Engineers

Borg Warner today is much more than a supplier of quality automotive components and systems. We're putting new emphasis on electronics, including microprocessors—to meet industry's increasingly demanding requirements.

Back of this focus on new-product development is our Roy C. Ingersoll Research Center—which brings new technologies to our increasingly diversified company and provides strategic support for our basic technologies. The work of the Center has the strong support of top management, with a new building now under construction that will add 30% to our floor space.

You can join a staff of over 125 professional applied researchers, including about 40 Ph.D.'s. You will work in small groups, have much freedom to be creative, and share the challenges and rewards of a success-oriented organization.

MICROCOMPUTER APPLICATIONS

Project Engineer to Group Manager

Projects include electro-hydraulic transmission controls, remote telemetry applications, and control of variable-speed drives. You should have a strong background in software, hardware, and interfacing of micro or minicomputers to real-time systems. Future Corporate-wide programs are envisioned, limited only by the drive and talent of the group.

FROM PLYMOUTH TO POLARIS.

DRC. Solidly established as the area's rich history. Forward-looking as the new space age. Our success in systems guidance/planning means opportunity for you. New England means a real home.

• TEST ENGINEER INERTIAL COMPONENTS
  Design and direct test programs on inertial components.

• WEAPONS SYSTEMS ENGINEER
  Develop and apply new analytic tools in the areas of manpower and life cycle costs for large scale weapons systems. Manage an engineering staff and maintain customer contact.

• SENIOR ENGINEER AVIONICS
  Engineering evaluation, program planning and customer interface in support of major avionics equipment programs.

• ENGINEER, GUIDANCE SYSTEMS
  Lead in the analysis of guidance system performance data.

• INERTIAL SYSTEMS COMPONENTS ENGINEER
  Perform engineering studies on inertial systems and components.

 Qualified interested candidates are invited to submit a resume, including salary requirements, to Mr. Jack Kelly. Dept. 226-E, at the address below.

DYNAMICS RESEARCH CORPORATION
60 Concord St., Wilmington, MA 01887
An equal opportunity employer.
ENGINES AND PROGRAMMERS — GROW NEAR SAN FRANCISCO

Back in 1973, when we started, sales of Triad computer systems were only $200,000. Last year we sold nearly $15 million worth of systems, and next year we'll deliver even more. You may find it hard to believe, but we've grown to only 280 employees! Now we need a few more.

As a Triad employee in our new Sunnyvale headquarters on the San Francisco Peninsula, you'll be part of the leading supplier of turnkey, on-line multi-terminal computer systems for a number of distribution industries.

Triad needs engineers and programmers to design computer systems, including CPUs, interfaces, controllers, terminals, and systems and applications programs. Projects involve conception, specification, development, generation of final documentation and training manufacturing, field service and sales personnel. Positions are available for both experienced professionals and recent college graduates.

Consider your growth opportunities. Consider the excitement of being part of an industry-leading computer systems company. Consider living in, and exploring, this beautiful part of America. Send your resume to Don Ruder, Vice President of Engineering, Triad Systems Corporation, 115 Independence Drive, Menlo Park, CA 94025. We are an equal opportunity employer.

TRIAD
Systems Corporation

FLIGHT TEST ENGINEERS

McDonnell Aircraft Company has immediate openings for engineers experienced in Flight Test data systems applications. Career opportunities include development, operation and support of Flight Test data systems on F-15, F-18, AV-8 and advanced aircraft projects in one or more of the following applications:

- Mini-Computer Technology
- Computer Programming
- Flight Test Data Assessment
- System Design
- Airborne Instrumentation
- Installation Design — Electrical & Mechanical
- Electronic Circuit Design
- Micro-Processor Technology

Please send your resume in confidence to:
W. B. Kelienberger, Section Manager
Professional Employment
Department E-02 • P. O. Box 516
St. Louis, Missouri 63166

MCDONNELL DOUGLAS
An Equal Opportunity Employer

NOW IS THE TIME ... TO HIRE A STUDENT THIS SUMMER.

First, it's later than you think, with schools closing on different semester schedules, and students torn between lining-up "sure" jobs now or gambling that something in their chosen field will come along later.

Second, and most important, it's in our industry's best interest to encourage and hold its life-blood by providing practical experience in their future profession.

And, since there'll always be more applicants than openings, you'll be able to select the cream of the crop, then evaluate them with an eye towards hiring, when as coveted graduates, the job market might be in their favor.

Because we believe this program is of mutual benefit to both employer and employee alike, we again offer our services as a clearing-house.

Just fill out and return the coupon below, and we'll include your organization in a free listing to be sent to Placement Directors and Department Heads at leading colleges and universities across the nation. They'll post it, and the students will contact you directly.

Free summer help listing
MAIL TO: ELECTRONICS/POST OFFICE BOX 900/NEW YORK/ NY 10020

NAME/TITLE (of individual to be contacted):
ADDRESS: (Mailing address of your personnel office):
ORGANIZATION: (Firm, Company, Government Agency or Institution):
TYPE AND NUMBER OF STUDENTS SOUGHT: (Electronics, Avionics, Technician, Computer Science, Other: Draftsman, etc.)

3/12/79

Note: Last date coupons can be accepted for this year's student mailings is 4/6/79
SEMICONDUCTOR TECHNOLOGIST

LSI/VLSI

Sperry Univac, a leader in the computer industry, has an immediate requirement for a semiconductor technologist. The successful candidate will plan and investigate technologies for the design of very large scale integrated circuits for use in future computing systems.

Research disciplines will include both Silicone and Gallium Arsenide materials, multilayer metalization systems, operation at cryogenic temperatures, submicron lithography, and design automation considerations.

Applicants should possess an MS or PhD in Physics, or a related field and should have a thorough familiarization with device physics.

Interested candidates please reply with a detailed resume. Including salary requirements to R.A. Pagano, Sperry Univac, P.O. Box 500, Blue Bell, Pa. 19424. Sperry Univac is a division of Sperry Rand Corporation.

"MAKING MACHINES DO MORE SO THAT MAN CAN DO MORE"

An Equal Opportunity Employer. m/f/v/h

HIT A NEW CAREER HIGH!

PRD Electronics Division, the world leader in Automatic Test Equipment, needs MORE versatile and imaginative hardware/software engineers to maintain its outstanding growth record and peak systems performance.

In fact, we support more than 80% of all new military aircraft and are currently developing an entire new generation of Automatic Testing Equipment systems which are giving PRD a depth and breadth of knowledge no other company in ATE can match. We want to retain our leadership position and reputation for quality, obviously, and to do so we have an immediate need for additional skilled engineering professionals.

These Are Among Present Opportunities to Give Your Future Security and Potential:

PROJECT ENGINEERS (Software)

Lead technical teams to define hardware and interface requirements with advanced ATE systems as well as computer based processing and control systems. Familiar with the disciplines of software development, language standardization, compiler throughput and on system operating systems capable of conceptual design. BSEE/Physics/Comp. Sci., Adv. Degree desirable.

SENIOR ENGINEER (Software)


PROGRAMMER ANALYST

Capable of working from conceptual specifications to the establishment of design to software specifications. Primary area is the expansion of computer systems technology to automatic programming aspects as well as program validation. BS Comp. Sci. required.

TEST PROGRAM ENGINEERS

Translate circuit operation in computer programs for automatic fault detection and isolation. Experience in design and analysis, digital/analog, R/F and micro-processor applications with BSEE or equivalent desirable.

PROJECT ENGINEERS

SENIOR ENGINEERS

(Analog, Video)

BSEE, 3-10 years hands-on experience in current Analog and Video signal processing technologies. Heavy emphasis on synthesizer and wide bank op amp applications.

(Analog, Video)

BSEE, 3-10 years hands-on experience in LSI and micro-processor technology, with leadership capability.

PRD Electronics Division is conveniently located in Syosset, Long Island: just minutes away from the magic of New York City. We're easy to take in terms of living cost, and nationally recognized for excellent schools and residential areas.

All our current openings feature competitive salaries and comprehensive benefit packages as well as a relocation allowance, if required.

Please forward your resume with salary history in confidence to: Mr. Tony Pfarrar, Harris Corporation, PRD Electronics Division, 6801 Jericho Turnpike, Syosset, New York 11791.

HARRIS

COMMUNICATIONS AND INFORMATION HANDLING

An Equal Opportunity Employer — Male and Female

Electronics / March 15, 1979

231
ENGINEER, ELECTRONIC

ELECTRONIC TEST SYSTEMS DESIGN

GENERAL ELECTRIC's Power System Management Department has a position available for a Quality Equipment Engineer skilled in electronic test system design.

Foremost responsibility will encompass the design and development of advanced analog and digital solid state test equipment for a diversified line of electrical and electro-mechanical products.

Must possess technical capability in the field, plus have a BSEE or the equivalent. Experience with the programming of microprocessor-based automated test equipment would be highly desirable.

Excellent salary to the high 20's, a full range of benefits and advancement opportunities. Interested applicants should send resume, including salary requirements, to:

Professional Relations 10804

GENERAL ELECTRIC

Switchgear Division
6901 Elmwood Ave.
Philadelphia, Pa. 19142

An Equal Opportunity Employer M/F

---

NOTICE TO EMPLOYERS:

Why we can recommend our readers for the top jobs

The subscribers to this magazine have qualified professionally to receive it. They are also paid subscribers—interested enough in the technological content to have paid a minimum of $15 for a subscription.

As subscribers to ELECTRONICS, our readers have told you several things about themselves. They are ambitious. They are interested in expanding their knowledge in specific areas of the technology. And they are sophisticated in their need for and use of business and technology information.

Our readers are now in senior engineering or engineering management, or they are on the road toward those levels. In either case, they are prime applicants for the top jobs in almost any area.

If you are interested in recruiting the best people in electronics, these pages are open to you for your recruitment advertising.

Our readers are not "job-hoppers". To interest them you will have to combine present reward with challenge and opportunity for future career advancement.

The cost of recruitment advertising on these pages is $65 per advertising inch. For information call or write:

Electronics

Post Office Box 900, New York, NY 10020
Phone 212/997-2556
<table>
<thead>
<tr>
<th>Company</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACCEL</td>
<td>22E</td>
</tr>
<tr>
<td>Alltech</td>
<td>174</td>
</tr>
<tr>
<td>Alco Electronic Products (Sub. of Auget)</td>
<td>170</td>
</tr>
<tr>
<td>Allen-Bradley</td>
<td>32</td>
</tr>
<tr>
<td>American Optical Scientific Instrument Div.</td>
<td>162</td>
</tr>
<tr>
<td>AMF Potter &amp; Brumfield</td>
<td>98, 99</td>
</tr>
<tr>
<td>Amp Inc.</td>
<td>49-52</td>
</tr>
<tr>
<td>Amplifier Research</td>
<td>168</td>
</tr>
<tr>
<td>Anritsu Electric Co. Ltd.</td>
<td>160</td>
</tr>
<tr>
<td>AP Products</td>
<td>171</td>
</tr>
<tr>
<td>A.P.E.M.</td>
<td>32E</td>
</tr>
<tr>
<td>Assembly &amp; Test Equipment Corp.</td>
<td>195</td>
</tr>
<tr>
<td>Bel Fuse Inc.</td>
<td>8</td>
</tr>
<tr>
<td>Boschert</td>
<td>15E</td>
</tr>
<tr>
<td>Bourns Inc.</td>
<td>2C</td>
</tr>
<tr>
<td>Bowmar Commercial Products</td>
<td>194</td>
</tr>
<tr>
<td>B.P. Instruments</td>
<td>210</td>
</tr>
<tr>
<td><strong>Burr Brown Research Corporation</strong></td>
<td>24E</td>
</tr>
<tr>
<td>Caddeco Electronics Inc.</td>
<td>43</td>
</tr>
<tr>
<td>California Eastern Labs</td>
<td>185</td>
</tr>
<tr>
<td>Cambridge Thermionic Corp.</td>
<td>165</td>
</tr>
<tr>
<td>Cherry Electrical Products</td>
<td>159</td>
</tr>
<tr>
<td>Chicago Miniature</td>
<td>18E</td>
</tr>
<tr>
<td>Citel</td>
<td>26E</td>
</tr>
<tr>
<td>C &amp; K Components</td>
<td>179</td>
</tr>
<tr>
<td>Clarex Electronics</td>
<td>4C</td>
</tr>
<tr>
<td>Conrac Div./Conrac Corporation</td>
<td>167</td>
</tr>
<tr>
<td>Continental Specialties</td>
<td>55</td>
</tr>
<tr>
<td>Culligan USA</td>
<td>73</td>
</tr>
<tr>
<td>Data General Corporation</td>
<td>213</td>
</tr>
<tr>
<td>Data Precision</td>
<td>183</td>
</tr>
<tr>
<td>Datascript Corporation</td>
<td>178</td>
</tr>
<tr>
<td>Deltec Corporation</td>
<td>150</td>
</tr>
<tr>
<td>Deutsche Messa Ag</td>
<td>191</td>
</tr>
<tr>
<td>Dialight</td>
<td>200</td>
</tr>
<tr>
<td>Digital Equipment Corporation OEM 11 Group</td>
<td>22, 23</td>
</tr>
<tr>
<td>DL-MCO</td>
<td>92</td>
</tr>
<tr>
<td>Ducati Elettronica Microfarad</td>
<td>4E</td>
</tr>
<tr>
<td>Eastman Chemical Products</td>
<td>192</td>
</tr>
<tr>
<td>Ebauches SA c/o McCann-Erickson</td>
<td>124</td>
</tr>
<tr>
<td>EH International</td>
<td>216, 217</td>
</tr>
<tr>
<td>Elec-Trol Inc.</td>
<td>77</td>
</tr>
<tr>
<td>Electro Scientific Industries</td>
<td>186</td>
</tr>
<tr>
<td>Electromatic Component Ltd.</td>
<td>3C</td>
</tr>
<tr>
<td>Electronic Navigation Industries</td>
<td>6</td>
</tr>
<tr>
<td>Elfaq</td>
<td>13</td>
</tr>
<tr>
<td><strong>EMI Technology Data Recording Division</strong></td>
<td>31E</td>
</tr>
<tr>
<td>EMM / Semi</td>
<td>28E</td>
</tr>
<tr>
<td>Enterec Schlumberger</td>
<td>7E</td>
</tr>
<tr>
<td>Essex Group (Sub. of United Tech.)</td>
<td>236</td>
</tr>
<tr>
<td>Fabrique D'Ebauches ETA SA</td>
<td>235</td>
</tr>
<tr>
<td>Fairchild Test Systems</td>
<td>20, 21</td>
</tr>
<tr>
<td>FEME S.p.A.</td>
<td>25E</td>
</tr>
<tr>
<td>Ferranti-Packard Ltd.</td>
<td>162</td>
</tr>
<tr>
<td>FIVRE S.p.A.</td>
<td>203</td>
</tr>
<tr>
<td>Fluidyne Instrumentation</td>
<td>216</td>
</tr>
<tr>
<td>John Fluke Mfg. Co.</td>
<td>93, 153</td>
</tr>
<tr>
<td>Forth Inc.</td>
<td>57</td>
</tr>
<tr>
<td>§ General Electric Instrument Rental Division</td>
<td>136</td>
</tr>
<tr>
<td>General Electric Company Semiconductor Dept.</td>
<td>161</td>
</tr>
<tr>
<td>General Instrument Microelectronics</td>
<td>47</td>
</tr>
<tr>
<td>General Instrument Corporation (Semiconductor)</td>
<td>87</td>
</tr>
<tr>
<td>General Semiconductor Industries Inc.</td>
<td>23E</td>
</tr>
<tr>
<td>Glasgow District Council, City of</td>
<td>154</td>
</tr>
<tr>
<td>Gould-Bionation</td>
<td>100</td>
</tr>
<tr>
<td>Gould, Inc./Instrument Systems Div./T &amp; M</td>
<td>193</td>
</tr>
<tr>
<td>Graetz Industries</td>
<td>172</td>
</tr>
<tr>
<td>Guardian Electric Mfg. Co.</td>
<td>145</td>
</tr>
<tr>
<td>Hamlin</td>
<td>176</td>
</tr>
<tr>
<td>§ Harris Semiconductor</td>
<td>173</td>
</tr>
<tr>
<td>Hewlett-Packard</td>
<td>1, 7, 10, 11, 18, 19, 30, 31</td>
</tr>
<tr>
<td>Hi-G Inc.</td>
<td>149</td>
</tr>
<tr>
<td>Hitachi Ltd.</td>
<td>142, 143</td>
</tr>
<tr>
<td>Honeywell TID</td>
<td>175</td>
</tr>
<tr>
<td>Hybrid Systems</td>
<td>75</td>
</tr>
<tr>
<td>I Corporation</td>
<td>144</td>
</tr>
<tr>
<td>I.C.E.</td>
<td>209</td>
</tr>
<tr>
<td>IEE Industrial Electronic Engineers, Inc.</td>
<td>204</td>
</tr>
<tr>
<td>ILC Data Device Corporation</td>
<td>148</td>
</tr>
<tr>
<td>Infrad Industries, Inc.</td>
<td>180</td>
</tr>
<tr>
<td>Interface Technology</td>
<td>210</td>
</tr>
<tr>
<td>§ Italphil/SIT</td>
<td>5E, 13E</td>
</tr>
<tr>
<td>§ Licon Division of Illinois Tool</td>
<td>139</td>
</tr>
<tr>
<td>Litonix</td>
<td>177</td>
</tr>
<tr>
<td>Macrodata Corporation</td>
<td>155</td>
</tr>
<tr>
<td>Magtral</td>
<td>158</td>
</tr>
<tr>
<td>Mallory Capacitor Co.</td>
<td>201</td>
</tr>
<tr>
<td>§ Marconi Instruments Inc.</td>
<td>17E</td>
</tr>
<tr>
<td>Matrox Electronic Systems</td>
<td>89</td>
</tr>
<tr>
<td>Matsuhashi Electric Trading Company</td>
<td>6E</td>
</tr>
<tr>
<td>M.C.P.</td>
<td>133</td>
</tr>
<tr>
<td>MDS Systems</td>
<td>148</td>
</tr>
<tr>
<td>Megadata</td>
<td>184</td>
</tr>
<tr>
<td>Micro Devices Division of Emerson Electric Co.</td>
<td>20E</td>
</tr>
<tr>
<td>Microsoft</td>
<td>9</td>
</tr>
<tr>
<td>§ Minthorne International</td>
<td>190</td>
</tr>
<tr>
<td>Mitsui Semiconductor Inc.</td>
<td>48</td>
</tr>
<tr>
<td>Mostek Corporation</td>
<td>27, 28, 29</td>
</tr>
<tr>
<td>Motorola Semiconductor Products</td>
<td>35, 45</td>
</tr>
<tr>
<td>§ Murata Corporation of America</td>
<td>140</td>
</tr>
<tr>
<td>§ Murata Mfg. Co. Ltd.</td>
<td>190</td>
</tr>
<tr>
<td>National Semiconductor Corp.</td>
<td>36, 37</td>
</tr>
<tr>
<td>NEC Microcomputers</td>
<td>64, 65</td>
</tr>
<tr>
<td>Neff Instruments Corporation</td>
<td>163</td>
</tr>
<tr>
<td>§ NEOHM SPA</td>
<td>3E</td>
</tr>
<tr>
<td>Niconet Instrument Corp. Oscilloscope Div.</td>
<td>156</td>
</tr>
<tr>
<td>§ Nippon Electric Co. Ltd.</td>
<td>140</td>
</tr>
<tr>
<td>§ NJE</td>
<td>172</td>
</tr>
<tr>
<td>§ Non-Linear Systems, Inc.</td>
<td>196</td>
</tr>
<tr>
<td>Northern Ireland Ind. Devel. Organization</td>
<td>187</td>
</tr>
<tr>
<td>Oregon Software</td>
<td>220</td>
</tr>
<tr>
<td>Optron, Inc.</td>
<td>26</td>
</tr>
<tr>
<td>Pace Incorporated</td>
<td>27E</td>
</tr>
<tr>
<td>Panametrics</td>
<td>198</td>
</tr>
<tr>
<td>Peterborough Development Corporation</td>
<td>38</td>
</tr>
<tr>
<td>§ Philips ELA</td>
<td>30E</td>
</tr>
<tr>
<td>§ Philips TMI</td>
<td>9E</td>
</tr>
<tr>
<td>Photodyne Inc.</td>
<td>60</td>
</tr>
<tr>
<td>Plessey Semiconductor</td>
<td>2E</td>
</tr>
<tr>
<td>Piezo Technology</td>
<td>194</td>
</tr>
<tr>
<td>Powercube Corporation (Div. of Uniland)</td>
<td>91</td>
</tr>
<tr>
<td>Power One Inc.</td>
<td>12</td>
</tr>
<tr>
<td>Practical Automation</td>
<td>235</td>
</tr>
<tr>
<td>Precision Monolithics</td>
<td>15</td>
</tr>
<tr>
<td>Projects Unlimited</td>
<td>214</td>
</tr>
<tr>
<td>Pro-Log</td>
<td>25</td>
</tr>
<tr>
<td>Proxtronic Funk GmbH &amp; Co.</td>
<td>220</td>
</tr>
<tr>
<td>Qantas Div. of North Atlantic Industries Inc.</td>
<td>215</td>
</tr>
<tr>
<td>RCA Solid State</td>
<td>66</td>
</tr>
<tr>
<td>§ Rental Electronics</td>
<td>80, 81</td>
</tr>
<tr>
<td>Robinson Nugent Inc.</td>
<td>82, 83</td>
</tr>
<tr>
<td>Rogers Corporation</td>
<td>199</td>
</tr>
<tr>
<td>Rohde &amp; Schwarz</td>
<td>59, 21E</td>
</tr>
<tr>
<td>§ Samtec</td>
<td>38</td>
</tr>
<tr>
<td>Savoy Electronics</td>
<td>8</td>
</tr>
<tr>
<td>Scientific Atlanta, Optima Division</td>
<td>146</td>
</tr>
<tr>
<td>Seacor Inc.</td>
<td>16</td>
</tr>
<tr>
<td>Semitec Corporation</td>
<td>70</td>
</tr>
<tr>
<td>Sternum</td>
<td>189</td>
</tr>
<tr>
<td>§ SGS-Ales</td>
<td>1E</td>
</tr>
<tr>
<td>Sheldon Inc.</td>
<td>214</td>
</tr>
<tr>
<td>Shipley Company</td>
<td>173</td>
</tr>
<tr>
<td>Siemens AG Munich</td>
<td>64</td>
</tr>
<tr>
<td>Signetics Corporation</td>
<td>134, 135, 169</td>
</tr>
<tr>
<td>Silicon Systems</td>
<td>221</td>
</tr>
</tbody>
</table>
Get your 1978 EBG while they last. 1979 edition not available until June.

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 1978 EBG.
□ I have enclosed $25 per copy delivered in the USA or Canada.
□ I have enclosed $35 per copy for delivery elsewhere ($47 if shipped by Air). Full money-back guarantee if returned in 10 days.

Name
Company
Street
City State Zip

Classified and employment advertising
F. J. Eberle, Manager 212-997-2557

- Beall Associates
- Borland M. A. V.
- Borg Warner Corp.
- Continental Personnel
- Corporate Recruiters
- DCI, Digital Communications Corp.
- Dynamic Research Corp.
- Engineers Index, The
- General Electric Co.
- GTE Lenkurt
- Harris Corp.
- ITT LBI Systems Support Co.
- Life-Tech Instruments Inc.
- McDonnell Douglas
- National Personnel Consultants
- Norden Systems Inc.
- Norcorp Corp.
- Pathfinder
- Stephen E.D.
- Spectrol Univac Computer Systems
- Triad Systems Corp.

For more information on 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. 30305: Michael Charlton
(404) 892-2688

Boston, Mass. 02116: Frank Mitchell
607 Boylston St. (617) 262-1600

Chicago, Ill. 60611
645 North Michigan Avenue
Jack Anderson (312) 751-3739
Robert M. Denmead (312) 751-3738
Cleveland, Ohio 44113: William J. Boyle
(216) 586-5040

Cotea Meza, Calif. 92220: Robert E. Boedicker
3001 Red Hill Ave. Bldg. #4 Suite 242
(714) 557-2929

Dallas, Texas 75201: John J. Uphues
1991 Bryant Tower, Suite 1070
(214) 744-1744

Deerfield, Colo. 80520: Harry B. Doyle, Jr.
123 Speno Blvd. #400
(303) 837-1010

Detroit, Michigan 48228: Jack Anderson
1400 Fisher Bldg
(313) 873-7410

Fort Lauderdale, Fla. 33390: Michael Charlton
3000 N.E. 50th Place
(305) 569-9111

Houston, Texas 77005: John J. Uphues
601 Jefferson Street, Dresser Tower
(713) 659-6361

Los Angeles, Calif. 90015: Robert J. Patty
Robert E. Boedicker, 2200 Wilshire Blvd., South Tower
(213) 487-1160

Milwaukee, Minn. 53233: Robert M. Denmead
40 W. W. 65th St.
(312) 751-3739

New York, N.Y. 10029
1221 Avenue of the Americas
John Galte [212] 997-3617
Matthew T. Reesaks [212] 997-3617
Phvladelphia, Pa. 19102: Matthew T. Reesak
3 Three Parkway
[212] 997-3617

Pittsburgh, Pa. 15222: Matthew T. Reesak
4 Gateway Center
[212] 997-3617

Rochester, N.Y. 14654: Willam J. Boyle
Power Mill Office Park, 1163 Pittsford-Horad Rd., Pittsford, N.Y. 14534
[716] 248-5620

San Francisco, Calif. 94111: Don Farris
Dean Service, 425 Battery Street, [415] 362-4600

Para: Patrick Moulard
17 Rue-Georges Bize, 75116 Paris, France
Tel: 720-72-51

United Kingdom & Scandanavia: Robert Ghey
24 Yorker Street, London W1
Tel: 01-493-1451

Scandanavia: Andrew Kamir & Associates
Kungsholmshagen 10
112 27 Stockholm Sweden
Tel: 08 51 93 70 Times: 179 51

Millen: Ferruccio Silviero
1 via Baracchini, Italy
Phone: 860-90-658

Brussels: 22 Chaussee de Wavre
Brussels 1040, Belgium
Tel: 13-79-95

Frankfurt/Main: Fritz Kruebeker
Lichtgrenlasse 27c, 27c, Germany
Phone: 72 01 81

Tulare: Alfo Salio, McGrew-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

Marlenee Meissner, Production Assistant
[212] 997-2843

Frances Vallenza
Reader Service Manager
[212] 997-6057

Electronics Buyers’ Guide
N.Y. Headland, General Manager
[212] 997-6642

Regina Hess, Directory Manager
[212] 997-5944

Thomas Kazich, Production Manager
[212] 997-2044

Marlenee Meissner, Production Assistant
[212] 997-2843

Frances Vallenza, Reader Service Manager
[212] 997-6057

Classified and Employment Advertising
Frank Eberle, Manager
[212] 997-2557
SBC compatible Board MV 80 has six double-sided edge connectors for bus-oriented parallel or serial input/output.

The board MV 80 holds up to 40-16 pin Robinson Nugent U-type wire-wrap sockets or a combination of 16, 24, 28 and 40 pin wire-wrap sockets. It has a 32 cm² free area for component and an area for an on-board 5 V ± 15 V, ± 150 mA DC/DC converter.

There are 10 independent heavy-duty power and ground buses on the back of the board. The connections for the by-pass capacitors are also provided on board.

The main advantage of this board is its low profile, the wrapping is done on the component side.

The board is delivered as a kit including board with insert bushes, wire-wrap pins and a set of screws for the fastening of the sockets. DC/DC converter and sockets are options.

There is also a set of Europecards using the same principle available.

For further informations and price quotations, please contact:

ETA SA FABRIQUES D'ÉBAUCHES · Division Diversification
2540 Grenchen/Switzerland · Tel. 065/51 11 21 · Tlx. 34284 asa ch

Feed all your forms to our wide-open printer

Consider the advantages!
Programmable character pitch, heavy-duty construction and an extra long-life dot matrix printing head means real durability. Its exceptionally long needle stroke turns out crisp multiple-copy printings on thicknesses from .003" to .015" — without adjustment.

Its easily replaceable ink rollers and self-reversing ribbon gives you a 10 million character life.

ALL THAT, YET STILL ECONOMICAL— ONLY $269 IN 100's.

PA PRACTICAL AUTOMATION, INC.
Trap Falls Road
Shelton, Conn. 06484
Tel: (203) 929-5381
ESSEX/SUFLEX has a wide selection of Astratite® heat shrinkable tubing to insulate and protect circuits, wiring harnesses, fuses, diodes, capacitors, terminals and junctions.

Polyolefin very flexible, flexible or semi-rigid... lower cost Polyvinyl Chloride tubings (cross-linked and non cross-linked) standard wall or thin wall... greater or lesser than 2:1 recovery ratio. All from one source — Essex/Suflex. And most of these Astratite versions are UL listed.

Samples, property data and prices available from 29 Essex/IWI Warehouse/Sales Centers and many independent distributors — or contact: Essex Magnet Wire & Insulation Division, Essex/Suflex, Newmarket, N.H. 03857, Phone: 603/659-5555.

Total fiberoptics (full range)
Total reliability

FORT Optical fibers: from 4 dB to 800 dB
Single-fiber or bundle:
TNC and SMA connectors
Components up to 30 MHz

Why take chances? With FORT, you've got 10 years' experience in the design of reliable optical fibers and cables tailored to your needs... plus an international user-support network at your beck and call.

FORT Z.I. de la Gaudree 5, rue Lambert 91410 DOURDAN FRANCE.
Tel. (1) 492.94.63 - Telex TXFRA 270105 F - REF. 643
Subsidiaries in Germany. Italy, Japan and representation in 15 countries.

RADIATION COUNTERS
for registration of
- alpha radiation
- beta radiation
- gamma radiation
- X-rays
- cosmic rays
- neutrons

Exporter:
V/O TECHSNABEXPORT
32/34 Smolenskaya-Sennaya,
121200 Moscow, USSR
Tel. 244-32-85 - Telex 7628

Come to see us at the Components Hall, Booth 43 Allee 11
Circle 237 on reader service card
### 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 March 15, 1979

This reader service card expires June 15, 1979

<table>
<thead>
<tr>
<th>NAME ( )</th>
<th>COMPANY ( )</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHONE ( )</td>
<td>STREET ADDRESS (Company □ or home □ check one)</td>
</tr>
<tr>
<td>CITY</td>
<td>STATE</td>
</tr>
<tr>
<td>Was This Magazine Personally Addressed to You? □ Yes □ No</td>
<td></td>
</tr>
</tbody>
</table>

**Industry classification (check one):**
- □ Computer & Related Equipment
- □ Communications Equipment & Systems
- □ Navigation, Guidance or Control Systems
- □ Aerospace, Undersea Ground Support
- □ Components & Subassemblies
- □ Test & Measuring Equipment
- □ Consumer Products
- □ Industrial Controls & Equipment
- □ Independent R&D Organizations
- □ Government

**Your design function (check each letter that applies):**
- □ I do electronic design or development engineering work.
- □ I supervise electronic design or development engineering work.
- □ I set standards for, or evaluate electronic components, systems and materials.

**Your principal job responsibility (check one):**
- □ Management
- □ Engineering

---

**Estimate number of employees (at this location):**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>31</td>
<td>46</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>32</td>
<td>47</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>33</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>19</td>
<td>34</td>
<td>49</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>35</td>
<td>50</td>
</tr>
</tbody>
</table>

**Estimate number of employees (at all locations):**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>31</td>
<td>46</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>32</td>
<td>47</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>33</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>19</td>
<td>34</td>
<td>49</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>35</td>
<td>50</td>
</tr>
</tbody>
</table>

---

**Electronics March 15, 1979**

This reader service card expires June 15, 1979

<table>
<thead>
<tr>
<th>NAME ( )</th>
<th>COMPANY ( )</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHONE ( )</td>
<td>STREET ADDRESS (Company □ or home □ check one)</td>
</tr>
<tr>
<td>CITY</td>
<td>STATE</td>
</tr>
<tr>
<td>Was This Magazine Personally Addressed to You? □ Yes □ No</td>
<td></td>
</tr>
</tbody>
</table>

**Industry classification (check one):**
- □ Computer & Related Equipment
- □ Communications Equipment & Systems
- □ Navigation, Guidance or Control Systems
- □ Aerospace, Undersea Ground Support
- □ Components & Subassemblies
- □ Test & Measuring Equipment
- □ Consumer Products
- □ Industrial Controls & Equipment
- □ Independent R&D Organizations
- □ Government

**Your design function (check each letter that applies):**
- □ I do electronic design or development engineering work.
- □ I supervise electronic design or development engineering work.
- □ I set standards for, or evaluate electronic components, systems and materials.

**Your principal job responsibility (check one):**
- □ Management
- □ Engineering

---

**Estimate number of employees (at this location):**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>31</td>
<td>46</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>32</td>
<td>47</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>33</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>19</td>
<td>34</td>
<td>49</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>35</td>
<td>50</td>
</tr>
</tbody>
</table>

**Estimate number of employees (at all locations):**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>31</td>
<td>46</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>32</td>
<td>47</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>33</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>19</td>
<td>34</td>
<td>49</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>35</td>
<td>50</td>
</tr>
</tbody>
</table>

---
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.

Electronics
P.O. Box No. 2530
Clinton, Iowa 52735
Who offers the ultimate in electronic relay automation? The control creators

S-SYSTEM BY ELECTROMATIC OF DENMARK. Also includes Electromatic Level Controls for Liquids and Granulates. Now bringing to America plug-in relay controls unique in modular design and unlimited functionality. Consult the control creators!

ELECTROMATIC COMPONENTS LTD.
742 West Algonquin Road
Arlington Heights, Illinois 60005
(312) 364-0100  TWX 910-222-3452

Outside the United States, contact your Local ELECTROMATIC Sales Office located in 43 countries World Wide

Circle 901 on reader service card

Distributor Inquiries Invited.
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 five-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 Number 902 on Reader Service Card