VOL. 22 NO.

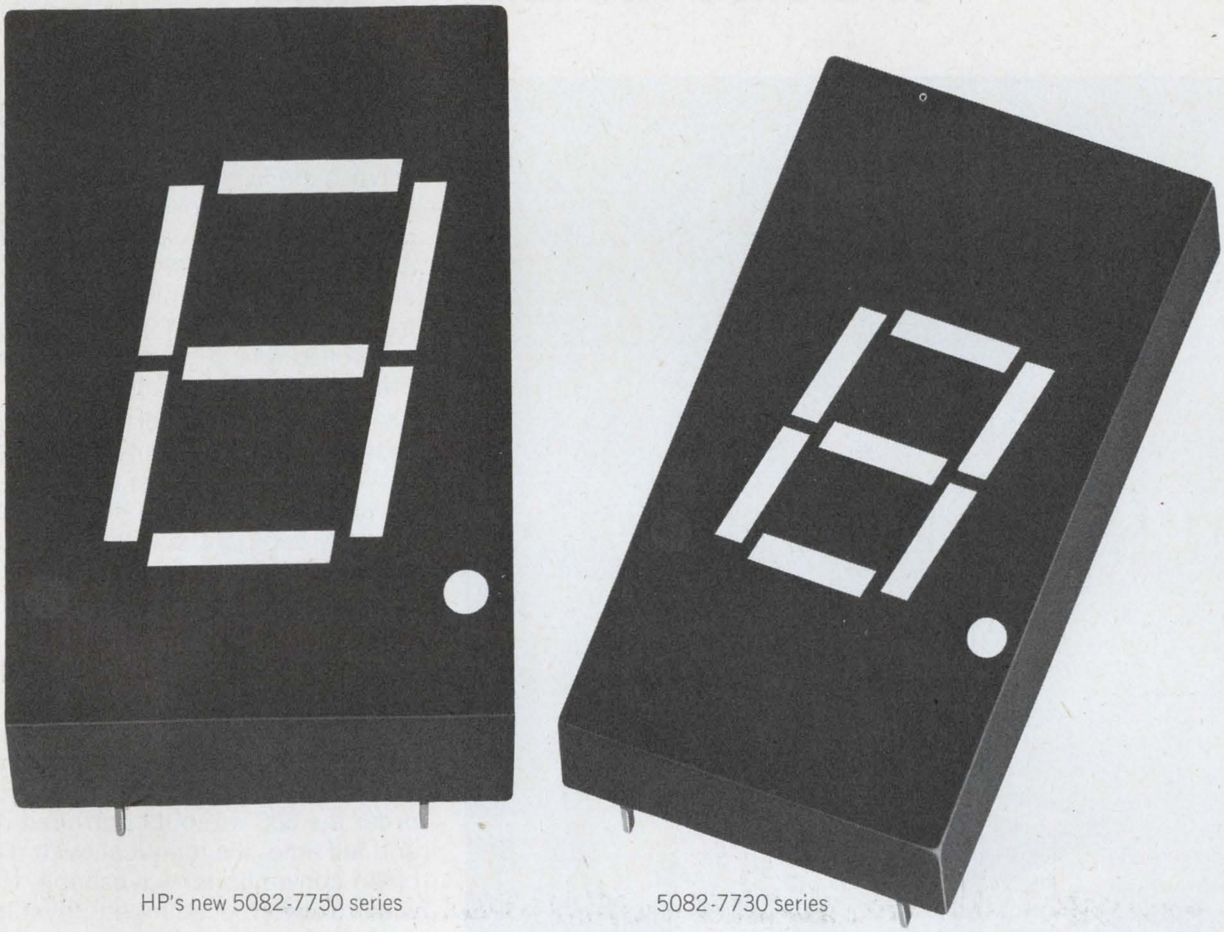
Electronic Design 9

FOR ENGINEERS AND ENGINEERING MANAGERS

APRIL 26, 1974

Large single-computer systems are increasingly being replaced by decentralized installations, consisting of multiple minis, data networks, microprocessors and intelligent terminals. The results? More flexible operation, simplified software and reduced computer downtime. For the latest trends in computer design, turn to P. 61.

SURPRISE!



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5082-7730 series

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01403A *Domestic USA price only.

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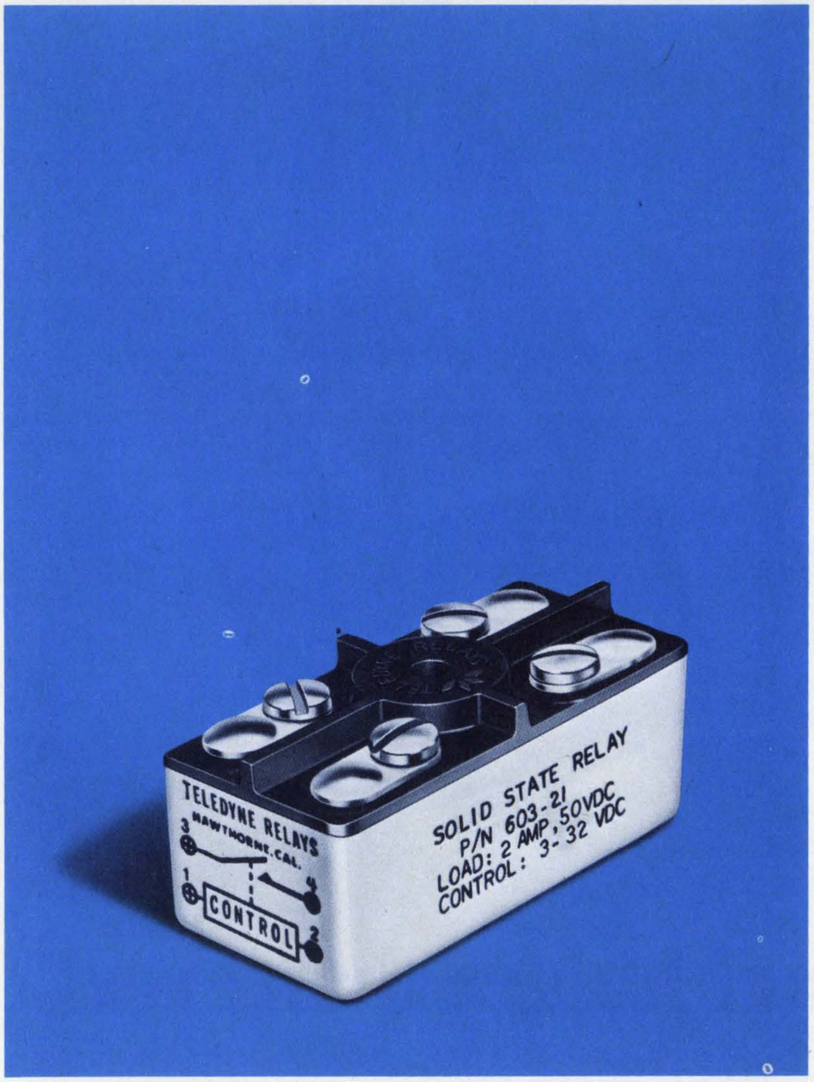
INFORMATION RETRIEVAL NUMBER 2

We shaped up DC

Solid state relay with controlled rise and fall time



Take a good solid state DC relay — Teledyne's 603, for example — add some shaping circuitry so its response waveshape is carefully altered (rise time, turn-off slope, etc.), and something good happens for designers. In-rush currents for capacitive and lamp loads are limited, and so are turn-off transients for inductive loads. Also, controlled rise and fall time minimize EMI and switching transients.

An excellent choice for applications like process control systems, and machine tool controls, the 603 is optically isolated, with sensitive control input (directly compatible with TTL). It's available for loads up to 5 amps, 50 VDC.

The 603 also features Teledyne's exclusive "adaptive" packaging . . . screw or quick-disconnect terminals for chassis mounting, pins for PC boards.

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INFORMATION RETRIEVAL NUMBER 3

Electronic Design

VOL. 22 NO. 9

FOR ENGINEERS AND ENGINEERING MANAGERS

APRIL 26, 1974

NEWS

TECHNOLOGY

PRODUCTS

Departments

Cover: Photo by Frank Chow, courtesy of General Automation, Inc.

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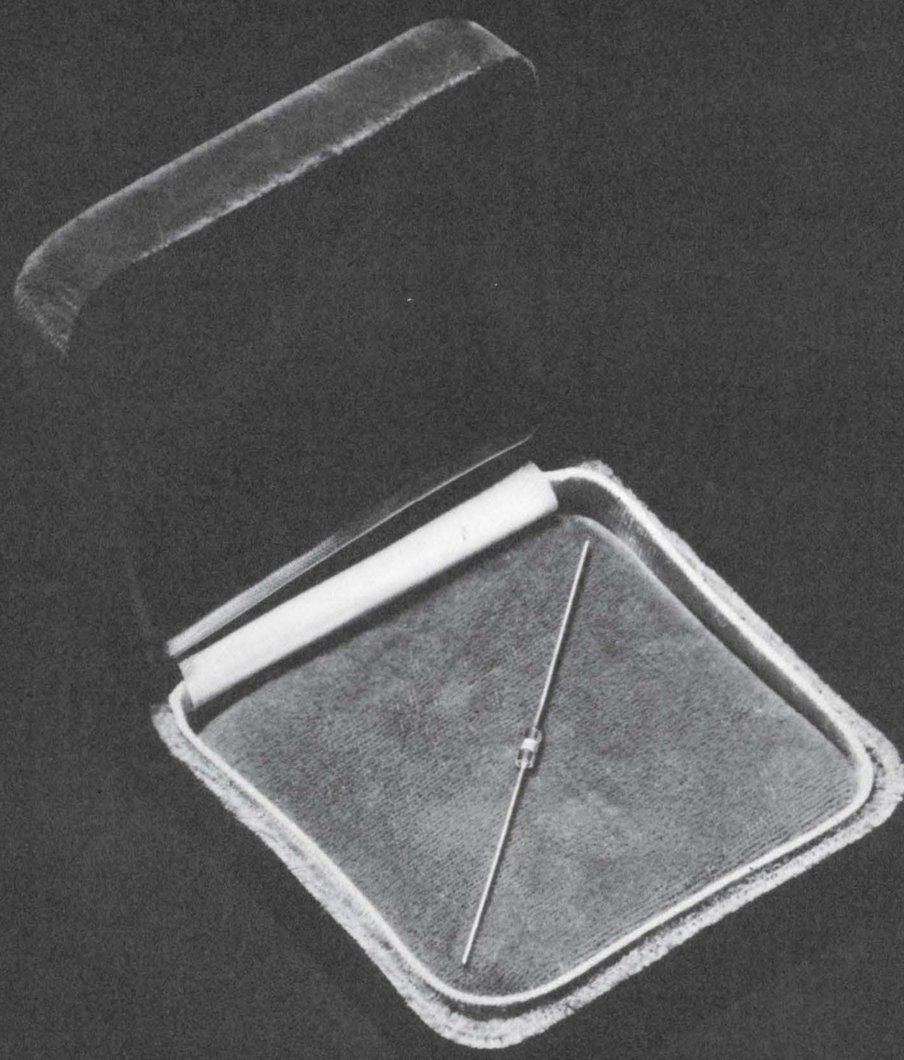
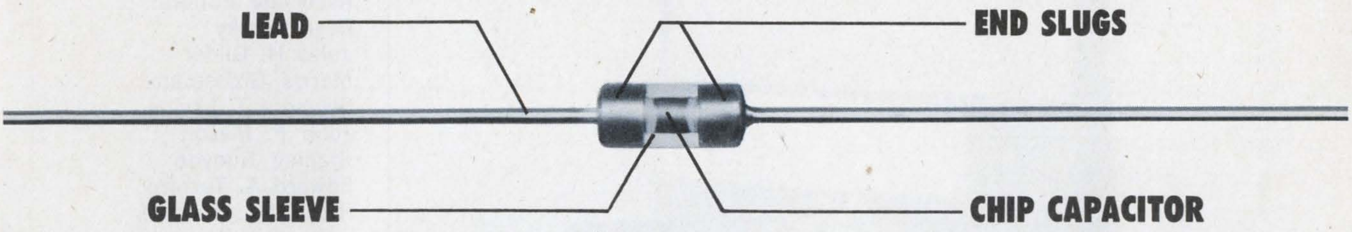
INTRODUCING MONO-GLASS



A JEWEL OF A CAPACITOR



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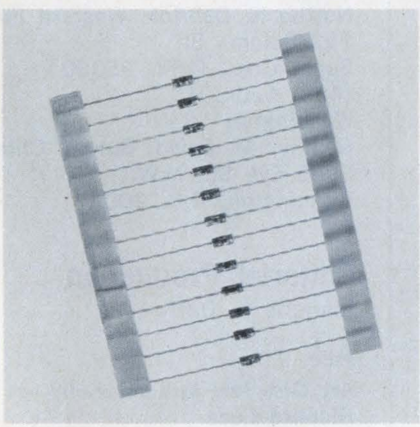
This glass encapsulated monolithic ceramic capacitor offers something special: for the Design Engineer looking for cost reduction and dependability; for the purchasing agent looking for low price with fast delivery; for the incoming Q.C. inspector who is looking for reliability.



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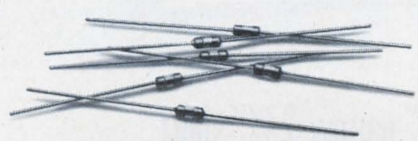
If you use it, you know the substantial savings in time and cost. MONO-GLASS is designed for automatic insertion with the same equipment used for diodes and resistors. Reel packed and ready for your machines.

DURABILITY:

Our hermetically sealed, glass-to-metal construction offers these advantages: solderless internal contacts that won't reflow in your wave-soldering process; no glass fracturing during lead forming—stress is transferred to the end slugs rather than the glass sleeve.



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INFORMATION RETRIEVAL NUMBER 4

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across the desk

Author defends design of v/f converter

This is in reply to Joel Cohen's letter "Promises, Promises—Watch Those Specs" (ED No. 6, March 15, 1974, p. 7), in which he contended the article promised too much.

I don't think the article "Linearize Your V/F Converter" (ED No. 23, Nov. 8, 1973, p. 112) is misleading. The question is whether the figure of accuracy is related to the fsd or the measured value. A glance at the table gives an immediate answer.

The deviation from a straight line is calculated as if the whole error is in the converter. There is, however, an error in the reference source used, as in every other, and the reference level can't be determined exactly. The nonlinearity of the converter is easily covered by the error of V_{in}, seen in the table, even if the frequency is measured with an error of only one digit. One can't really say what has been checked, the v/f converter or the voltage reference.

Look at the number of decades. There are two trimming points in the v/f converter. One is for zero-frequency output adjustment, with the input short-circuited. The other is used to set the conversion factor (Hz/V). Of course, you can't set the v/f so that the transfer curve passes exactly through origin. But it's not unreasonable to set the v/f to oscillate at 0.01 Hz max, with the input short-circuited.

The table and title state that the transfer curve does not diverge more than 0.2 Hz from a straight line. If a voltage-to-frequency curve is plotted—one that exhibits an ideal transfer function—the measured transfer and allowable deviation show that the number of decades would be more than five, rather than less. You can easily increase the upper-frequency limit by a factor of 2 simply by doubling the clock frequency.

Look at the figures of a 0.005%, five-decade v/f converter. Even if the lower voltage limit is as high as 1 mV, it has to be measured with an accuracy of ±50 nV and kept within this small band for a long period. There is a large noise problem involved in such measurements—as well as other problems.

I have shown a way to build, with only two trimming points, a v/f converter that can be compared with a voltage reference where the absolute error is only 10 μV. This was the main purpose of the article. The four hints on how to minimize the absolute error at low levels therefore refer to a further development.

Bengt Alvsten
Fysiska Institutionen
Lunds Universitet
Lund, Sweden

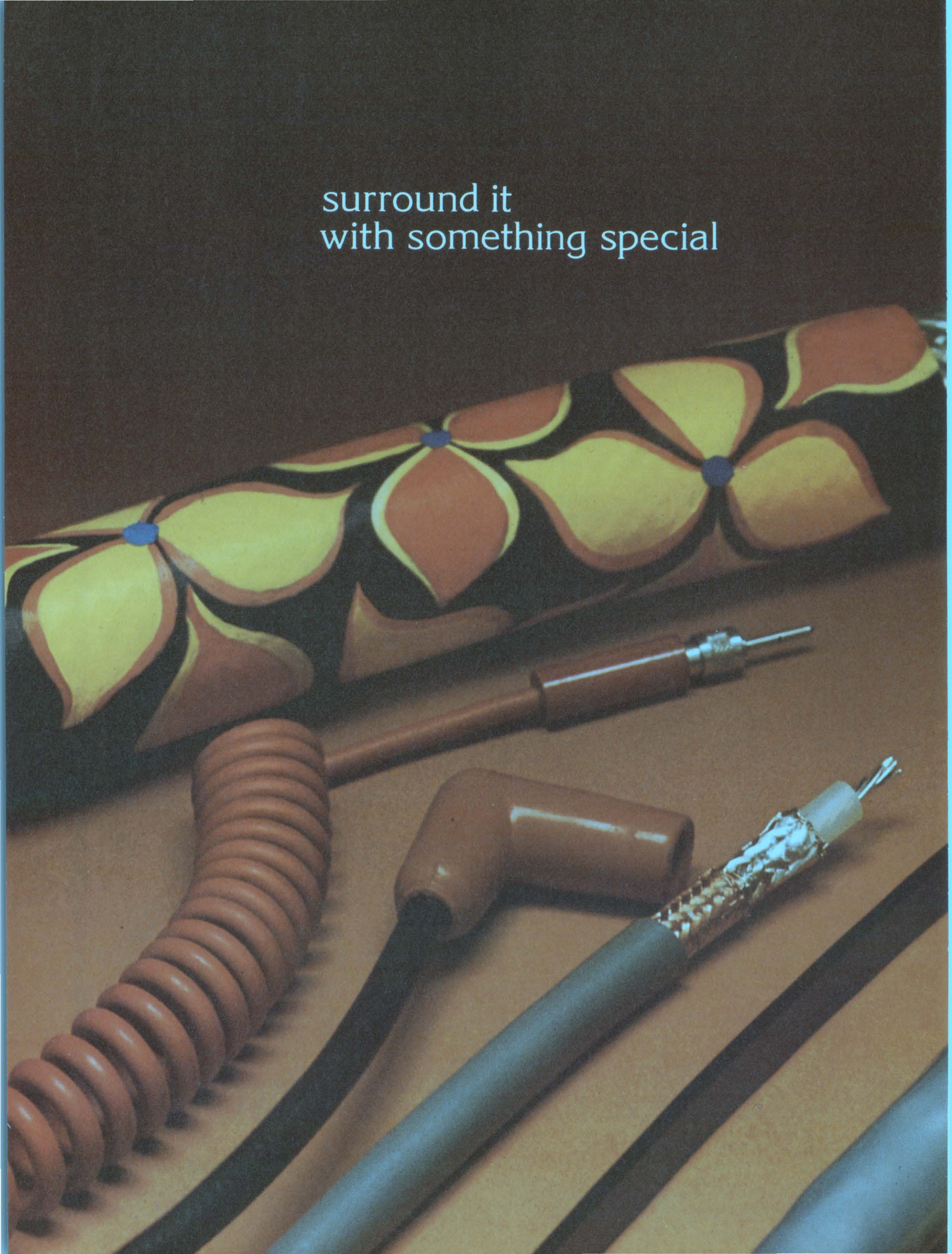
Temporal-priority circuit raises design questions

The circuit in the Idea for Design, "Temporal-Priority Circuit Latches After Receipt of First Input Signal (ED No. 23, Nov. 8, 1973, p. 132), has at least two problems that will bag the unsuspecting designer.

First, it is possible for none of

(continued on page 12)

Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Managing Editor, Electronic Design, 50 Essex St. Rochelle Park, N.J. 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld on request.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INFORMATION RETRIEVAL NUMBER 234

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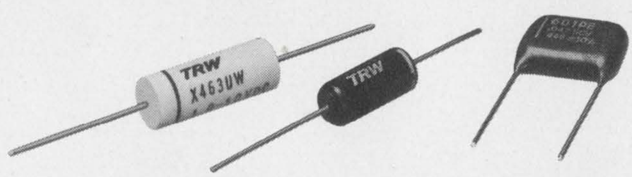

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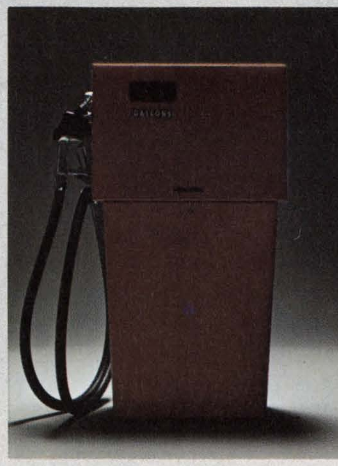

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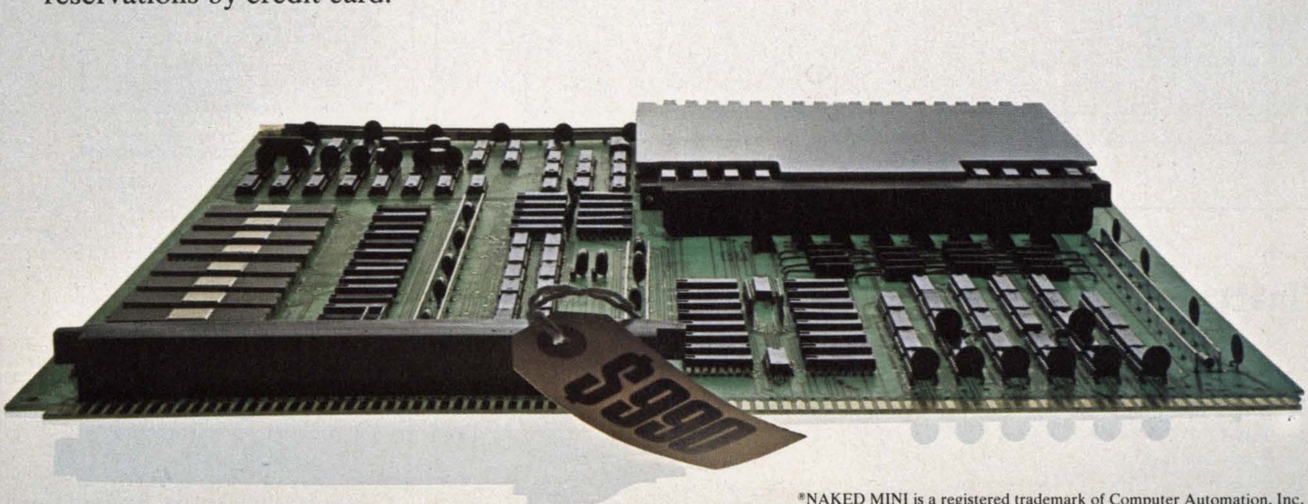

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(continued from page 7)

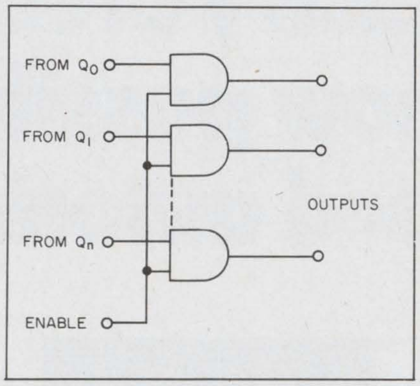
the 174 outputs to be true and to have the G_1-G_2 latch set. Using Texas Instruments' specifications for the devices, one finds the following:

S04 Tphl (min) = 2 ns,
H30 Tphl (min) = 3.4 ns,
174 Tsetup (min) = 20 ns.

Therefore the 174 can be clocked before the data setup spec has been met, resulting in all ZERO outputs.

Second, a timing condition exists where the output of the 174 (or any other flop that I am aware of) will glitch for a period of several times the specified maximum propagation delay of the device. The final result of this glitch may be either ONE or ZERO from the flop. There seems to be a narrow window prior to the clocking edge, during which a change in the steering term drives the flop mad. This glitch can adversely affect downstream logic.

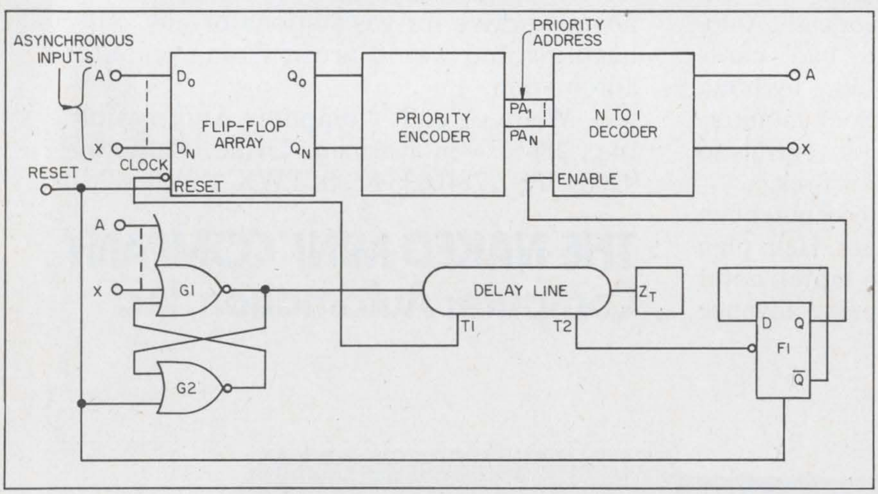
The logic in the illustration will provide unambiguous outputs, at the expense of degraded time resolution and additional components. The delay line tap T_1 is selected such that the minimum



delay of $G_1 + T_1$ is greater than the minimum setup time for the flip-flop used. This ensures that at least one of the Q_N will be set after the strobe.

T_2 is selected such that $(T_2$-$T_1)$ + Tphl (F1) min. is greater than the glitch width of the input flops + the priority encode delay + the decode delay. This combination ensures a valid output at $\approx T_2$ after the initiating event.

J. M. Brown
Senior Member of the Technical Staff
Modular Computer Systems
1650 W. McNab Rd.
Fort Lauderdale, Fla. 33309



'Inaccuracies' reported in log-amp article

There are inaccuracies in the article "The Hows and Whys of Log Amps" (see ED No. 3, Feb. 1, 1974, p. 52).

Logarithmic diodes with seven ranges are available—off the shelf. The contention "...diodes have a

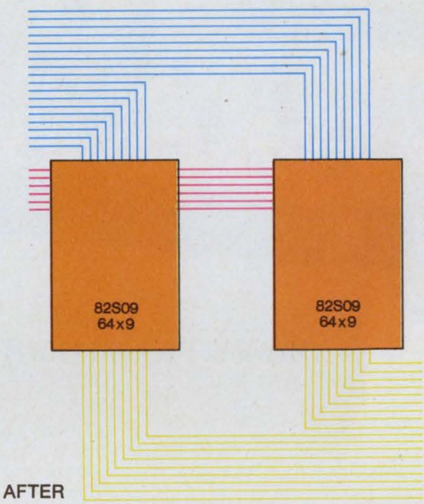
(continued on page 16)

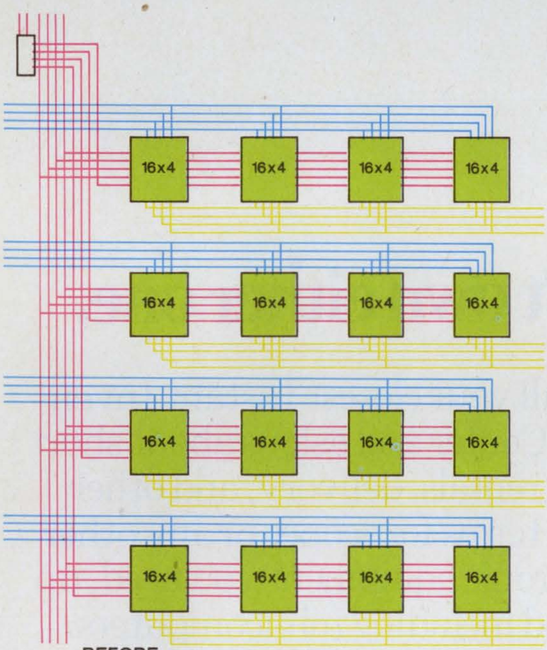
Now, a 576-bit RAM for men of few words.

Target-designed 64 x 9 for 45ns buffers and scratch pads.

Making small talk just got easier. With still another world's first from Signetics. Our 82S09 RAM of 576 bits: the largest bit count ever put into a bipolar RAM with more than one bit per word. This 64 x 9 is available now in volume, and multiple-sourced.

What's in it for you? Say you've got a scratch pad or buffer that only calls for 16 to 128 words. Till now your choices were all bad news. Either you wasted memory capacity with oversized organization and gadgety multiplexing schemes, or you strung together a lot of little RAMs. Either way, you lost. In terms of high tabs for extra circuitry, bigger boards, and the power to keep them going. Not to mention penalties in memory speed.





		"Before"	"After"
Parts Cost*	Decoder 8225/7489	$ 2.80 96.00 $98.80	$ 0.00 85.20 $85.20
Board Space		1.5	1.0
Access Time (1)	Decoder 8225/7489	20ns 50ns 70ns	0 45ns 45ns
Power Dissipation	Decoder 8225/7489	0.1 Watt 6.4 Watts 6.5 Watts	0 1.7 Watts 1.7 Watts
Solder Connections	Decoder 8225/7489	16 256 272	0 56 56

(1) Even with 3101A (35ns), the total 64 x 16 array access time is 55ns.
*Signetics 100-up published price.

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INFORMATION RETRIEVAL NUMBER 10

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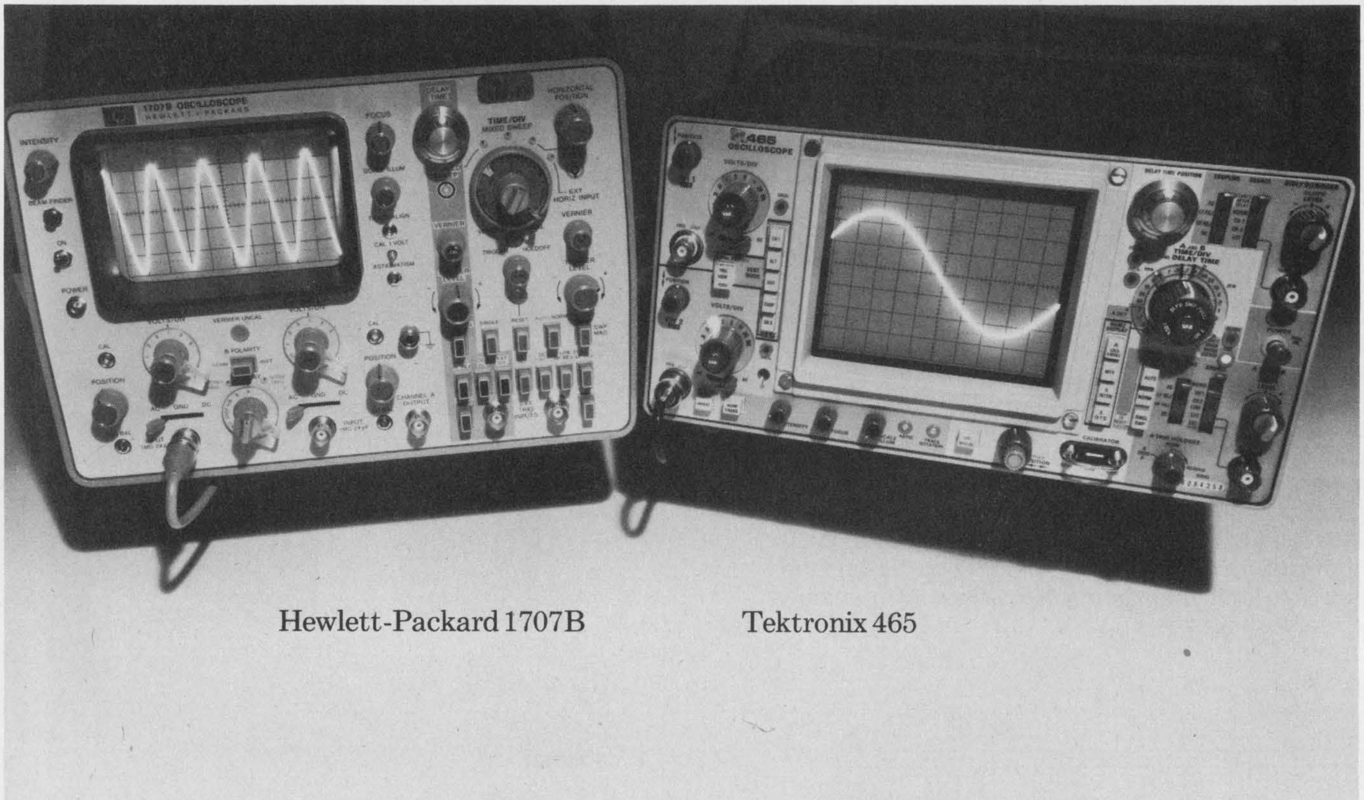

Hewlett-Packard 1707B   Tektronix 465

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INFORMATION RETRIEVAL NUMBER 12

ACROSS THE DESK

(continued from page 12)

limited logarithmic range" did not consider that the dual, matched transistor design has a smaller range. Codi abrupt-junction devices can be specified with maximum deviations of ±2, 5 or 10 mV from the theoretical diode equation.

Sy Glasser
Assistant to General Manager
Codi Semiconductor
Pollitt Drive
Fair Lawn, N.J. 07410

The author replies

Mr. Glasser's point is well taken. Special-purpose diodes, such as abrupt-junction types, can be fabricated or selected for wide logarithmic range. Then the diodes can be computer-matched in pairs for I_s temperature compensation.

In the paragraph following the one quoted, I did say that diode-connected, dual-matched transistors were better than *general-purpose* diodes, which are usually optimized for characteristics other than log behavior.

However, that doesn't tell the whole story. High-β duals, with geometry like that of the AD811, typically cost less than $1 a transistor. And they are inherently capable of as many as six decades of accurate logarithmic behavior when connected as two-terminal diodes—and even more as transdiodes.

Such diodes are inherently matched, and because they are essentially isothermal, they retain the match with either transient or steady-state temperature changes. A 1-C difference is equivalent to a 2-mV mismatch, which corresponds to an input ratio of $\log^{-1}(2/70) = 1.07$, or an error of 7%, assuming mkT/q = 70 mV per/decade.

Your readers may find it interesting to reinterpret the 2, 5 and 10-mV initial log-conformity errors in terms of percentage of the input in a log-ratio circuit, by use of the formula $\% = 100(\log^{-1}\Delta V/70 - 1)$. For example, a 10-mV error corresponds to a ratio-error of 39%.

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No matter where you go, you won't find a more versatile line of circular plastic connectors. AMP has a variety of design options. From mating plugs to panel-mount or free-hanging receptacles. From square flange to feed-thru pressure bulkhead receptacles. They're available with many types of contacts and arrangements. And in popular shell sizes: 11, 17, 23. What's more, there are sealing boots, strain relief/shield components, posted or solder contacts, plus standard or splashproof models.

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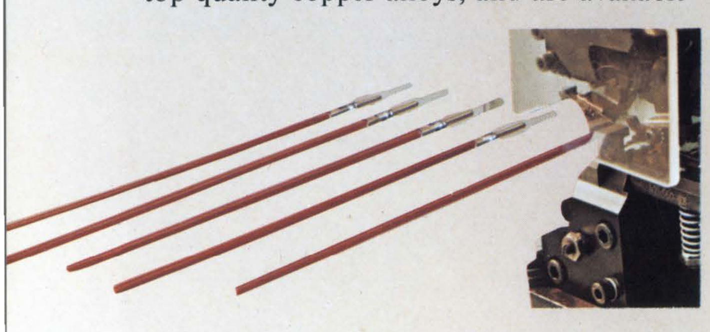

AMP automatic machines. For high-speed termination.

The contacts are supplied in continuous strip form. So termination is possible at volume production rates. And at the lowest possible cost to you. To be certain that you'll be able to take full advantage of these savings, AMP worldwide has over 1,000 field service and sales engineers to assist you with design and production applications. No matter where in the world you're using AMP commercial connectors.

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AMP is at the core of reliable circular plastic connectors.
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AMP has some 100 manufacturing plants, warehousing facilities and sales offices worldwide. So we can handle virtually all your circular plastic connector needs no matter where you're doing business. Call (717) 564-0100. Or write AMP Incorporated, Harrisburg, Pa. 17105.
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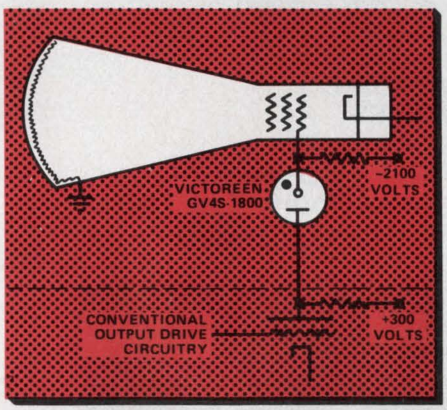
Problem solving... with Victoreen High Voltage Technology

1 UNORTHODOX CRT DRIVE

How did we meet ever-expanding requirements for increased bandwidth and lower power consumption, coupled with the availability of high-voltage zener-type diodes (Victoreen Corotrons)? With an unorthodox drive scheme for CRT's.

Basically, this scheme is a mirror-image of the conventional method. Instead of supplying the CRT anode with very high voltage, we ground the anode and supply a drive signal, riding at approximately — 1800 volts, to the grid. The advantages? Being direct-coupled there are no reactive components to limit high-end frequency response or cause roll-off



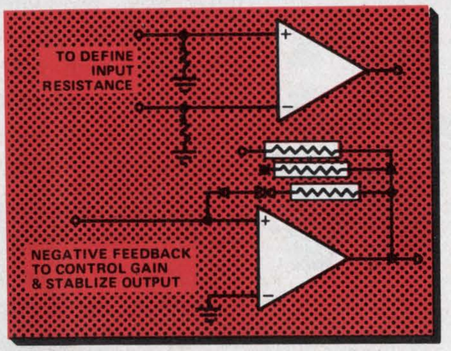
at the low end. Second, the face plate of the CRT does not build up static charges which can distort the display.

Even though the Corotron operates in the corona mode of discharge, it has no voltage jumps or jitters. Corotrons are not tied to "natural" operating voltages and are adjustable in manufacture from 350 to 30,000 volts. Corotrons also have a positive regulation curve eliminating possible relaxation oscillation.

2 FROG MUSCLES TO BRAIN WAVES

Colleges and universities, medical research laboratories and a number of R&D firms are faced daily with the need for controlled high-amplification of a wide variety of extremely low level signals. Such signals are derived from frog-muscle experiments, brain-wave measurements, cardiac research, avalanche-breakdown, currents in ionization chambers as well as from a range of constant-current sources.

The operational amplifier provides the amplification required because of theoretical infinite-gain characteristics. However, at full gain an op-amp tends to be unstable and go into oscillation; further, amplified signals are difficult to fully analyze if the gain is unknown.



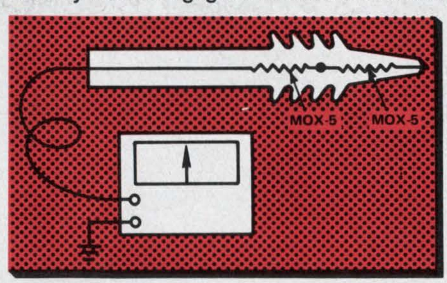
Victoreen MINI-MOX resistors are used widely to modify op-amp characteristics to: 1. Stabilize output and eliminate oscillation. 2. Define gain so measurements can be quantified. 3. Restrict bandwidth to the region of specific interest.

Smaller than a conventional resistor and compatible with a TO-3 can, MINI-MOX resistors are ideal for highly-stable, low-level, miniature electronic circuitry.

They typically have a voltage coefficient of −5 ppm/volt, full-load drift of less than 2% in 1000 hours, temperature coefficient of 100 ppm, and a Quantech noise of less than 1.5 μV/volt at 20M ohms. They are available in values from 100K to 10,000M ohms in 1, 2, 5 and 10% tolerances.

3 A PROBE FOR HIGH POTENTIAL

Two Victoreen MAXI-MOX resistors used in series can serve as a probe in radar circuitry capable of measuring voltages up to 60,000 volts. The probe, compatible with a number of voltmeters of different manufacture, has both short- and long-term stability. Short-term stability assures negligible drift and fluctuation



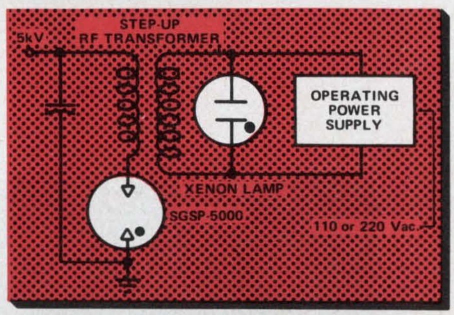
during measurement, while long-term stability maintains the original calibration accuracy of the probe.

Each MOX-5 resistor used in the probe has a maximum operating voltage of 37,500 volts with a power rating of 12½ watts. The voltage coefficient is 1 ppm/volt over the complete voltage range of the MOX-5, while the temperature coefficient is better than 300 ppm from −55° to 125°C.

MAXI-MOX resistors have full-load drift less than 1% in 2000 hours of operation, and are available in tolerances of 1, 2, and 5% in values from 10K to 2,500M ohms. A silicone varnish conformal coating provides environmental protection while allowing a maximum hot-spot temperature of 220°C. In addition, it is compatible with commonly-used potting compounds.

4 SPARK GAPS SPARK INTEREST

Victoreen SGSP spark gaps normally protect electrical circuits from damage from transient voltage spikes; however, Optical Radiation Corporation, Azusa, Ca. uses them to ignite a Xenon lamp in a theatrical lamphouse to project motion pictures. Xenon lamps provide two



advantages; one, being very small and brilliant, light radiation is easier controlled; second, efficiency is higher, so smaller lamphouses with greater output result. The design won the company an Academy Award in technical achievement.

In operation, the capacitor is charged until the SGSP-5000 breaks down. The stored energy is released through the transformer primary, producing a very high voltage pulse in the secondary which ignites the Xenon lamp. This provides an extremely reliable method of starting the lamp. Once ignited, operation is sustained by a lower-voltage line operated power supply.

Victoreen Instrument Division of VLN Corp. 10101 Woodland Avenue Cleveland, Ohio 44104

VICTOREEN

INFORMATION RETRIEVAL NUMBER 14

TREAT THIS 300 NSEC, NMOS MEMORY LIKE A COMPONENT

JUST PLUG IT IN

You're looking at the new MICRORAM 3000N, a complete NMOS semiconductor memory on a single printed circuit card assembly. Just plug in a power supply (±15VDC, +5VDC) and you have a fully functional memory system that cycles at 300 nsec, and accesses at 180. (A high speed version that cycles at 180 nsec. is available, too.)

The MICRORAM 3000N is available for delivery to meet your production schedules. It mounts on a printed circuit card 11.74″ by 15.4″, and is basically compatible with our MICROMEMORY 3000 core memories. The standard 16K by 20 configuration is alterable to 32K by 10. Numerous other capacities and word lengths are also available.

Like all members of the MICROMEMORY 3000 Family, the MICRORAM 3000N is available either as a single card memory or as a multi-card system in a chassis containing up to 16 memory cards, power supply, self-test and interface cards and various other options.

Get the full story on the MICRORAM 3000N from your local EMM office or call Commercial Memory Products Marketing Department at (213) 644-9881.

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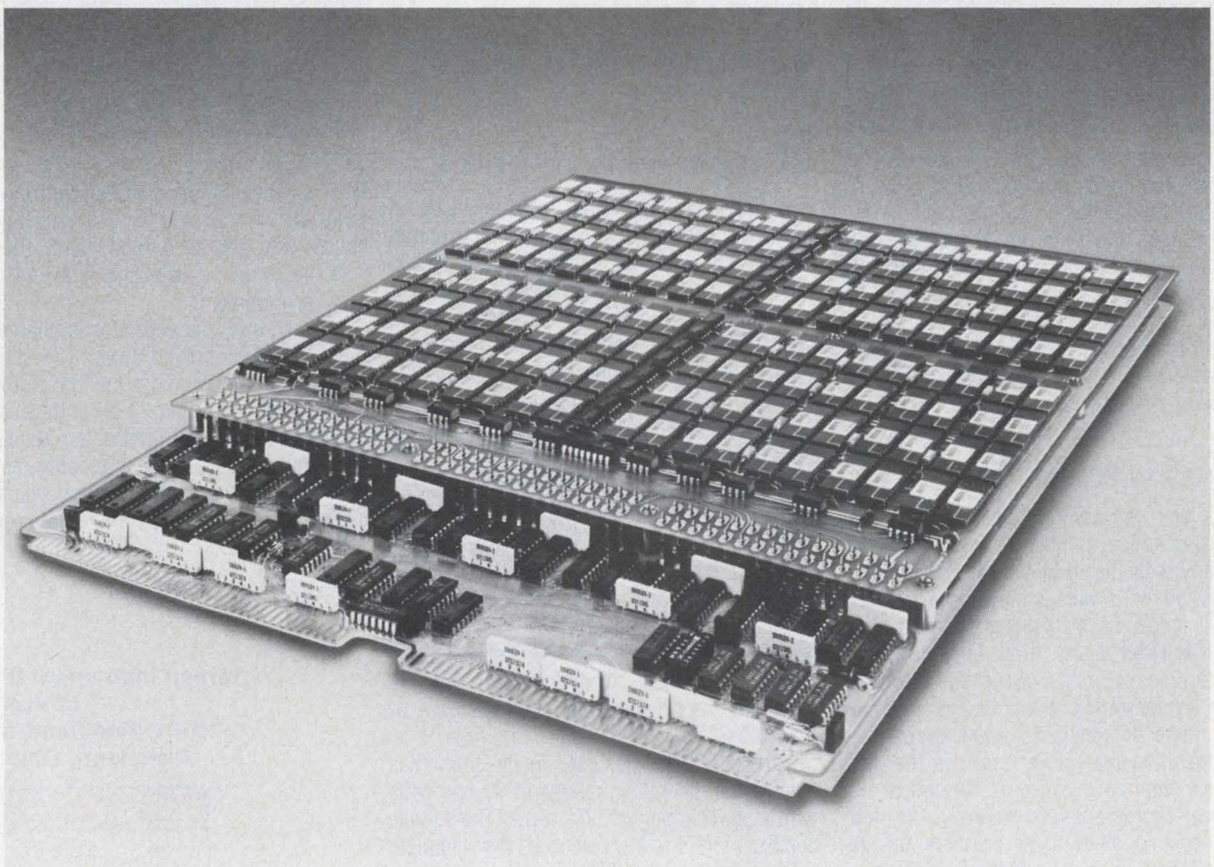

"See us at the NCC Show in Chicago, Booth 671"

INFORMATION RETRIEVAL NUMBER 15

The world's biggest little black box is coming your way

It's a unique display of TRW Electronic Components' newest, most exciting products, circuit applications and ideas. A walk-through exhibit of TRW state-of-the-art technology, coming right to you.

And its form is every bit as unique as its content!

Picture a typical electronics chassis, grown to mammoth proportions. In fact, to the size of a 40-foot tractor-trailer; far and away the world's *biggest* "little black box." Inside are scale models of all the most familiar components, but looking like nothing you've ever seen before—because the scale is *giant*. Five feet high for some.

Our technical experts will be on hand to answer specific questions. And you'll get a close-in view of more than 1000 life-sized products. They represent the 14 separate divisions that, together, form TRW Electronic Components—a single entity that can be the source for all your electronic component needs. That's why it takes the world's biggest little black box to show-and-tell our story of electronic components from A (actuators) to Z (Zener diodes).

And the show is on the road right now—right into your plant's parking lot, or somewhere nearby. We're zig-zagging our way across country, stopping at 155 plants in 27 states.

Watch for announcements of when we'll be in your area. TRW's little black box is where electronics is, and we're bringing it to where you are.

Because we *are* TRW.

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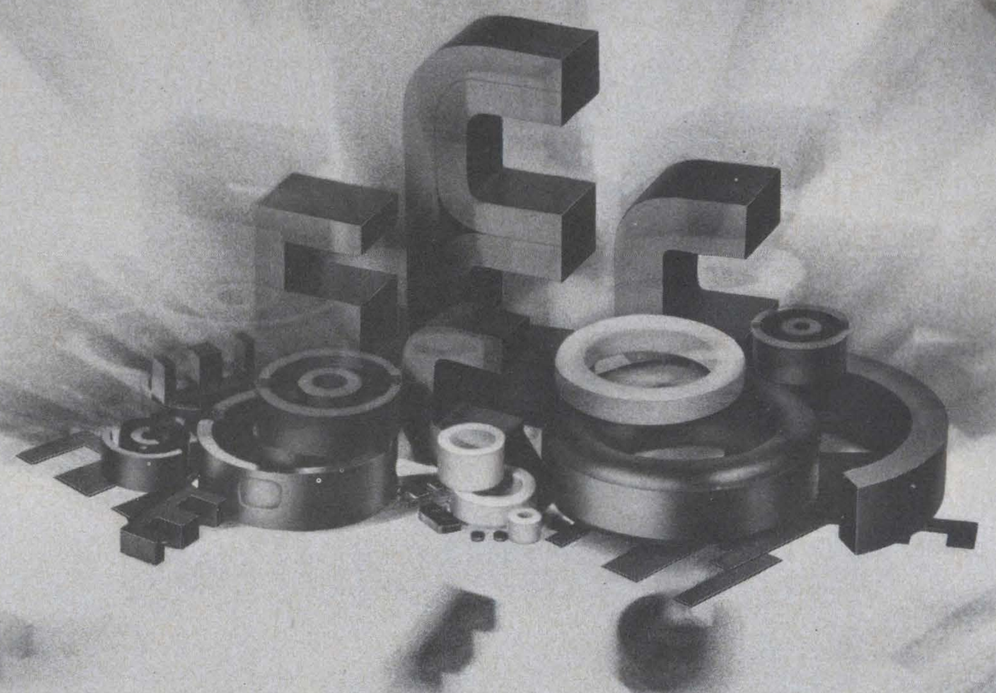
When Viking talks to us from Mars it'll use cores by Magnetics.



Best reason on earth to rely on us for your own communications components.

Magnetics' miniature tape cores were used in the computers that sent our astronauts to the moon and back. And now we're exclusive supplier of tape cores, powder cores, nickel-iron C cores and bobbin cores for the Viking Mars Lander.

In addition to reliability, we offer you a choice when it comes to your magnetic components—whether they're off-the-shelf or something specially developed for your needs.

Low core loss, temperature stability, frequency stability, Hi Q, low cross talk, low dc shift, time stability—these are just a few of the demanding properties we can fill. For applications like filters, inverters, oscillators, load coils, bridge lifters and many others. From telephone circuits and mobile communications to space communications.

To learn more about us and our broad range of components, including ferrite cores, send for our application and product literature, Bulletin APB-1.

MAGNETICS

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INFORMATION RETRIEVAL NUMBER 18

For years, people thought Teletype® machines only talked to themselves.

Teletype is a trademark registered in the United States Patent Office.

Fact is, Teletype machines have been carrying on intelligent conversations for years with some of the fastest information movers in the world. Computers.

We've earned a good, solid name for ourselves in computer communications because our equipment is compatible with practically any computer-based system.

Our product line proves the point.

The number one standard-duty data terminal in the industry is our model 33 series. And our new wide-platen model 38 offers big system features at economy system prices.

Heavy-duty operation with minimum maintenance? Check out our model 35. And our model 37 series delivers the utmost in flexibility and vocabulary for complex data systems.

We also build equipment for paper tape systems, as well as a magnetic tape terminal for greater on-line savings. As you can see, our reputation in point-to-point communications has served us well in computer terminals. No one comes close to us in reliability, flexibility and economy.

It takes more than manufacturing facilities to build the machines Teletype Corporation offers. It also takes commitment. From people who think service is as important as sales. In terminals for computers and point-to-point communications.

That's why we invented a new name for who we are and what we make. The computercations people.

TELETYPE ®

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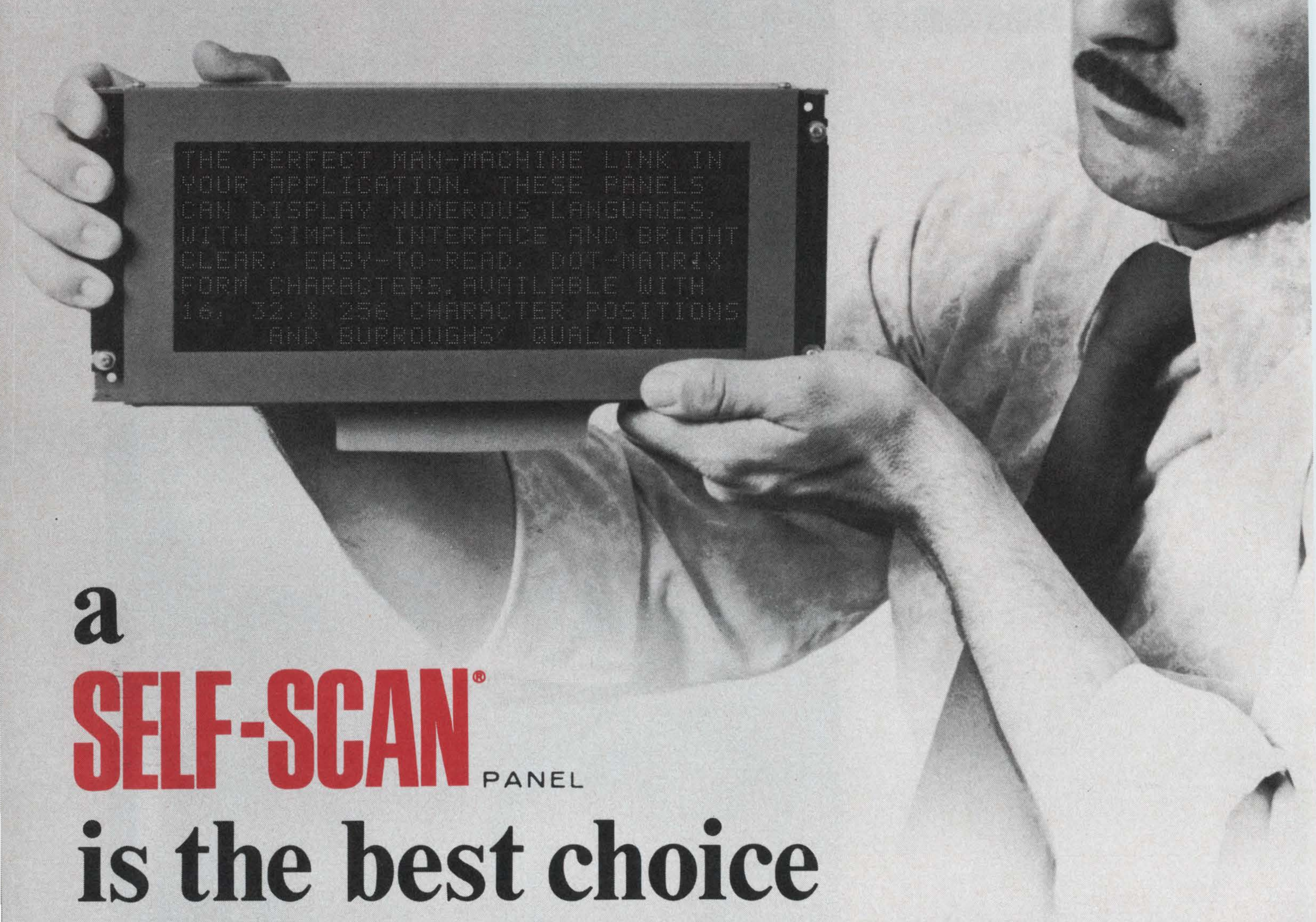
you can see why...



a SELF-SCAN® PANEL is the best choice

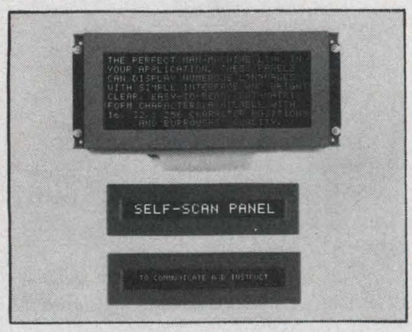
SELF-SCAN panels are best because they can provide alphanumeric display of data — 16 to 256 characters per message — for data entry, automatic checkout systems, wherever man-machine interface takes place.

SELF-SCAN panels are best because they are brighter. Burroughs technology makes possible sharp characters with no fuzziness, no loss of focus, no distortion, a 120-degree viewing angle, and readability up to 25 feet with minimum glare and reading fatigue.

SELF-SCAN panels are best because they are the most versatile self-contained display panels commercially available. A wide variety of character generators offers 45 different displays, including Cyrillic, Hebrew and Karakana alphabets as well as standard ASCII code.

SELF-SCAN panels are best because they can be packaged in less than 1/2" depth and are less costly than CRT's with comparable message capability. The cost per light-emitting dot will amaze you.

Want to see SELF-SCAN panels in operation? Write the Electronic Components Division, P. O. Box 1226, Plainfield, New Jersey 07061, or call (201) 757-3400 or (714) 835-7335 for a demonstration.



You can see the difference

INFORMATION RETRIEVAL NUMBER 20

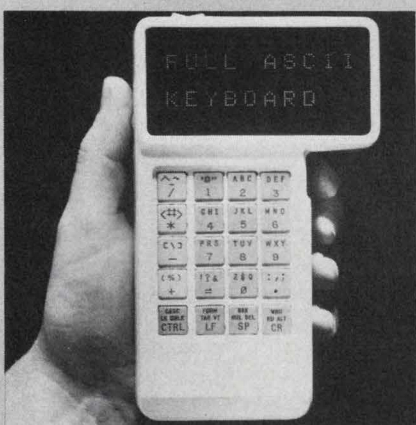
Burroughs

Hand-held computer terminal gives a full ASCII display

A hand-held computer terminal that looks more like a pocket calculator than a computer input device will be introduced next month at the National Computer Conference in Chicago.

Called Termiflex, the pocket-sized terminal features a 20-switch keyboard that, along with three special shift keys, can generate all 128 ASCII characters.

William Turner, vice president of Termiflex Corp., manufacturer of the terminal in Nashua, N.H., notes that as data are received,



they appear as one or two-line displays. A display line consists of 10 5 × 7 LED dot-matrix characters. When a line is filled, the display scrolls automatically. A 1000-character scrolling memory is built into the unit. And by operating one switch, the user can move forward or backward in this memory, to recover any part of a message that has been sent or received.

The hand-held feature lets engineers perform diagnostics anywhere in the computer room. And production engineers can start up, direct or monitor a system, without need to walk back to a teletypewriter or command console whenever they want to input an instruction.

Other applications for the terminal include use as an auxiliary in debugging systems, as a control device for automated drafting systems, in field service and in demonstration of computer equipment.

The Termiflex also features several selectable parameters. These include communication speed, which can be 10, 15, 30 or 120 characters per sec. Parity can be chosen as either odd, even, mark or space. And the transmission mode can be selected as either half or full duplex. Other selectable features include upper or lower-case letters and line justification.

The basic terminal, with a one-line display and a 500-character memory, costs $1190. For a two-line display with a 1000-character memory, the price is $1570. For $480 more, an acoustic coupler, power supply and carrying case are available.

Heart monitor replaces skin-piercing methods

With the development of an instrument called an impedance cardiograph, the mechanical pumping activity of the heart can now be monitored without puncturing of the skin. Heretofore implanted sensors or the injection of tracer elements into the blood were required.

According to Winston Hagen, vice president of Instruments for Medicine, Greenwich, Conn., which manufactures the new machine, the impedance cardiograph can measure cardiac output, stroke, volume and contractility, as well as peripheral circulation and chest fluid changes—all with an accuracy equal or superior to commonly used skin-puncturing methods.

Four band electrodes are connected to a patient—two around the neck and two around the chest, Hagen explains. The lower neck electrode and the upper chest electrode are both used to set up a reference impedance, which eliminates the need for external calibration. The other two electrodes provide information that enables the instrument to generate a continuous flow trace.

The flow trace is an electronic analog of the information normally obtained by the surgical implantation of an electromagnetic flowmeter on the ascending aorta. Any standard recorder or cardioscope can be interfaced with the impedance cardiograph to display the trace.

While the use of impedance monitoring is not new, notes Hagen, its successful application to cardiac monitoring is. Previous applications of the impedance technique have been largely in the area of respiration monitoring.

The basic idea for the system, says Hagen, came from the instrumentation developed to monitor the Mercury astronauts. However, circuit improvements, particularly in oscillator stability, were neecssary.

A major advantage of the impedance cardiograph, Hagen points out, is that it can monitor a patient continuously. This is not possible with skin-puncturing, which inject dyes or radioactive tracers into the blood.

Large-scale display to use 3-color LEDs

A large-scale, three-color LED display is under development for the Army by the Data Systems Div. of Litton Industries in Van Nuys, Calif.

According to David M. Piatt, manager of advanced display technology, the contract calls for a 36-in.^{2} feasibility model for the Electronics Command in Ft. Monmouth, N. J. It is, says Piatt, the first step toward development of a 4-ft.-square, 3-in.-thick, three-color flat panel that will be overlayed by a standard, printed military map for tactical display.

The display is to contain an array of 1024 × 1024 LEDs on 45-mil centers, of a type produced by

Texas Instruments in Dallas and Bowmar Ltd. in Ottawa, Canada. The display will present alphanumeric symbols, vectors and graphics in red, green and yellow at a resolution of 22.5 lines per in.

The 36-in.^{2} feasibility model will be constructed with 32 LED modules, each 3/4 × 1-1/2 × 4 in. deep. Each module will contain 512 LEDs, arranged 16 × 32, plus column and low-driver electronics, and a dual, 512-bit MOS refresh memory. One-half of the memory will control the red-diode mode, and the other half will control the green mode. When both red and green are called for, the diode will glow yellow. The diodes will be of GaP material and will emit a color determined by drive level.

The large display will be built of rows of these modules—32 across and 64 down, for a total of 2048. Using a proprietary multiplexing scheme, all 2048 modules, including over a million LEDs, will be addressable with approximately 127 lines from the display generator.

The updating of a character, symbol or vector on the display is to be accomplished in 64 μs, and display surface is to consume only about 350 mW/in.^{2} of power.

Acoustic microscope nearing production

The first acoustic microscope—a device that uses microwave sound instead of light to see details inside materials heretofore impossible to see—is ready for production, according to Lawrence W. Kessler, president of Sonoscope, Inc., Bensonville, Ill.

Kessler, who was one of the original researchers at Zenith Radio, where the system was developed, reports that a demonstration model is under construction at Sonoscope. The company is build the microscopes under an exclusive license from Zenith, Kessler says.

The acoustic system is a true microscope, the Sonoscope president points out, having a field of view that is limited to about 3 mm, which is typical of standard optical instruments.

"We can get resolutions down to about 3 μm at sonic frequencies of 500 MHz," Kessler says. The resolution of present equipment is on the order of 15 to 20 μm with frequency in the range of 100 to 200 MHz, he points out.

Real-time images are obtained with 100 and 200-MHz sound, Kessler says, while the pseudo real-time images are produced at 500 MHz.

In operation, the acoustic microscope illuminates the specimen with vhf or uhf sound. The sound is transmitted through the specimen to impinge on an optical mirror. This mirror becomes distorted by the sound pattern, which carries details of the specimen's internal structure. The mirror distortions are read out with a scanning laser beam. The beam is synchronized with the raster of a TV monitor, and the laser image is picked off the mirror and produced on the TV screen.

Because the sonic picture contains details of the internal structure of the material under examination, it is substantially different in appearance from a surface view with an optical microscope. For orientation, Kessler points out, the sonic microscope also gives the user an optical, surface image of the area being scanned at the same time he gets the sonic picture.

If there are many useful details in both pictures, Kessler says, the operator can superimpose both visual and sonic pictures on a color TV monitor. The visual picture is presented in one color and the sonic picture in another.

2 new ways reported to detect trespassers

Changes in the capacitance of buried, sensitive wire and a coaxial cable rigged to function as an electret microphone are two of the newer techniques being tested by the electronics industry to detect trespassers. The work was described last week at the University of Kentucky in Lexington, at the Carnahan Conference on Electronic Crime Countermeasures.

In the wire technique, standard Teflon-covered hookup wire is used because it has electret qualities. The wire is threaded into a metallic tube and buried a few inches beneath the ground. The device detects personnel or a vehicle passing above it, according to Fred S. Geil, manager of audio and ultrasonic technology at the Westinghouse Research Laboratories in Pittsburgh, where the setup is being investigated.

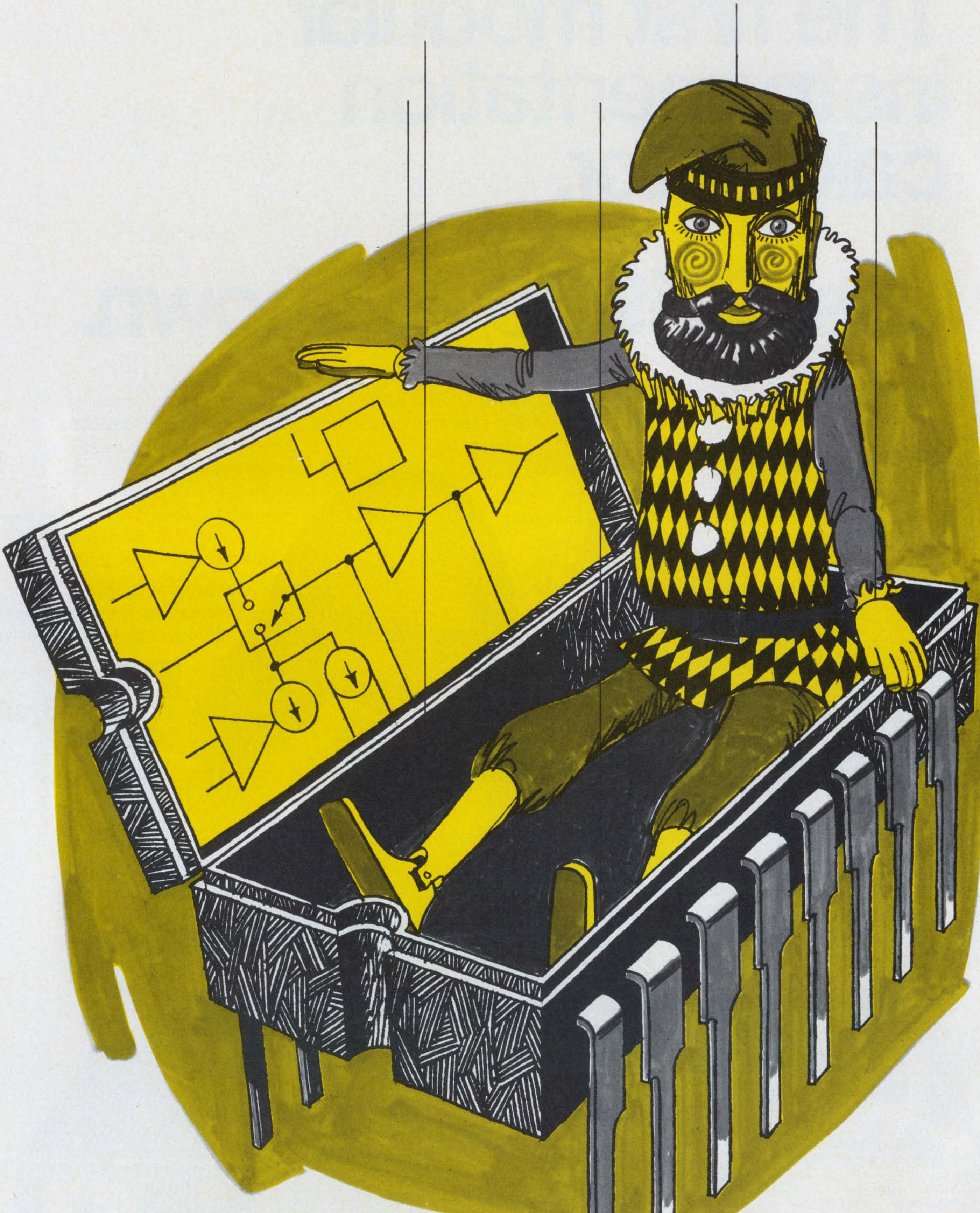
In tests to date, the tube has been an ordinary refrigerator tube. The wire acts as a capacitance sensor, detecting capacitance changes between it and the tube. Such changes occur through pressure and vibration. If a person crosses the buried wire slowly, the tube bends very slightly, causing a small displacement of the wire and thus a low-frequency response. The impact of the intruder's step also causes vibration—a rattling of the wire in the tube. This causes a high-frequency response. The redundancy provided by these two responses insures a high immunity to false alarms.

The second device to foil the bad guy is a standard Teflon coaxial cable that functions as an electret microphone. The device detects intruders climbing or cutting a wire fence, or passing over a road, if it's buried, according to Kirby Miller of GT&E Sylvania's Western Div. in Mountain View, Calif., which is developing the alarm.

The cable is processed under elevated temperature and high voltage, which transforms it into an electret transducer. When the cable is attached to a fence with ties, vibrations in the fence can be detected. With a special processor, it's possible to detect signatures that reveal whether someone is climbing the fence or cutting it, Miller says, and the device discriminates against unwanted alarms. The readout is either a flashing light or an audio tone.

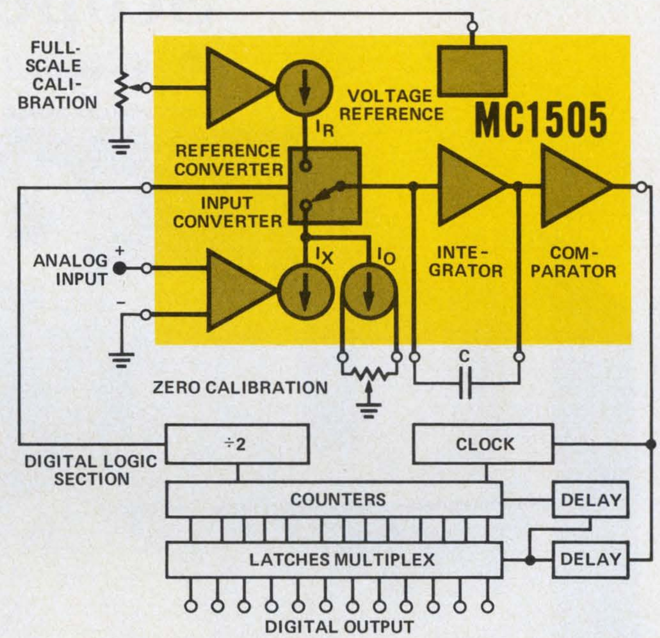
DOD standard designs

Defense officials say the current shortage of components for military programs is leading to standardized designs and the coordination of requirements among programs. The Pentagon is looking towards a program instituted by the Air Force's space and missile systems organization which requires designers to check approved parts lists during design and to justify any deviations from them.



Like A Puppet On A String

The MC1505L performs the diverse roles required of analog-to-digital converter subsystems. Instrumentation, data acquisition, industrial controls, or remote sending. Wherever you call for an analog signal to be displayed or controlled digitally, the MC1505L A/D Converter Subsystem can be your marionette.



Behind The Scenes

The tried and true "dual ramp" technique. Your assurance of system immunity from all but the most rapid changes in external component values, temperature drifts, etc.

In The Spotlight

Accuracy. Outstanding accuracy. With the digital system of your choosing; counters, a clock, and some gates, you can show off an A/D converter of either 3½ or 4½ BCD bits or up to 13 bits in the binary code.

Simplicity. Since the MC1505L provides its own voltage reference, two calibration potentiometers (full scale and zero adjust) and one integrating capacitor are all you need for normal operation in the A/D subsystem itself.

Compatibility. The digital logic system is yours for the choosing. Digital inputs and outputs are equally at home with either TTL or CMOS.

Conservation. Keep Watts under your thumb with the MC1505L's low power consumption of 42 mW @ +5.0 V. Tailor-made for battery operated instrumentation systems. Like those using CMOS. And, single power supply operation (+5.0 to +15.0 V) lets you eliminate extra circuitry.

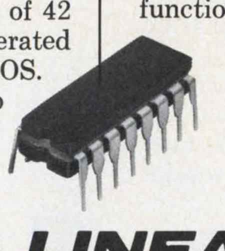
Budget Production

An A/D converter doesn't need to cost the typical hundred dollar plus figure associated with many twelve bit modular units. Comparable accuracies can be yours simply by building onto the MC1505L with a few dollars worth of counters and gates. For a thrifty $5.95 (100-up) you can get started with our limited temperature range version MC1405L subsystem.

Put It All Together, It Spells Success

Try it in a 3½ or 4½ digit A/D converter – combined with either CMOS or bipolar logic for the complete A/D converter function. Particulars can be found in the detailed 14-page data sheet. The data sheet can be found at P. O. Box 20912, Phoenix, Arizona 85036, or circle the reader service number below.

Try the MC1505L wherever you want to digitally display, process, measure, control or store an analog function.



Try it in quantity, off-the-shelf today.
The MC1505L analog-to-digital converter subsystem.
Your wish is its command.

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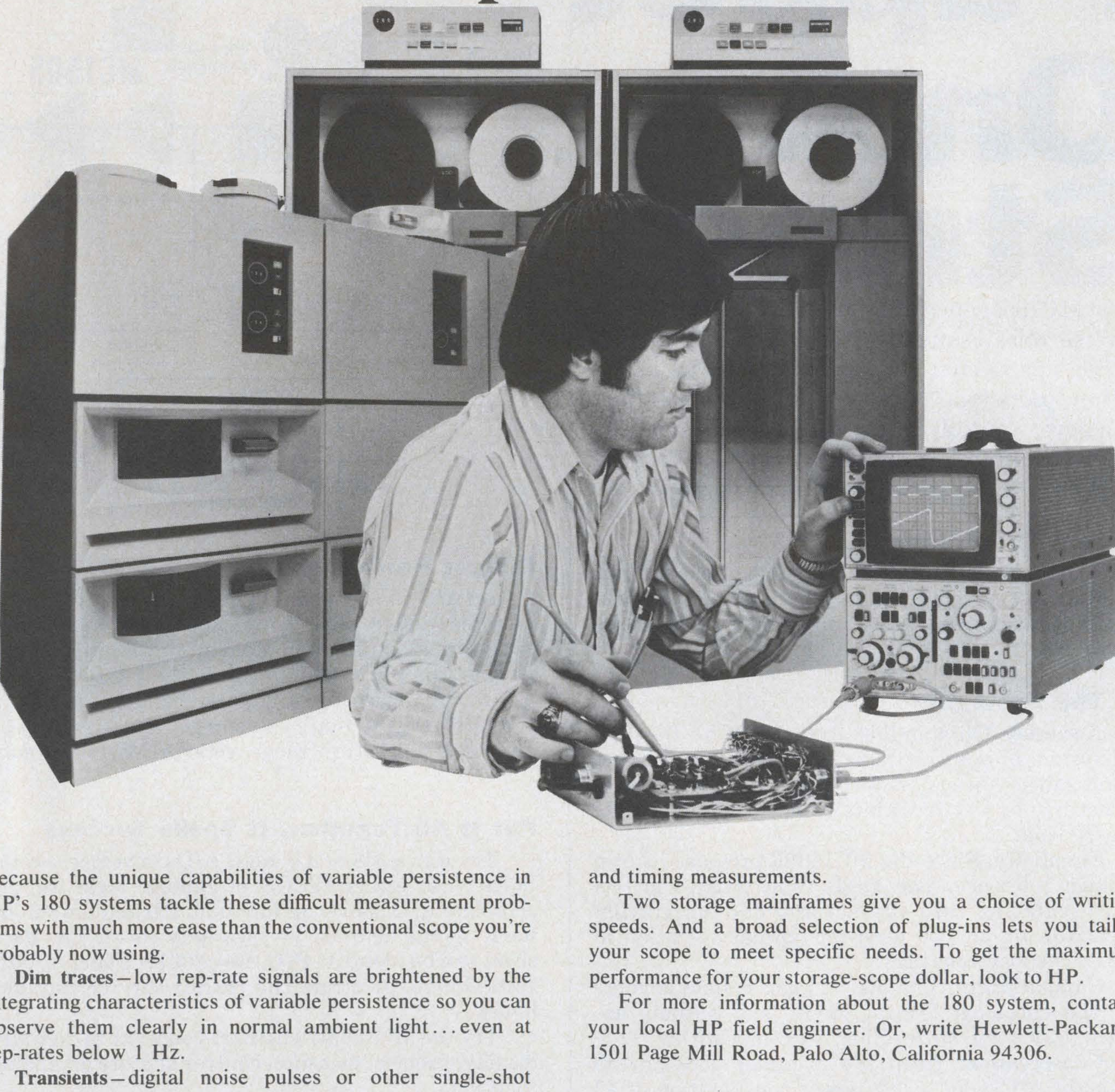
INFORMATION RETRIEVAL NUMBER 22

Handle Troublesome Signals Easily With HP Variable-Persistence Scopes.



Because the unique capabilities of variable persistence in HP's 180 systems tackle these difficult measurement problems with much more ease than the conventional scope you're probably now using.

Dim traces—low rep-rate signals are brightened by the integrating characteristics of variable persistence so you can observe them clearly in normal ambient light . . . even at rep-rates below 1 Hz.

Transients—digital noise pulses or other single-shot events are made visible by the high writing speed of HP's mesh-type storage and variable persistence.

Slow-moving waveforms—electromechanical events or transducer outputs that appear as a "bouncing ball" on conventional scopes will be displayed as a continuous trace with variable persistence, allowing more accurate voltage and timing measurements.

Two storage mainframes give you a choice of writing speeds. And a broad selection of plug-ins lets you tailor your scope to meet specific needs. To get the maximum performance for your storage-scope dollar, look to HP.

For more information about the 180 system, contact your local HP field engineer. Or, write Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94306.

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INFORMATION RETRIEVAL NUMBER 23

INFORMATION RETRIEVAL NUMBER 24 ►

New Tool New Board New Method

it's part of the TY-RAP® System

Now tie quicker than ever before...

Our new high speed tool does it all . . . feeds a TY-RAP tie around bundle, cinches to a preset tension, locks securely and trims evenly . . . all in 8/10 of a second. There is no tool adjustment needed regardless of bundle diameter from 1/32" to 5/8".

The off-the-board harnessing method allows the tool optimum use. This technique utilizes our new harness board and harnessing aids. The board is reusable and reversible. It's modular too . . . snaps together for larger work areas. It's constructed of polyethene foam sandwiched between two metal screens — nails are pushed in by hand. It's all part of the TY-RAP System to lower your costs of harness fabrication.

Write for new catalog, The Thomas & Betts Company, Elizabeth, New Jersey 07207 (201) 345-4321. In Canada, Thomas & Betts Ltd., P. Q.

Sold Only Through Authorized T&B Distributors

New, pneumatic tool (TR-225) installs just about every size of TY-RAP tie for 1/16" to 4" diameter bundles.

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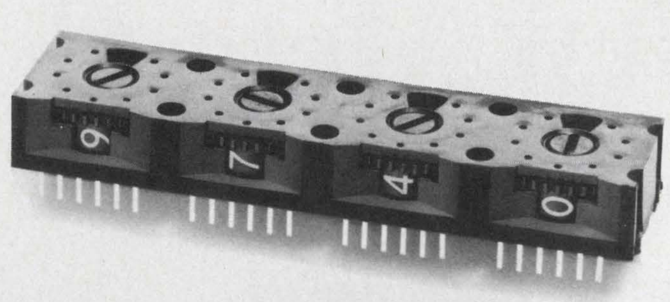
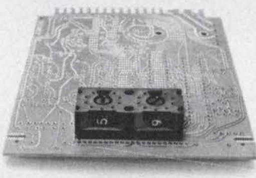


Introducing the programmable memory with visual readout.

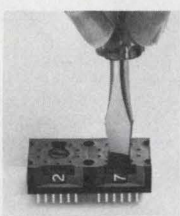
We're talking about our unique Stripswitch,™ the miniswitch for direct printed circuit board



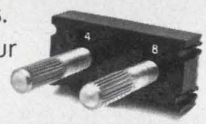
mounting or panel installation. This little marvel is molded of impervious Valox*, and is guaranteed for two years.

Other facts: it comes in one, two, three, four, five, and six station models ($1.95 per station, standard); in a variety of codes, including decimal, BCD, Complimentary, Special Binary, and 1, 2, 3, and 4 pole.

On a custom basis we can do lots of other things to your Stripswitch. Like interconnections, markings and legends, color coding, stops, number of switch positions, additional stations, et cetera.



A 10¢ stamp will get you an immediate reply, or your finger on the dial of your telephone will get you instant answers. Call us collect. Or one of our distributors: G.S. Marshall, Hall•Mark, or Schweber.



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INFORMATION RETRIEVAL NUMBER 25

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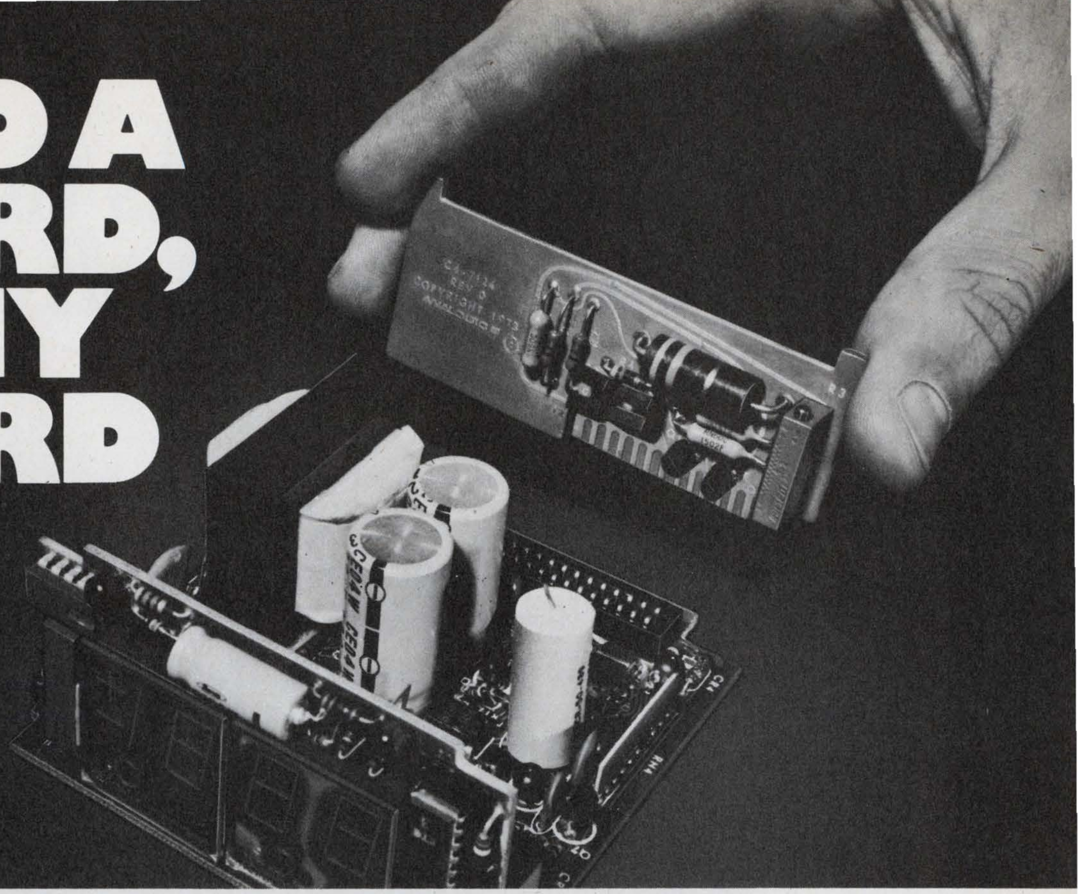

The first DPM that transforms into your own product by simply plugging in a P.C. card.

AN2553/AN2533 DESIGN SPECIFICATIONS

ANALOG INPUT	
Configuration:	Bipolar balanced symmetrical differential inputs
Dynamic Input Impedance:	1000 megohms nom
Common Mode Rejection Ratio:	80 dB standard, up to 160 dB optional
ACCURACY/STABILITY	
Accuracy:	0.05% of reading ±1 count
Range Tempco:	35 ppm of reading
CONVERSION TECHNIQUE	Dual-slope integration
DISPLAY	.55" 7 seg. Sperry or .5" L.E.D.
DIGITAL SIGNALS	
Logic Levels (all inputs and outputs):	External Blanking, Hold, Overload, Clock, Latch, Carry, EOC, Polarity
UNIVERSAL POWER INPUTS:	100, 117, 220, and 240 VAC RMS ±10% 49 to 63Hz @ 2W
Operating Temperature:	−10°C to +60°C
Dimensions:	DIN-STANDARD: 96mm bezel width x 48mm bezel height; 95.4mm max depth

NOTE: Model AN2553 offers additional capabilities

$89.00 Base Price AN2533 quantity 100

- ☐ Universally powered
- ☐ True differential inputs
- ☐ Low power consumption
- ☐ DIN Int'l Std. case size
- ☐ Surprisingly low cost
- ☐ Bright self-illuminating display
- ☐ High reliability

Build any required circuit on the uncommitted analog interface card we furnish. Then just plug it into the special powered signal interface connector in our AN2553 3½-digit DPM. It's that easy to incorporate the value-added options that make your product more profitable. . .or specify application requirements, and we'll build them in before shipment.

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The Rolm 1602 has the power to get your program off the ground

For $18,750 the 1602 Ruggednova is the most powerful, yet lowest priced mil spec, 16-bit processor with 8K of memory on the market

The 1602 is loaded with power features. 450 nanosecond semiconductor memory read cycle time. Memory expansion to 256K words. Dual Port memories. Floating point hardware. Stack processing. Double precision arithmetic. 32-bit instructions and powerful interrupt processing.

We could go into detail on how each of these features improves your system . . . but better yet here are five ways the 1602's power improves your overall program.

1. Reduce programming costs. The 1602 allows you to program in less time because you have more power per instruction. In addition to instruction power ROLM also provides a wide selection of documented software proven in over 8000 commercial and military installations.

2. Reduce risks. You don't have to worry about underestimating size of computer with the 1602. With its execution speed and expandability, there's plenty of computer to do the job. You can get out of speed binds with our semiconductor memory or custom microcode. And don't worry about memory binds with our external memory which is expandable up to 256K words.

3. Reduce I/O processing problems. With the 1602 power, the expanded interrupt structure, the DMA, and Dual Port memories you can handle more data on your computer system. To aid you in utilizing this I/O power, ROLM has available over 30 general purpose interfaces for the 1602. Your special interfaces can even be placed right inside the 1602 with no time lost in designing an extra chassis or power supply.

4. Reduce hardware costs. A lot of the extra hardware normally needed can be eliminated since the 1602 has the power and capacity to do a wide range of tasks. You can reduce your costs by reducing the number of computers needed, not to mention the fact the 1602 is the least expensive full mil-spec machine available.

5. Avoid qualification tests. The powerful 1602 Ruggednova has already met Mil-E-5400 airborne environments, Class II; Mil-E-16400 shipboard environments, Class I; and Mil-S-901 for high impact shock. Its military name is AN/UYK-19(V). The 1602's performance is qualified and guaranteed after delivery with a 90-day warranty. This saves a lot of your time.

These are just a few of the ways the 1602 takes the risk out of selecting the right computer. If you would like those specific technical details we mentioned about the 1602, drop us a line . . . or, if your program needs to get off the ground faster, call:

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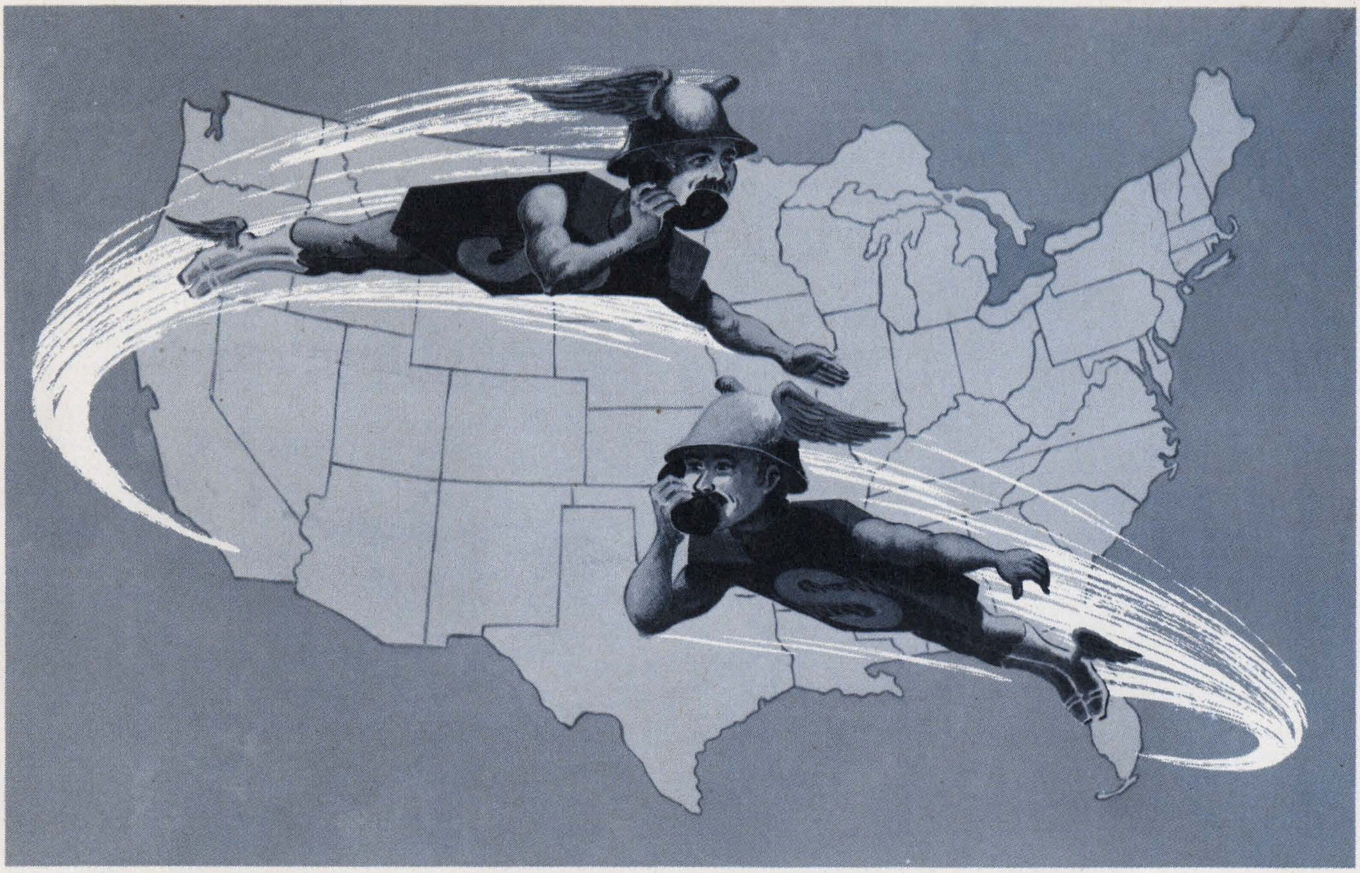

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INFORMATION RETRIEVAL NUMBER 205

Monsanto

FOR DEMONSTRATION CIRCLE #206

washington report

Heather M. David
Washington Bureau

U.S. acts to screen exporting of technology

Secretary of Commerce Frederick B. Dent has asked Congress to extend and amend the Export Administrative Act and add a requirement that U.S. companies and their affiliates abroad report within 15 days "any written understanding that would be likely to result in the export to a Communist territory, other than Yugoslavia, of any technical data of U.S. origin that is not generally available." According to Dent, the Dept. of Commerce, "and indeed the Government as a whole," are frequently not aware of the nature of these agreements until the American company applies for an export license. The reason for the new clause, the Commerce Secretary says, is "to deal with the U.S. party to the transaction, as appropriate, to minimize the risk that significant strategic technology will inadvertently seep to the Communist country in question."

The Senate Banking, Housing and Urban Affairs Committee will hold hearings on the extension of the export legislation, which expires June 30.

Global technology data net proposed

Rep. Richard T. Hanna (D-Calif.) proposes a U.S. International Science and Technology Transfer Institute to permit instantaneous exchange of information between experts in this country and other nations. The institute would use Intelsat and NASA global telecommunication systems, as well as prototype satellite models and microwave communications, so data could be transferred by voice, video, teletypewriter, facsimile, computer retrieval and interactive television and cathode-ray devices. The institute, an idea developed in a staff study prepared for the House Science and Astronautics Subcommittee on International Cooperation in Science and Space, would be linked to the National Science Foundation. Existing governmental mechanisms for technology transfer are not adequate, Hanna says, and "the transfer of technical information to other countries will undoubtedly hasten the creation of new outlets for American industry and commerce."

Defense Dept. refocuses its electronics research

The Defense Dept. has reorganized some of its basic electronics research programs to focus on efforts that promise practical military weapons according to Dr. Malcolm Currie, Defense Research and Engineering Director. Display research programs, which until now have concentrated on advanced technology, are being brought down to earth. Research is being directed toward making displays part of a military system that can be easily operated by people.

In other developments, infrared research is emphasizing the 8-to-14 μ spectral region. And integrated-circuit research is stressing designed-in reliability rather than what Currie indicates has been the usual practice of testing ICs after design, then going back to correct reliability problems. In the development of radiation-hardened ICs, the Pentagon has asked researchers to concentrate on metal-insulator semiconductor (MIS) circuits instead of hardened bipolars. MIS devices, Currie says, offer higher packing density, lower power and potentially lower cost.

New jet landing procedure would need more electronics

A new two-segment landing procedure designed to cut jet noise levels would require some $130-million in new electronic equipment. The procedure is being considered by the Federal Aviation Administration for 58 airports in this country. The agency is proposing that the airports require a shorter, steeper glide slope during the first part of the landing approach and a leveling off to the usual angle for the actual landing. The technique, developed jointly by the FAA and NASA, would require the installation of distance-measuring equipment (DME) on the 100 runways serving jets, to give pilots precise navigational information, and corresponding receiver equipment in the aircraft. The FAA would foot the $5-million bill for ground equipment, but it estimates that it would cost some $66.6-million to outfit airliners with the new avionics, and a similar amount to outfit general-aviation jets.

Coast Guard studies coastal navigation aids

Coast Guard officials have concluded that the increased shipping that will result from the construction of the trans-Alaskan pipeline will make critical the need for a precision surface radio navigation system in the Pacific coastal region. But after studying the various alternative systems, they are also reluctantly concluding that no single system appears capable of providing positional fixes both on the high seas and in the narrow confines of a harbor. At present, Loran-C is the leading candidate for precise navigation in coastal waters and harbor areas, but the longer-range, easy-to-use Omega seems superior for navigation on the high seas.

Capital Capsules: The Naval Air Systems Command, which is pushing the design of a minicomputer for tactical applications, is **asking industry to provide information on the interface characteristics of off-the-shelf mini peripherals** so the computer design will be compatible with commercial devices. . . . The Rome (N.Y.) Air Development Center is **planning to contract a study to determine whether fiber optics can be used instead of a microwave link for communications between the ground and a high-altitude balloon.** A fiber-optic cable would be incorporated into the balloon tether. . . . Gordon Rule, controversial civilian Navy procurement specialist, **has warned Congress that a $3.5-billion patrol-ship program is heading for disaster unless production schedules are slowed** to make sure an Italian gun and Dutch-designed fire-control system will work. Rule says foreign guns and control systems have never been successfully "Americanized." . . . The **Army will put a new infrared sensor and side-looking airborne radar on the 0V-1 Mohawk Observation plane.** The infrared equipment, the Army says, can detect a man from an altitude of approximately one mile, even though his temperature may differ only slightly from that of his surroundings.

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In its 3" x 5¼" x 9" package, the 221 has rechargeable batteries. It can be operated and charged from practically any power source from 90 to 250 V. 48 to 62 Hz AC, or 80 to 250 V DC without switching. Double insulation protects the operator while making elevated voltage measurements. Its impact-resistant case absorbs the rough treatment you expect in field maintenance.

221 Portable Oscilloscope, including batteries and probe . . . $775

Other 200-Series miniscopes offer 500 kHz bandwidth in single- or dual-trace, or dual-trace storage models.

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INFORMATION RETRIEVAL NUMBER 30

FOR DEMONSTRATION, CIRCLE 210

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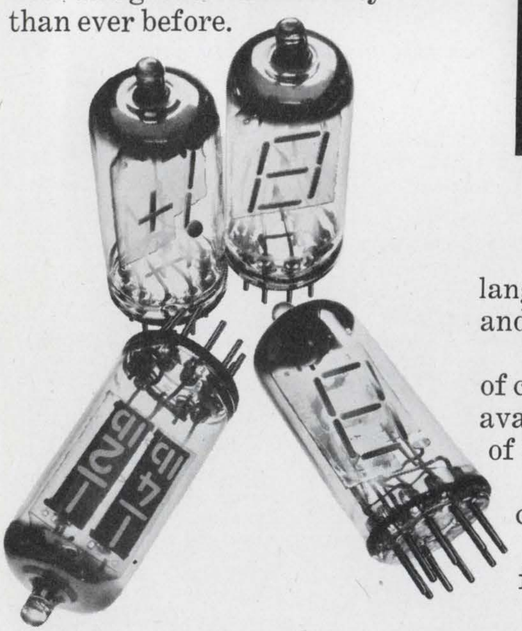
You won't see the exclusive mica substrate which supplies mechanical strength and helps emphasize lighted segments through a desirable halo effect.

You won't see the low cost, lower than competing readouts with fewer customer advantages.

Of course, there are things about our Tung-Sol® Digivac 1000 you can see.

Like the Digivac 1000's brightness. 50% more brightness and greater uniformity than ever before.



You can see the flexible language with alpha, numerical and symbolic figures.

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And because of the unique construction, you can see the accurate viewing assured from virtually any angle.

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- Low voltage, low power.
- Direct LSI drive.

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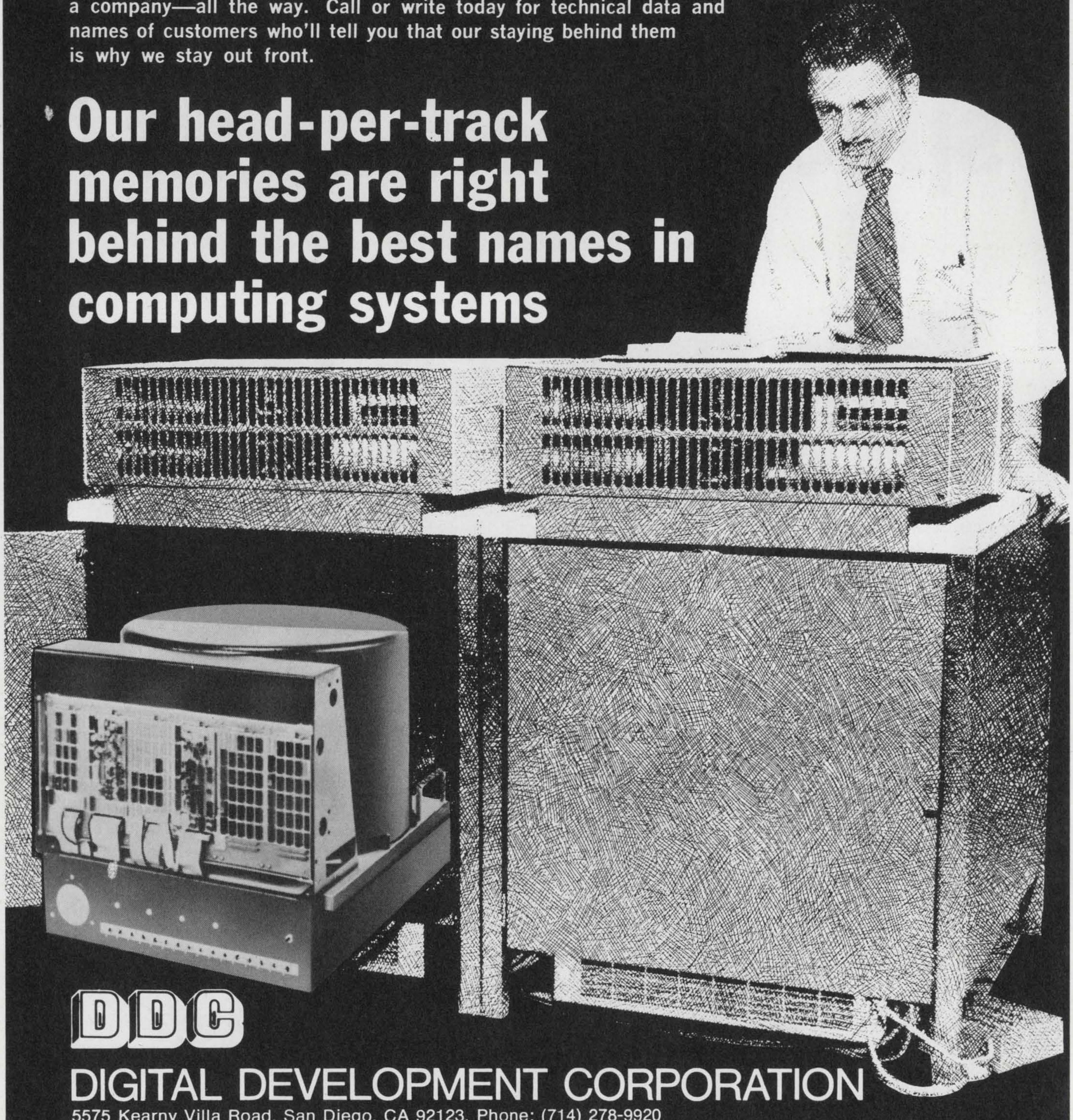

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Style AM8, PETP-polyester film
Style AS8, polystyrene film
Style AF8, PTFE-fluorocarbon film

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Style LM9, metalized PETP-polyester film
Style LS9, metalized polystyrene film
Style AP9, polycarbonate film
Style AM9, PETP-polyester film
Style AS9, polystyrene film
Style AF9, PTFE-fluorocarbon film

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Style LM7A, metalized PETP-polyester film
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Style AP7A, polycarbonate film
Style AM7A, PETP-polyester film
Style AS7A, polystyrene film

RADIAL-LEAD

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Style LS7S, metalized polystyrene film
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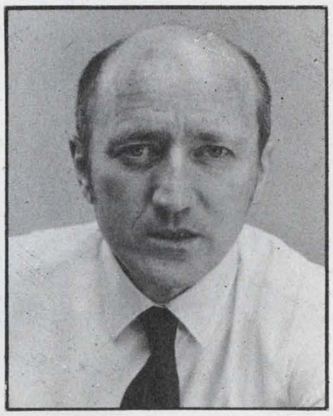
editorial

We lie a lot



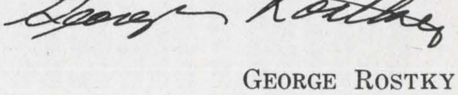
I don't think I've ever met an honest man. All of us lie. These days many of us justify it because there's obviously one hell of a lot of lying in the highest government circles and, after all, "If it's OK for them, it can't be too bad for me."

But our lying goes further back. Most of us learned to lie as babes; we lied to avoid pain or the displeasure of our parents. We would do something pleasurable, but forbidden, then deny it to avoid unpleasant consequences. Later we learned to deliver half-truths. We wailed that "Johnnie belted me in the eye," while conveniently forgetting, "I socked him in the teeth, first." Later, as adults, we lied because it's socially acceptable and proper. When our neighbor's youngster scratches away at his violin, it's unlikely that we'll say to our neighbor, "Gad, that's awful. Can't you burn that thing?" And we're not likely to tell our own children they were dreadful in the school play.

In business life we lie to protect our jobs or advance our competitive positions—just as politicians do. When we write specifications to describe the products we sell, we tend to omit those specs that cast our products in a less than lovely light. We suggest more than we can deliver and conceal our product's weaknesses. We use qualifiers like "up to" and "as low as" to describe specs our customers may never encounter. We highlight multiple specifications that may not be concurrent. And we give the best specs of different products leaving the reader to assume that these specs cover a single product. We "forget" to indicate conditions that may limit the achievement of headlined performance levels. And it's the rare engineer who will confess, "Wow! I really loused up that design." So we lie by omission, by commission and by expression of partial truth.

Yet, lying, *per se,* isn't necessarily bad. Only a hard-hearted purist would argue that we should crush our children by telling them they were rotten in the school play. Only a misogynist would argue that we should stop telling ugly old ladies how young and lovely they look. And only a hermit would demand that we destroy our relationships with our neighbors by telling them their children are untalented brats.

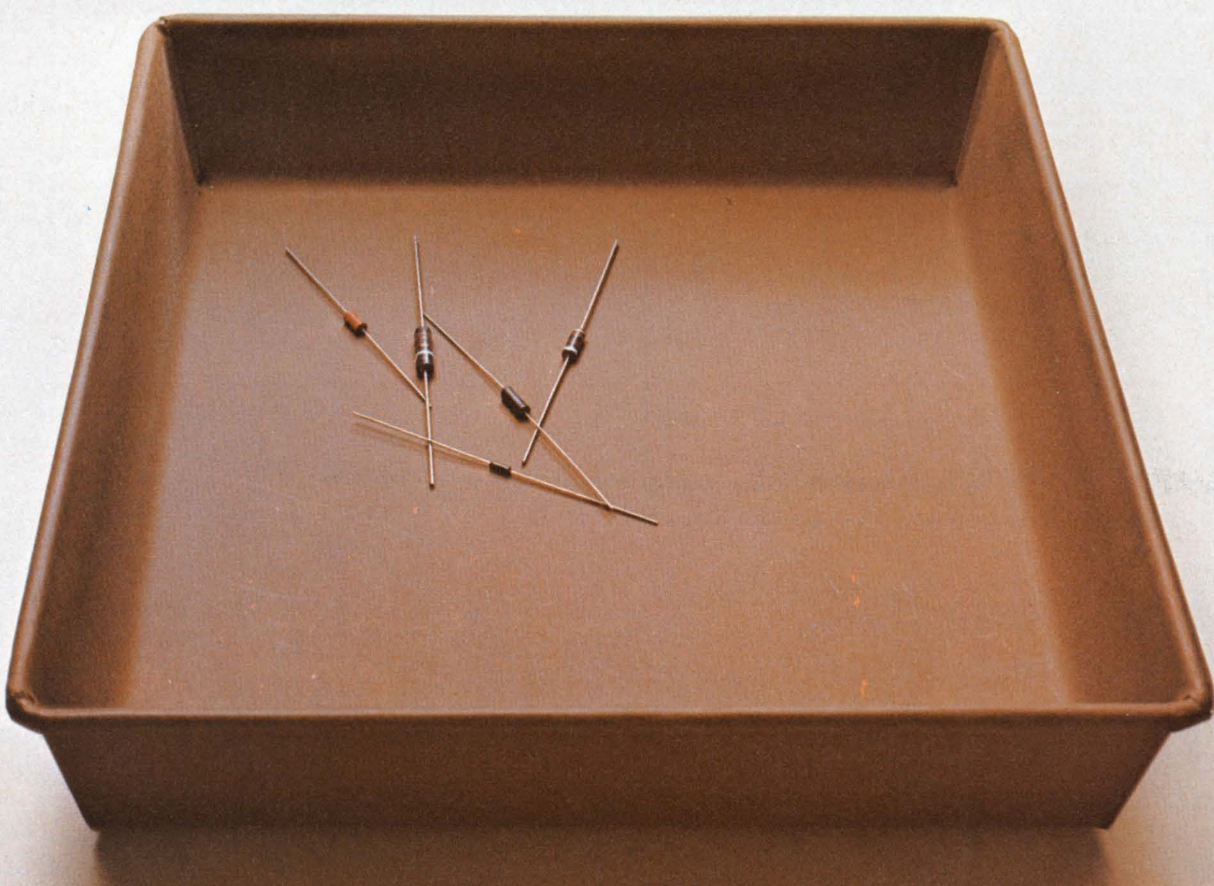
It's not likely we'll quit lying. But we all might be more comfortable if we could make ourselves more conscious of why others lie and more aware of why we do.



GEORGE ROSTKY
Editor-in-Chief

INFORMATION RETRIEVAL NUMBER 38

Why is Corning running an 8-page ad on its components, now, during the worst component shortage since 1942?



Here's why:

To our customers—We know your production and design plans depend on a clear and accurate picture of component availability. And since Corning's components represent such a large percentage of total supply, we'd like to show you where we stand today... and tell you what you can expect from us in the future.

To our prospects—We believe we're the first component supplier to emerge from a backlog situation. We'd like to update you on our new capacity, expanded lines, and developments.

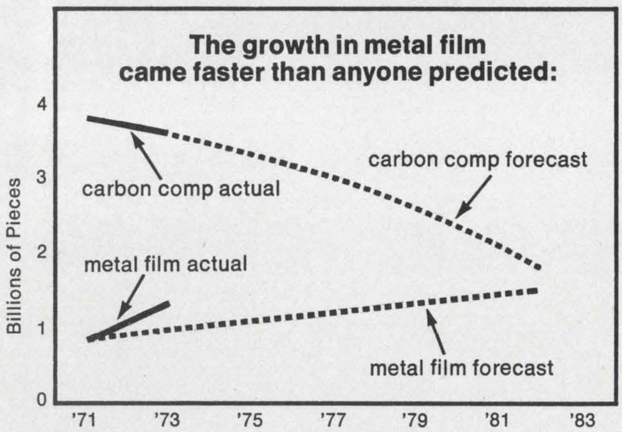
That's why we're running this 8-page report.

The metal film resistor shortage and what we're doing to end it-

Demand for our metal film resistors soared during the past 18 months. There were two reasons...

First, designers continued their move away from carbon comps and wirewounds to metal films as they recognized the superior price/performance value that metal film resistors offer. The effect of lower metal film prices combined with the tighter tolerance needs of upgraded circuits suddenly created demands far beyond the industry's most optimistic forecasts.

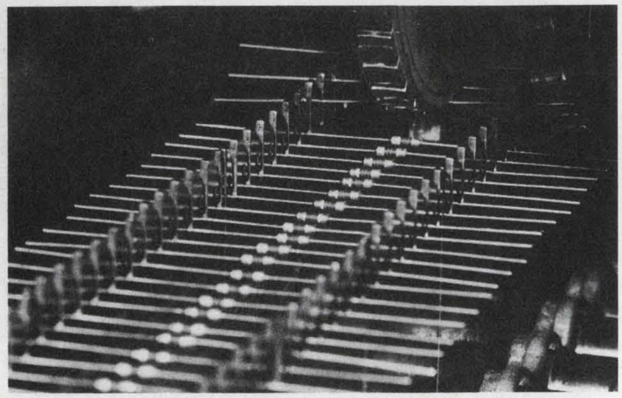
And second, we were deluged with larger metal film resistor orders because other suppliers couldn't deliver as fast as we could. Demand was heaviest for the ¼ and ½-watt styles.



Industry demand vs. Corning production.

At its worst, order lead times ranged from 24 to 60 weeks and longer—compared to 6-week deliveries that were normal for us the year before.

But fortunately we had already begun a major metal film resistor expansion program. As such, we were able to meet an exceptionally high percentage of all promised shipments, and then gradually reduce lead times to a current average of 12 weeks—with 6-week delivery on several styles.



Our engineering staff developed many new techniques in all phases of resistor production.

Our expansion program came in three phases, which let us move faster than the "brick and mortar" route to expansion.

Immediately, we moved to a full 3-shift-per-day 7-day-per-week production schedule. Our production and quality control staff was expanded quickly by transferring many experienced people back to our plants. And many more were hired and trained.

Secondly, we designed, tested and installed new high speed automated equipment and improved techniques in practically every stage of manufacturing. More than 18 state-of-the-art devices were developed by our engineering staff in this program.

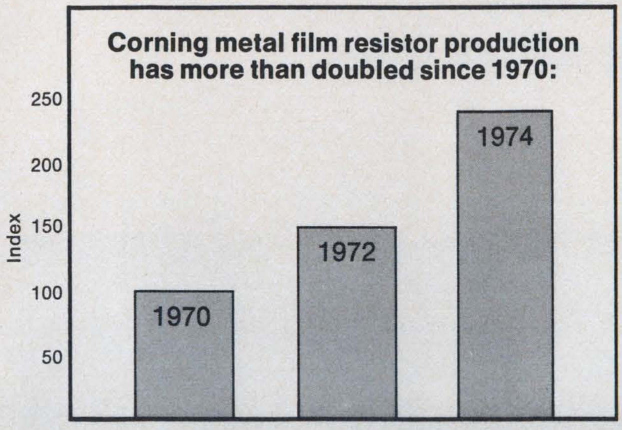
Thirdly, we significantly expanded our basic resistor manufacturing operations at both Wilmington, N.C. and Bradford, Pa. This included a doubling of our resistor substrate capacity to keep us free from shortages in basic raw materials.

Just these last two stages required a multi-million dollar investment in capital equipment and facilities—all geared to increase output.

Throughout, our chief concern was keeping absolute control on product quality. More resistors—but bad resistors—is no progress at all! So we moved quickly—but at a pace and on a plan that would not risk quality problems that could cancel out production gains.

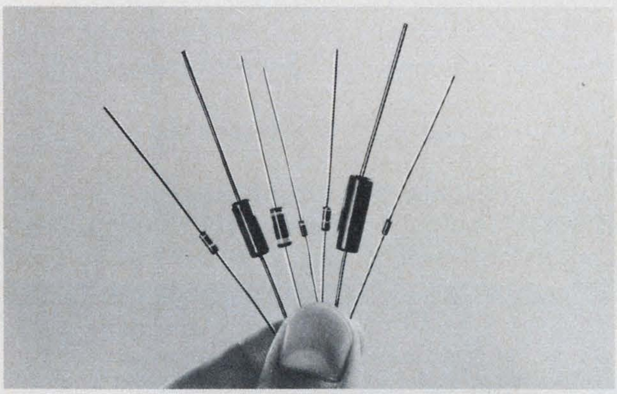
Corning is a major supplier of metal film resistors.

As a result of this expansion, we're now shipping more than twice as many metal film resistors as we did in 1970. We supply more metal film resistors than anyone else in the U.S. today.



New additions you can expect to see this year.

Our current resistor line includes precision, semi-precision and general purpose parts—in a wide range of sizes and styles including ER and our flame-proof resistor line.



We are adding substantially increased capacity for precision parts with temperature coefficients of 50ppm/°C. And 25ppm/°C. parts are in the final stages of development. This will extend the range of our metal film performance capabilities significantly. As soon as samples of our 25 ppm resistors are available for evaluation, we'll let you know.

What to expect in the next 3 to 5 years.

We believe the metal film resistor supply situation will greatly improve in the second half of this year. But we also expect metal films to continue to be the fastest growing segment of the discrete resistor market.

As the lower power requirements of new designs make wirewounds less popular, and the needs for greater precision (particularly in automotive and instrumentation applications) make carbon comps less suitable—we expect to see an annual demand growth of at least 10 to 12 percent. And we've geared our production to meet this demand.

Keeping tabs on our progress.

Throughout the shortage, we've regularly surveyed our customers to measure how we're doing versus other suppliers.

The result of the latest reading is shown below...

How users rate Corning's metal film resistors

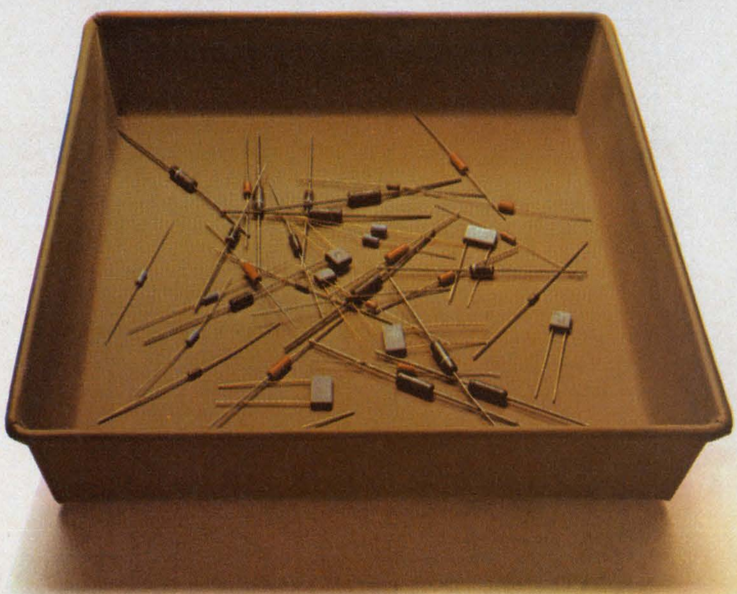
	Corning	Firm A	Firm B	Firm C
Buyers' ranking of				
—best quality	#1	#3*	#3*	#2
—best value for cost	#1	#4	#3	#2
—best distributor availability	#1	#4	#3	#2
Engineers' ranking of				
—best quality	#1	#4	#2	#3
—best value for cost	#1	#4	#2	#3

*tie

We're pleased—but not totally.

Obviously, we're still having to say "no" too often to new orders from new customers.

We hope we can change that soon. We're working at it. And we'll keep you posted as our metal film resistor supply backlogs further ease.



The Capacitor Shortage:

And what we're doing to end that too-

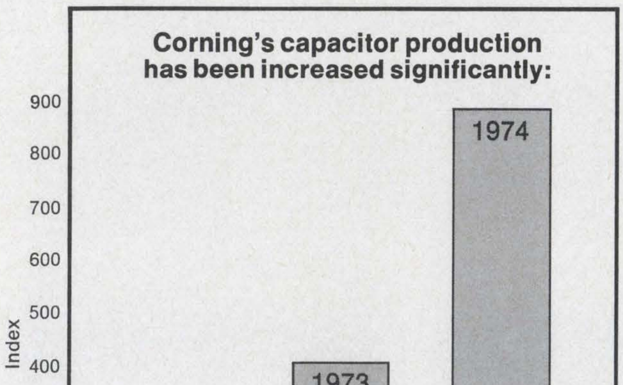
Corning has begun a major expansion into the ceramic capacitor market. And we're gearing our initial operations to very large volume production of a relatively tight line of low cost parts.

For the past three years we've been supplying a major portion of the computer industry's axial monolithic ceramic capacitor needs. And have initially concentrated on miniature size, epoxy-cased ceramic capacitors for automatic insertion applications.

Now, with a number of new product developments nearing completion, we are planning the introduction of a high volume low cost commercial axial ceramic line and an expansion into commercial radials in a major way.

Corning's expansion into ceramic capacitors.

During the past year, we've more than doubled our capacitor production. And because capacitor production is far more labor-intensive than resistor production, this has required a significantly enlarged technical and manufacturing staff, plus facilities expansion at our Raleigh, N.C. plant.

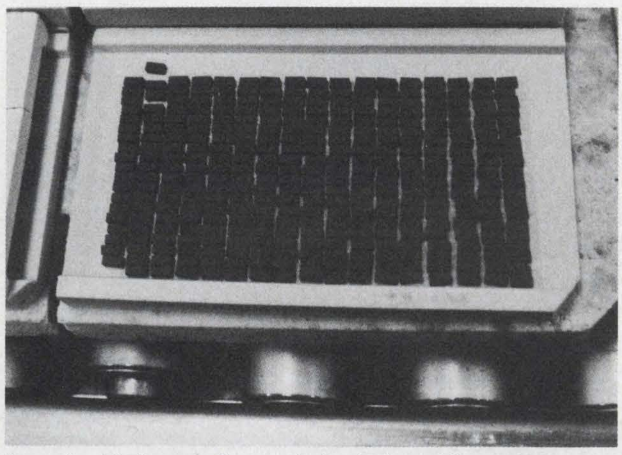


But 1973 increases will be eclipsed by the size of our expansion schedule this year and beyond.

1975 production will triple 1973 levels. 1978 production will have tripled again. And 1980 production will be 70 percent over 1978 levels.

But our expansion program is just beginning.

And the impact on longer term ceramic capacitor supply will go far in precluding another ceramic capacitor shortage.



Ceramic chip inventories are being built at this very minute.

Glass and Glass-K™ Capacitors.

Our glass-dielectric capacitors have been in strong demand for applications where high stability over a wide temperature range is required. In the fall of '73, delivery lead times rose to 30 weeks, but 8- to 10-week schedules are now more typical and distributor stocks are being rapidly replenished. Soon availability will be back to normal.

The same holds true for our Glass-K glass-ceramic capacitors—which combine the volumetric efficiency of a monolithic ceramic with the stability of a glass-dielectric.

New developments nearing completion.

Our new "spin-seal" conformal-coated axial could be the industry's long-term answer to a truly low cost automatically insertable ceramic capacitor.

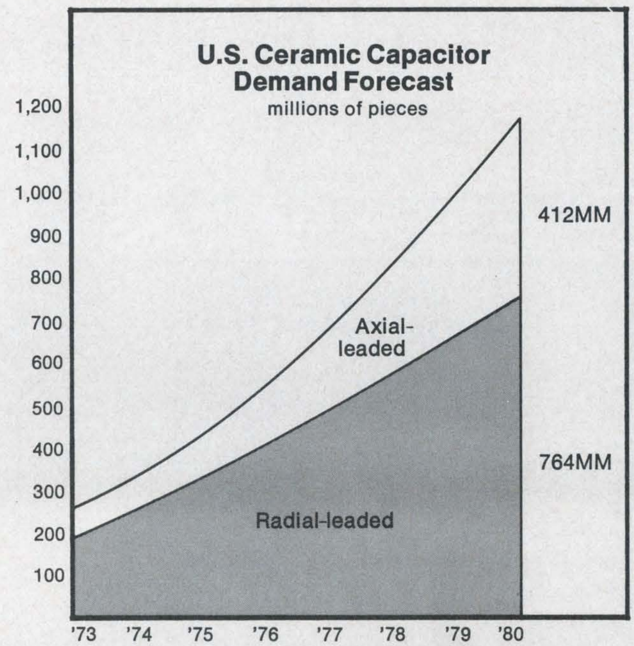
Using techniques we originally developed for—and currently use in producing—our resistor line, this epoxy-jacketed series has the uniformity and handling characteristics necessary for automatic insertion. But at lower cost in larger volume production. The "spin-seal" technology permits us to manufacture axials at much higher speeds than are possible with molded case styles. Throughout, coating thickness is automatically gauged and controlled to keep uniformity and performance exact.

As soon as evaluation samples are available in quantity, we'll announce their availability.

Industry demand forecasts:

Currently, molded axials represent 25 percent of the leaded ceramic capacitor market. Through 1980 they'll continue to move in on radials based on current trends to automatic insertion. As such, axials will remain a prime area of concentration for us.

When our "spin-seal" axials are ready, we expect to be able to supply axials at prices that



encourage a switch away from radials. This should push axial growth even faster.

But we'll also be ready with our radial line, to provide whichever types of ceramic capacitors your production requires.

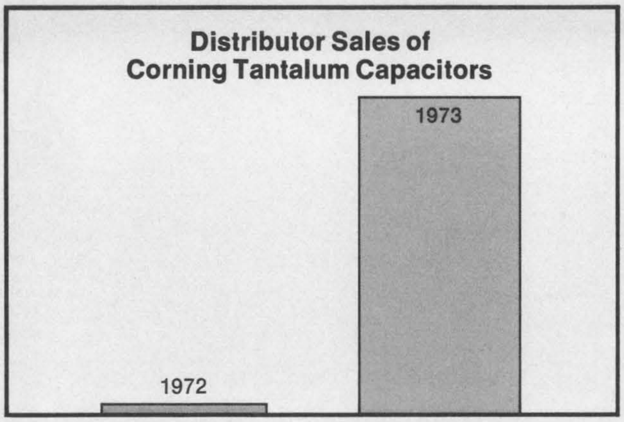
In short, Corning plans to become a major factor in all types of ceramic capacitors in the years ahead.

The Tantalum Capacitor Shortage:

And what's available now-

During 1973, we concentrated on keeping our distributors supplied as fully as possible with tantalum capacitors from our Components Incorporated subsidiary.

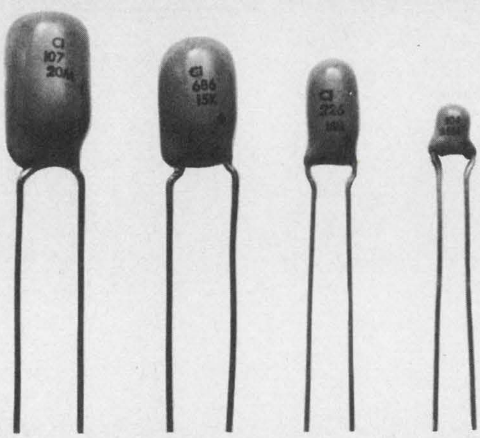
By year end, this meant that a major percentage of the tantalum capacitors being sold through distribution were ours.



Recently, we introduced two more tantalum lines into distribution and availability on both should be excellent soon in most areas of the country.

1. Our TK line:

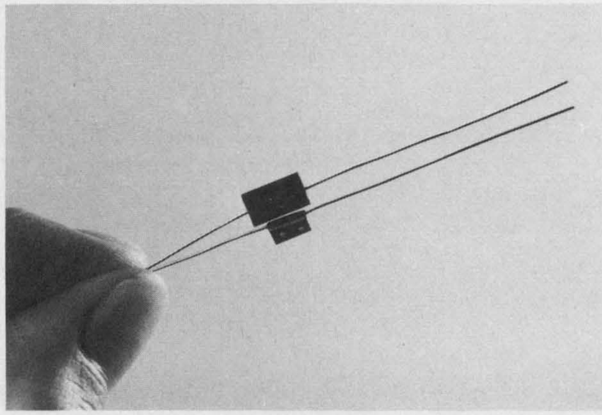
These low cost, radial leaded, epoxy dipped solid tantalum capacitors have capacitance values in the 0.1 to 330MFD range—with working voltages of 6 to 50VDC and tolerances of ±10% and ±20%. Their low-profile configurations



and availability with a choice of lead bends make them well suited for convenient insertion and assembly.

Incidentally, our companion line of DIPATAN® TD series epoxy-coated radials are now in fairly good availability in most areas, too.

2. Our MINITAN™ line:



These microminiature solid tantalum capacitors are epoxy-sealed in a polyester sleeve. They're available in both cylindrical cordwood and rectangular modular form, with a choice of axial or radial leads. Capacitance values are 0.001 to 220MFD, working voltages are 2 to 50VDC, and tolerances are ±10% and ±20%. They're in excellent supply. We can meet your needs now.

Supply problems exist elsewhere.

Industry wide, supply problems are still enormous for axial-leaded, metal-can-enclosed solid tantalum capacitors. These parts have soared in demand because of their wide use in high volume machine-insertion applications.

Corning, like other suppliers, has been unable to gear up quickly to new demand levels for these metal-cased parts, because their fabrication is labor intensive and the very skilled workmanship required cannot be expanded rapidly without risk of quality.

We are in the process of training additional personnel and have supplemented existing facilities, but frankly it will take months to catch up with current demand levels for both our MILITAN® hermetically sealed ER line and our ECONOTAN® epoxy-sealed consumer and industrial line.

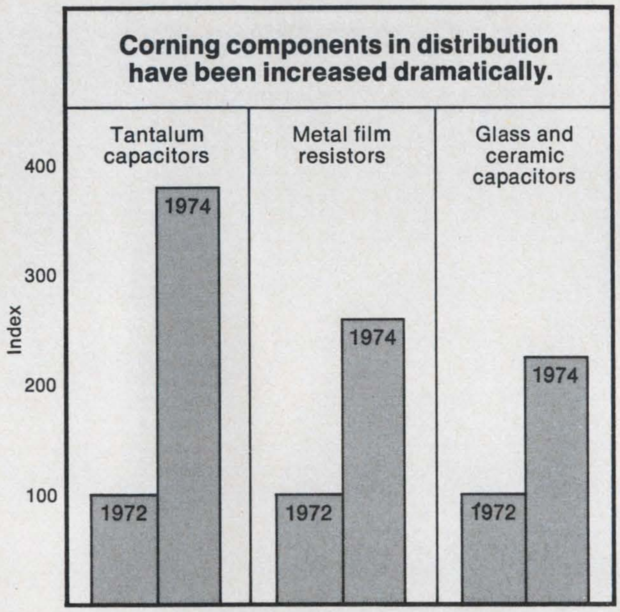
In the meantime...

In the meantime, we suggest you take a closer look at our MINITAN and TK series as good alternatives to your immediate needs.

Our distributors have assumed a pivotal role:

Corning component availability-

In spite of shortages, we've made significant gains in distributor availability across all three Corning component lines. Progress here can be seen in the chart below.



We believe that a strong, well supplied authorized distributor network is the only way a component supplier can responsively meet the large and growing needs of the thousands of firms across the electronics marketplace.

That's why our distributors are now our largest "customer," and why they'll be assuming an even more pivotal role in Corning's future marketing and supply plans.

An expanded distributor supply center.

To make this work, we've added a major new distributor supply center at a location separate from our plants. This supply center literally buys Corning components from all locations in anticipation of future distributor needs. In the fullest sense, it's become a "Distributor's distributor." And it operates under a strict policy that prevents our OEM sales group from tapping into distribution supplies.

Frankly, it will take a few months before our new distributor supply center builds inventory to levels where we can once again meet our goals of shipping distributor orders directly from off-the-shelf stocks.

But each week we're making progress. For example, our lead time on RN55D metal film resistors has dropped from 22 to 11 weeks. CK12, 13, 14 BX ceramic capacitors are now available for off-the-shelf delivery from your local distributor.

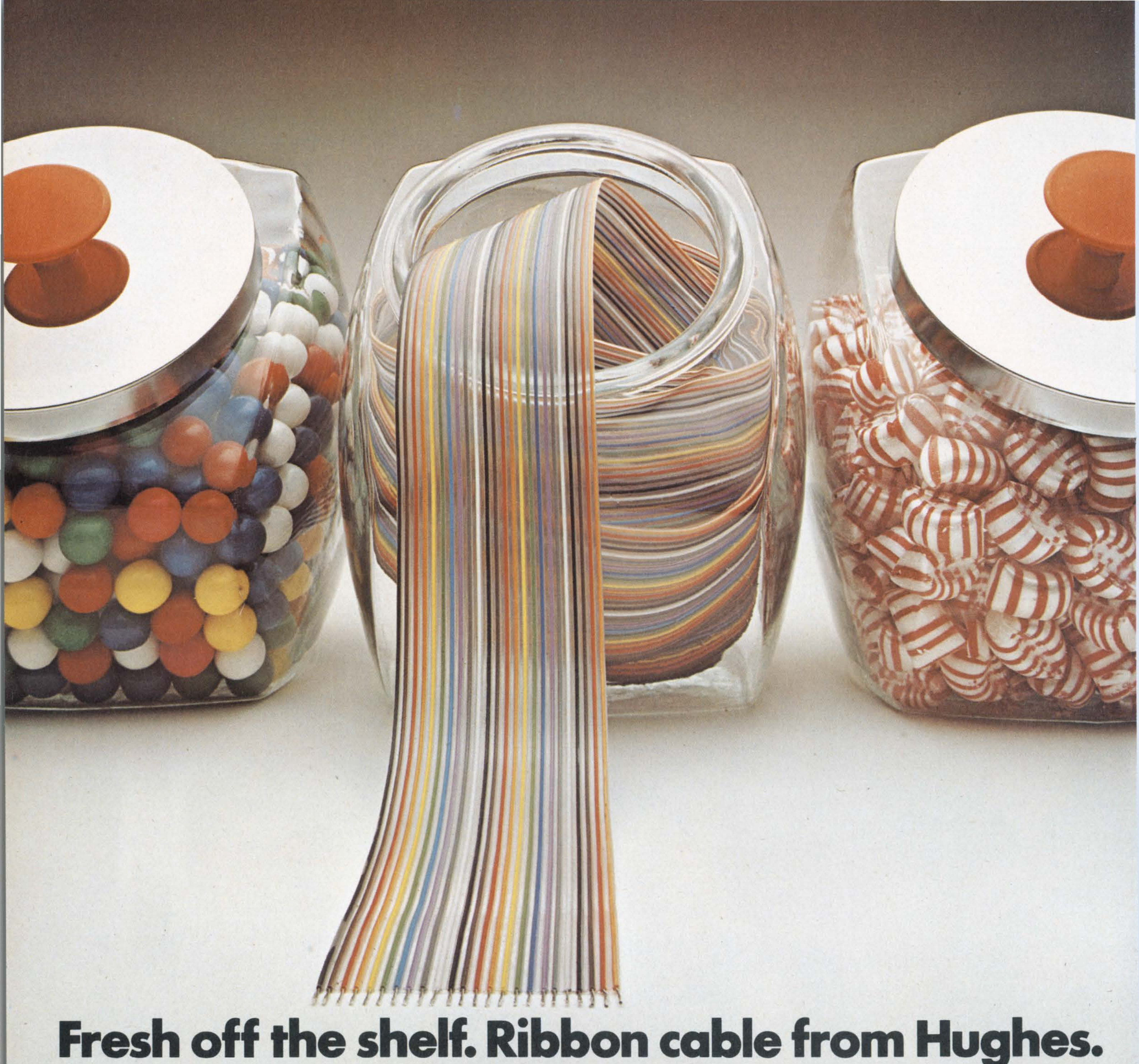
Strong emphasis on distribution means more firms will be introduced to Corning components than ever before. Engineers and buyers who've never used our resistors and capacitors will be buying them in future months.

We'll keep you posted.

By being first to ease component supply, Corning hopes to make new friends and win new long-term users. This in turn will let us keep expanding in increments large enough to achieve low cost pricing for our parts.

We'll keep you posted.


The liberated computer
PRIME
PRIME 300
It's smaller, powerful
and more independent



Fresh off the shelf. Ribbon cable from Hughes.

It could be as good an idea as penny candy: getting your ribbon cable from the same people who crack your tough flat conductor-cable problems.

We offer it by the foot, or as you like it. We not only make it, but we cheerfully cut it, strip it and terminate it for you.

Our new ribbon cable comes in widths from two to 100 conductors. The conductors are round (solid or stranded), and have color-coded PVC insulation. You can get 22 to 28 AWG.

Of course, all our cable comes with Hughes quality built-in. And we handle your order with the helpful attitude of one of the most competitive companies in the cable business.

So write us soon. Hughes Connecting Devices, 500 Superior Ave., Newport Beach, Ca. 92663. Or call (714) 548-0671.

HUGHES

HUGHES AIRCRAFT COMPANY
CONNECTING DEVICES

We crack the tough ones.

INFORMATION RETRIEVAL NUMBER 39

Computer '74
A Special Issue

Cover photo by Barry O'Rourke, courtesy of Prime Computer Inc.

Big, small and tiny,

Is the era of the general-purpose supercomputer at an end? Will it be replaced by new generations of midis, minis and microprocessors now on the market or on the drawing boards? The answer depends on whom you talk to.

There is general agreement that in many applications it's a lot more efficient and economical to decentralize the computing workload—distributed computing—particularly in industrial process control and communications networks. On the other hand, a supercomputer designer, James Thornton (see p. 100), sees a growing role for the big machines. For many applications in the aerospace, scientific and Government fields,

computers advance

he says, the small computer just won't hack it. "How else, for example, can aerodynamicists simulate a giant swept-back aircraft wing, except by a gigantic computer," Thornton notes.

Nevertheless most of the talk in the computer industry these days is about the small-to-medium-sized machines. The still new, but promising, "computer-on-a-chip (or chips)" microprocessor still has a way to go to live up to its potential as a major circuit element. Although microprocessors are now found in data-entry and point-of-sale terminals, electronic scales, specialized medical instruments and a number of other applications, they still have not been designed into industrial process-control and test and measuring instruments to any appreciable degree.

And despite their lower cost and size, microprocessors are not expected to make significant inroads into traditional minicomputer territory for some time. The microprocessor is no match yet for the mini in speed, word length, memory capacity, number of instructions and computing power.

But the explosive growth of the minicomputer in recent years has not been without its problems. A major area of concern has been the high cost of preparing, debugging and executing the application programs—an expense that may cost 10 times the original investment in hardware. The minicomputer industry is attempting to cut these costs by providing system software that requires less programming time.

Peripherals also are being affected by a significant development—the combining of the intelligent terminal, and its built-in memory and processing capability, with floppy discs. The discs can provide up to 5 million bits of random-access at relatively low cost.

And yet another area that is beginning to attract attention is the storing, processing and retrieval of data with optical techniques.

For a fast look at what's available in computers and what's to come turn the pages of this special section.

Today's computers handle many jobs concurrently, from batch input to graphics, as this IBM setup shows.

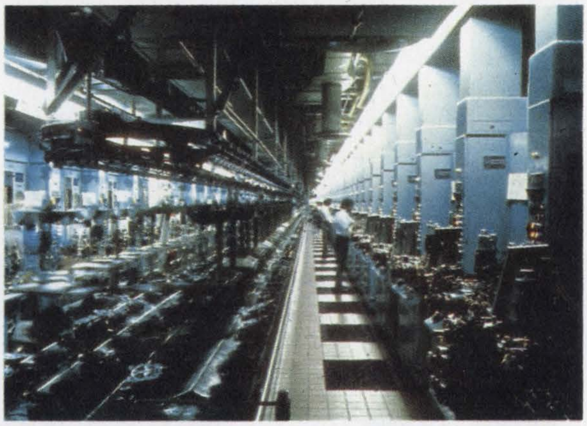
Decentralized networks allowing the computer to be moved to the job

Seymour T. Levine, Associate Editor

The 1970s may mark the end of a dinosaur: the super-sized central computer. Low-cost, high-performance minicomputers—and their LSI counterpart, the microprocessor—make it economical to decentralize the computing workload.

Moreover present experiments with medium-sized computers point to the possibility that their work may be subdivided, too.

With few exceptions, the more ambitious computer designs of the 60s attempted to construct one remote general-purpose machine for use with all problems. Today computation is more personalized. The topology of the network is geared to individual jobs. Minicomputers and microcomputers are placed where the work is.



Rows of carburetor-flow test stands are individually controlled by SPC-16 minicomputers from General Automation. Groups of 31 stands report to an IBM System/7 supervisory computer, which, in turn, acts as a data concentrator for a 370/145. This hierarchical computer organization operates at the Rochester Products Div. of General Motors.

Job helps define architecture

With the subdivide-and-conquer approach, each processor performs a clearly defined job, communicates with its neighbor processors, as needed, and perhaps also responds to commands from a higher-ranking, or host, machine. In this way the software breaks down to a manageable level, programming time and costs are slashed, and data are available where needed. The relatively low cost of today's minicomputers—typically \$2000 to \$4000—makes it economical to operate them at less than 90% of their capacity while still achieving a targeted operational economy.

The leader in this trend is not the hardware systems designer but the sophisticated end user. He either sets up and programs the particular network or frequently hires a software consulting firm to set, configure and program his system. The computer manufacturer supplies the ancilliary electronics that bind the system into a manageable unit.

For example, data-communications systems often use ring or network configurations. The minis at each node route the messages through the links according to the appropriate algorithm, which maximizes throughput. The communication shares resources from several sites—like time-sharing. And the organization becomes leveled—that is, each element is equally important.

Factory control systems inevitably use a hierarchial configuration, where each mini is assigned specific tasks but reports key results to a central, or control, computer one level above. The resulting configuration closely resembles a line organization chart.

Networks with one host computer and a group of terminals often take on a star structure, in which data radiate outward or inward toward the host. If communication becomes necessary between terminals, the host acts as a central message switch to pass the data between them. This configuration makes the network simple to control, because all data flow in and out of a single node. However, failure of the one node stops the entire system.

As a low-cost alternative, the ring, or loop, system is often used when buffered terminals and more than one host are in close proximity. Data are passed between any pair of interfaces on a multiplexed basis. Control passes in succession to each interface, which, if it has a message, addresses a given destination. The need for proximity occurs because the loop (actually a data bus) must handle the peak data rate for the entire system without degradation.

The finished product tests other System/7's at IBM before shipment. The System/7 under test (left) is linked to the computer that monitors memory operation, control functions and data flow. Test data are printed out on a console (right, background) and relayed to a central System/360. A single System/7 can test up to four processors.

Computer communication networks are expanding in two major directions—network control and distribution of information—according to Jack Branch, president of Incotel, Ltd., New York City, a software consulting house. The first use involves message switching, line switching and circuit (data) concentration. The second shows more imagination, since the network is used in conjunction with host computers to perform inquiry/response, data entry, information retrieval and related functions.

One example of a geographically distributed system designed by Incotel uses a network of three PDP-11 minis to support nationwide terminal-to-terminal communications, inquiry-response and bulk-data transmission. Message tables in the minis route the incoming data to the intended destination. If a data link fails, the operator can inform the mini to route the request to an alternate computer. The latter reacts as if the message arrived from a terminal attached directly to it.

The over-all traffic load determines the number of computers and the links between them. As more message centers are needed, more minis are placed, and links are established to balance or prevent blockage at the nodes.

Arpanet, a more elaborate switching system, was placed in operation in 1969, and has grown from four cities to 34. The minis form the nodes of this topological network. They break up data into 1000-bit packets at the sending site, route each packet over a separate link, then reassemble all at the receiving site. Hosts of all sizes interface via the minis, which are called IMPs (for interface message processors).

In the GE Mark III Information Services Network, remote concentrators feed central concentrators, which in turn connect to large computer systems. The network, composed of more than 100 interconnected communication and data-processing computers, serves over 360 cities in the world.

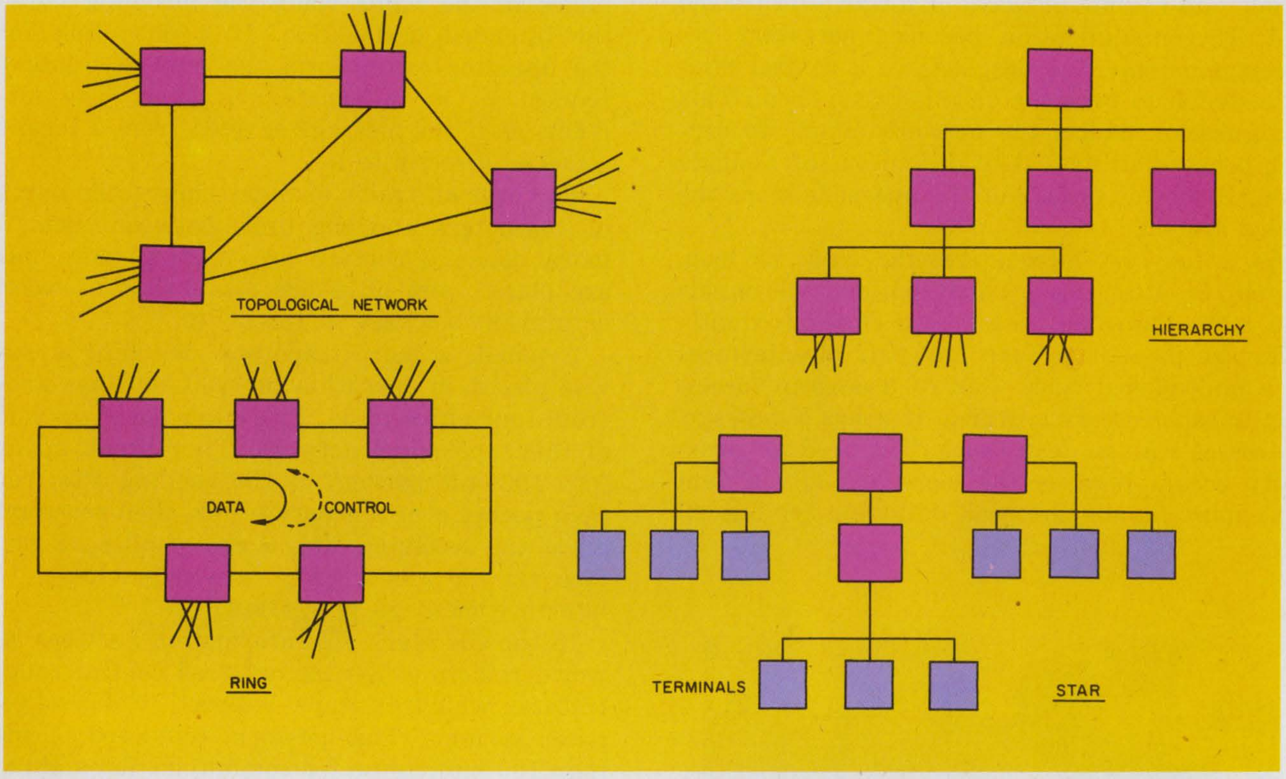
The Tymshare, Inc., network, called TYMNET, uses 120 communications minis, which access at least 35 host computers. The topology resembles a multiple ring. A user calling into a particular node is assigned a route through the network to an appropriate CPU.

The Collins C-System is both a computer communications system and part of a dispersed computing facility. The inner loop forms a data-ring topology that operates at 32 Mbit/s and provides 16 channels, each with a capacity of 2 Mbit/s. Front ends to the hosts mimic standard terminal controllers and little modification to host software is made. The facility interconnects high-speed peripherals, such as tapes and discs, to multiple hosts. Slower outer loops join unit-record devices, character-oriented terminals and so on to the main data path.

Real-time control achieved in factories

The automation of a factory with a single large computer invites disaster. If the computer fails, the entire factory halts—as with any single-node system.

The more logical approach is to automate the job a piece at a time, then interconnect the pieces to complete the job. In the resulting system, individual minicomputers perform such dedicated tasks as control of 240 aluminum reduction cells, or control of a single paper machine that converts pulp to finished rolls. Analysis functions



Configurations often seen in practical computer networks include the topological network, ring, hierarchy and star. The topological network handles distributed data communications, and the hierarchy is used for factory control. The star predominates when satellites are controlled by a single host, the ring when more than one host and buffered devices are in close proximity.

are split off from data collection and summary operations. The user must provide some form of data-transmission path between the "worker" computers and the hosts.

The operation of the lower-level computers is oriented towards real-time control. As noted by Terry McMullen, manager of manufacturing automation systems marketing at Texas Instruments, programs at this level consist of brief re-entrant tasks or modules that are scheduled on a priority basis by a software monitor. A real-time clock periodically (about every 100 ms) initiates the scheduler, which, in turn, passes control (allocates the CPU) to active tasks on priority basis.

Command and control with the host has relatively low priority and is the function of a brief telecommunications package. The host interrupts the worker machine to activate the module, but the worker machine schedules the communication at its own convenience. Of equally low priority are summary transmissions from worker to host. These low priorities ensure that the worker computer remains alert to the real-time process under its jurisdiction. Excessive machine-to-machine communications could cause serious lags in reaction to time-critical events. The data rates between host and workers is fairly low—200 to 1000 baud—when compared with the tens of kilobauds for data-communication work. As a result, asynchronous telephone-line communication techniques are the most common medium. Yet the over-all system handles thousands of bits a second from an aggregate of hundreds of input lines.

Managing large hosts

The simplest network relieves a large host of such functions as combining characters into blocks, acknowledging transmission of each character and checking for error. A minicomputer, often referred to as a front end, takes over these functions while delivering complete blocks of data to the host. The host, in turn, sees the mini as a standard peripheral. The user applies the manufacturer's software without need for costly investment in terminal support programs.

This interface between small and large machines is almost universal in the world of distributed computation. For example, the ARPA network appears to the large hosts as a data file.

Computerized graphic systems also make use of the front-end interface. Applicon of Burlington, Mass., provides a system for PC network layouts. A mini performs software editing and display from digitizer to CRT terminal. The host performs the large-scale computation algorithm that provides routing and interconnects. The mini appears to the host as a standard remote job-entry terminal, and the applications programs can be written in Fortran.

The hierarchy can be extended a step further, explains Richard Diephius, a senior designer at Applicon. Microcomputers can relieve the mini by picking up coordinates and tracking the input pen with the CRT beam.

Extensive hardware support provided

An ample abundance of practical hardware and software exists for those who want to take advantage of distributed computing.

Users of maxis and midis can exploit the architecture of computers like Control Data's Cyber 70 series or the Xerox 550 and 560 computers. These have an internal hierarchial system that allows the addition of processing capability in semiautonomous modular groups.

The major subdivision of tasks in these machines is between peripheral processors and a central processor or processors. The peripheral processors (PPUs) control, direct and disseminate I/O data between central memory or extended storage on an as-needed basis with the 70-series. These small processors operate independently of the central processor. Both types share central storage on separate data paths.

With the Cyber series, the CPU with its 60-bit word length, executes programs, does high speed computations and performs time-critical operations. But the operating system is controlled by a monitor program in a peripheral processor. System software coordinates the units.

The subdivision of labor is more straightforward with the Xerox 550 and 560—both 32-bit midicomputers. And the tasks performed by each component are more specialized.

The Xerox CPU is subdivided into a system control processor and basic processor. The system processor is a centralized interface that controls the operation of the basic processor and all I/O processors; the basic processor contains the arithmetic and logic unit.

The I/O processors are connected in groups to individual memory blocks, but they can share memory with other processor groups. Also, the system processor can control a direct interface to the basic processor. The direct interface equips the 550 and 560 for data-acquisition and control operations.

Multiplexed I/O processors handle unit-record equipment and magnetic tapes. Rotating memory processors handle disc data and perform such procedures as error correction, angular position sensing and automatic seeks for alternate tracks.

The Collins C-System uses a localized high-speed ring to join hosts and storage devices. Low-speed loops drive terminals and input devices. The system shown provides a statewide Iowa police network, with access to more than seven million traffic records and 250,000 criminal records on file in a System/370 complex at Des Moines.

Data-communication hardware for minis includes plug-in PC boards that handle up to eight asynchronous channels, each with rates to 19,200 baud—the Digital Computer Controls Model 116431. Digital Equipment's DH 11 interface handles 16 asynchronous channels at rates to 9600 baud each. A single PDP-11 computer accommodates up to 16 DH 11's (256 lines). Synchronous adapters include Data General's 4073, which handles four synchronous lines at up to 2400 baud each. A single Nova mini accommodates 16 units.

The software for data communications performs the following functions:

- Performs error checks.
- Acknowledges the message.
- Formats the message for use by the requesting program.
- Routes the message to the requesting program.

A hierarchy for factory automation and testing that operates via telecommunications is IBM's System/7 which can test other System/7's before shipment to customers. The latest System/7's, available since last December, handle up to 384 analog sensors and can communicate with the System/370 at speeds to 50-k bit/s in binary synchronous format.

As the processing tempo increases—for

Four interactive graphics terminals, each linked to its own minicomputer, help design electronic circuits with Applicon's system. The host, also a mini, provides additional support for this star configuration and can act as a front-end to an IBM 360, which calculates the PC art-work routings.

example, with nuclear power-plant control or aircraft flight-simulator control—character-by-character communication gives way to memory-to-memory transfers. For example, Data General's 4038 multiprocessor communications adapter (MCA) allows up to 15 Nova minis to communicate with one another at rates to 140-k words/s. Elystec's MCI-10 offers the same capability with a 1-MHz rate. Also, the allowable computer-to-computer distance is increased from 50 feet to 250 feet.

Interdata of Oceanport, N.J., plans to introduce a shared memory system similar to that used in Xerox's 550 and 560 computers. Each machine addresses a portion of shared core assigned to it as if it were an extension of its own address. Other machines can read from the assigned portion but cannot write into it. A message area allows the machines to check if others have left data from them to pick up. For more rapid response, the machines nudge each other through external interrupts. The ability of the 32-bit Model 7/32 to address a million words of memory directly allows the compiler to insert the shared references in a straightforward way—through the definition of a multiprocessor or global COMMON statement.

Digital Equipment's bus window, the DA-11F, performs a similar function, but between two processors. Computer 1 requests access to a block of memory data from Computer 2. When Computer 2 acknowledges the request, the first computer can treat an 8-k-bit module as an extension of its own memory. Computer 2 can also access a block in Computer 1 in a similar fashion.

With low memory costs, today's minis do not suffer from a lack of high-level languages and operating systems. And a number of features in these systems lend considerable support to dispersed computing.

Communications capability often accompanied by time-sharing and multi-tasking (CPU time multiplexed among small jobs that run independently) are harbingers of distributed intelligence. For example, the MAX III operating system performs real-time and time-sharing operations on Modular Computer Systems MODCOMP II and MODCOMP IV computers.

The MAX III system shares time between as many as 256 program segments (called tasks). Through an extension of the time-sharing capability, a satellite computer attached to the host can perform a job normally assigned to the host. In fact, the satellite has access to all the main peripheral equipment attached to the host.

In a related development, this time in the intelligent-terminal market, Linolex of North Billerica, Mass., has introduced a terminal that can broadcast a program from one terminal to another for execution. The system lets the user generate the program in an interactive mode, then transmit the result by telephone to any remote site.

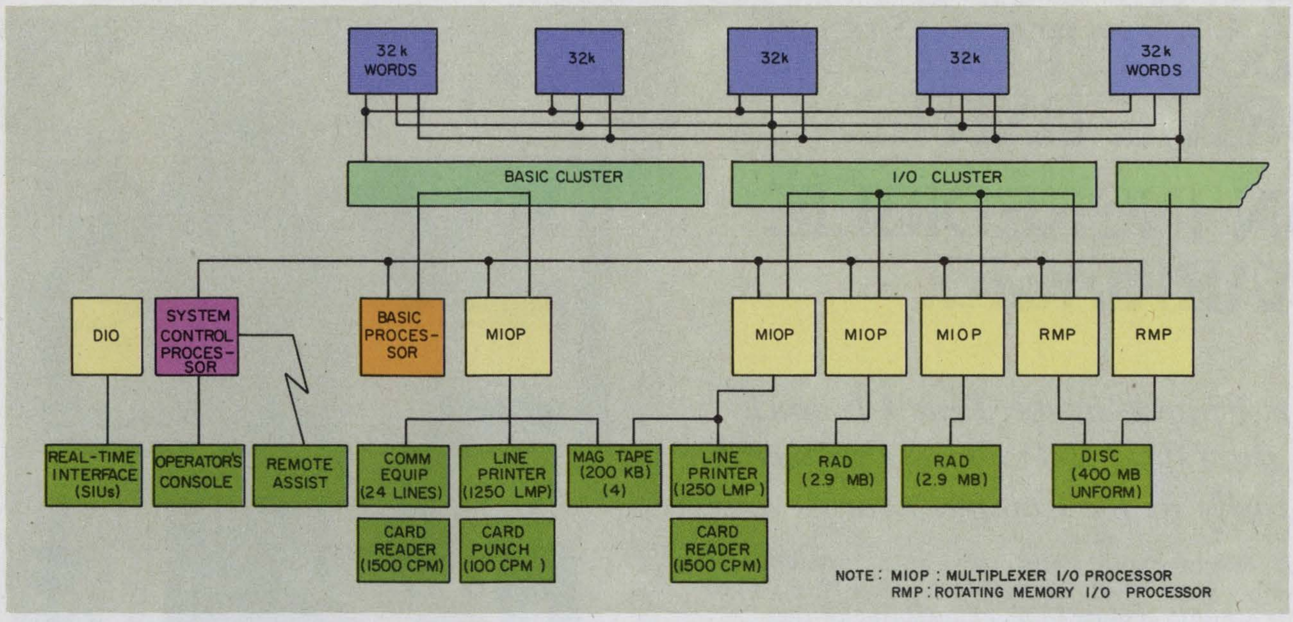
Experiments unlock new potential

Maxis are still best for processing the large volumes of data found in astronomical, seismic and weather-forecasting calculations. Also, software support for high-level languages tends to be better with large-scale machines than with minicomputers.

Yet, less than a year ago, use of large centralized data bases was also cited as a reason for use of the maxis. Since then, minis have been mated to IBM 3330 disc drives that store 1.6 billion bytes. A controller called the Computroller, manufactured by Diva of Eatontown, N.J., performs the feat.

Experiments conducted by David J. Farber, associate professor of the University of California, Irvine, could ease the general-purpose maxi out of small-to-medium data-processing jobs. At Irvine, a network of four minis (three Lockheed Sue's and a Varian 620i), joined in a ring configuration, divide program tasks in accordance with the capacity available at each machine. The goals of the experiment are twofold:

- To create a network in which one machine can request services of another machine, such as a file, printer or card reader.
- To create a larger distributed machine that can link microprocessors—say, in a typewriter—



A very modern midi, the Xerox 560, makes use of an hierarchical architecture. Input-output and arithmetic processors have distinct functions but are controlled by a single system control processor. Each processor can share memory with other clusters when needed.

with the file-handling and processing capability of minis.

An interface between each machine and the ring stores the names of programs and files for the machine. The programs send messages around the 2.3-Mbit/s ring and receive answers from machines that can perform the task. The sender need not know which mini has the program. The data are processed between the programs themselves. No one machine is the exclusive controller.

Programs can move from one computer to another to balance the load. As a program runs, a periodic request for a bid to do the job is sent around the ring. Each machine in the ring has an algorithm that it uses to price the bid. The lowest available bidder "wins" the job. The system has been in operation at Irvine for seven months. Future research will center on improvement of the present simple cost algorithm, to gain a good general sharing of resources.

While minis seem to dominate the distributed computer scene, the midis and general-purpose maxis are striving for their debut. Control Data Corp. is impressed enough with its Cyber 70 series to supersede them with the Cyber-170, announced this month. The new series continues the distributed architecture present in the Cyber-70 series, with an upgrade to bipolar and MOS LSI circuitry. The machines, which feature increased speed and reduced size, are designed to operate in a computer network.

One of the projects at Bolt Beranek & Newman Inc., the consulting and R&D firm in Cambridge, Mass. is on distributed computing. Dr. William R. Sutherland explains that the project group is looking into how the 10 computers on the ARPA network—which support the Tenex operating system, developed by BBN—can operate as a single, unified system. One difference between this work and the Irvine experiments is that Tenex runs on a midi, the PDP-10.

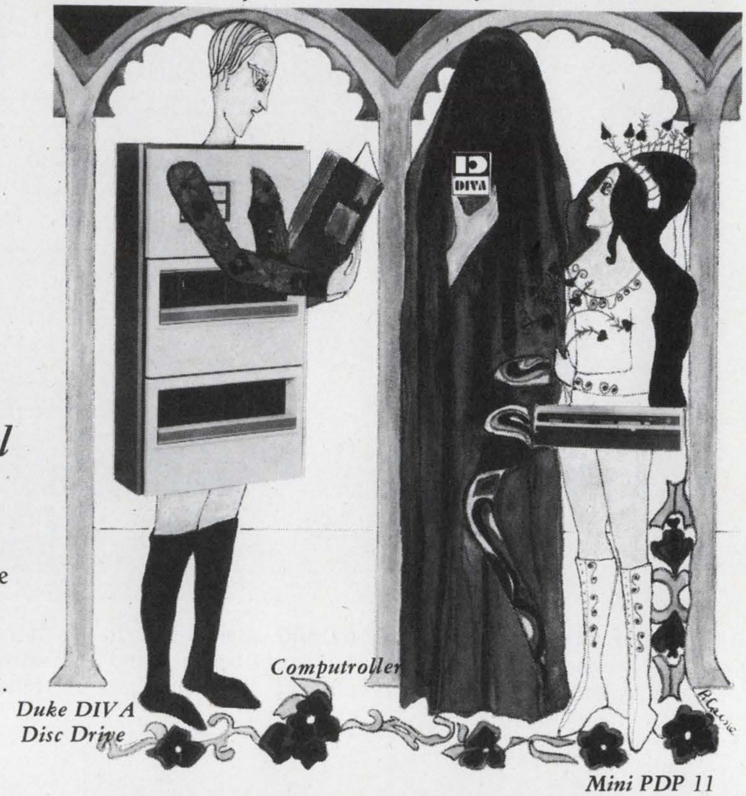
Another concept in the beginning stages, but in operation, is a distributed data base. This extension to the time-sharing ability to append files works as follows: Say, file F00 is at Stanford Research Institute in California and file TEXT is at BBN. The command APPEND F00 TO TEXT causes one file to move across the country to join the other on its disc. And the new file can be made to reside at a third location.

In an unusual demonstration of load leveling, a different program runs for a while, stops, then picks itself up and migrates over the network to another machine, then executes there for a time. For the demonstration, a user prods the program to move on, but in the future, the programs could migrate automatically when they sense that the machine they are running on is heavily loaded. The migration, of course, would be to a more lightly loaded machine.

Dr. Sutherland cautions that these exotic capabilities are now still in the research stage, but he expects that their enormous commercial potential will make them tomorrow's reality. ■■

DIVA'S COMPUTROLLER, PDP 11, AND 3330 TYPE DISC DRIVE UNITE.

AN INCREDIBLE MARRIAGE.



An Episode in the True Chronicle of the DIVAS, Proudest Peripheral Family in the Computerworld.

The computerworld stares in awe at the incredible wedding scene which has unfolded before them. The bride is minicomputer PDP 11, offspring of the illustrious maxi-computer clan, begat of Abacus. The bridegroom is DIVA COMPUTROLLER, scion of this proud, most respected peripheral family. Officiating at the ceremony is Duke DIVA Disc Drive, direct descendant of IBM compatible 3330 type disc drives.

Realizing the great impact this interfacing will have on the computerworld, our happy guests monitor the wedding with joyous solemnity.

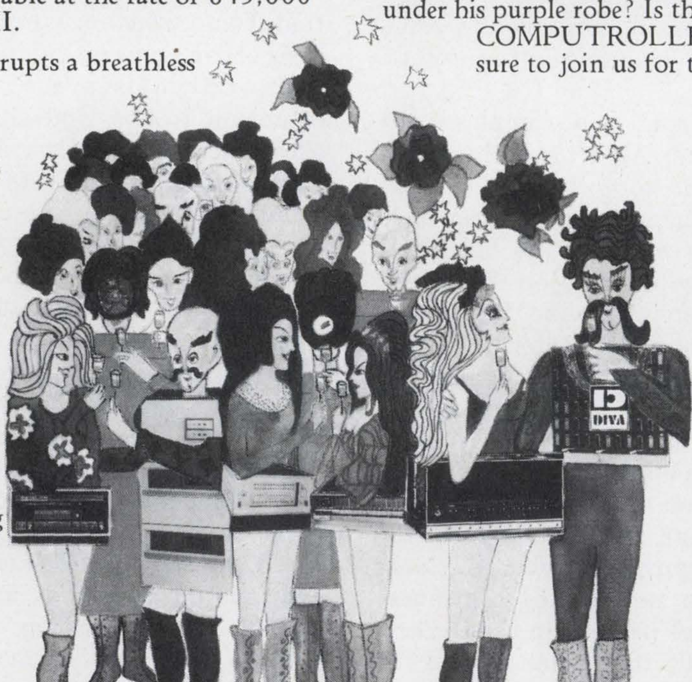
"Mated," Interdata 70 whirrs, "PDP 11 will have access to 100 million bytes of data on a single spindle or 200 million bytes on a dual spindle disc drive unit within an average access time of 32 msecs."

"And with COMPUTROLLER providing a buffering sector, data will be transferable at the rate of 645,000 bytes/sec," marvels Nova II.

"And keep in mind," interrupts a breathless TI 980A, "that with COMPUTROLLER controlling eight drives, mini will have access to 1.6 billion 8-bit bytes of data!!"

But, hush! Listen to Duke DIVA repeating those always-inspiring words: "With the data stored in me, and with provided interconnecting cables and distribution panel, I now pronounce you linked in holy matrimony."

Resounding cheers befitting the occasion arise from the crowd. "A toast! A toast! A toast!" they roar. As is the custom, the proud parents, mini processor and DIVA controller, propose the toast to the dazzling couple: "To the most splendid and significant union in all our memories."



"*Vive*, DIVA! *Vive*, DIVA! *Vive*, DIVA!" Everyone unwinds.

But even as we listen to the clink of ceremonial glasses and the exuberant laughter, we sense an underlying sadness. Those unchosen minis — do they count for nothing now? Will they not be able to enter the world of high speed data storage/access and low cost/bit performance? And why — throughout this entire festivity — has COMPUTROLLER remained hidden under his purple robe? Is there more to COMPUTROLLER than meets the eye? Be sure to join us for the next episode in the True Chronicle of the DIVAS when we will hear the horrendous accusation: "Bigamy! BIGAMIST!"

In the meantime, learn COMPUTROLLER'S inside story. Find out about the free implementation and training courses, the software packages, and warranties that go with each disc system. All you PDP 11 users call George Roessler at 201-544-9000 for cost and delivery information.
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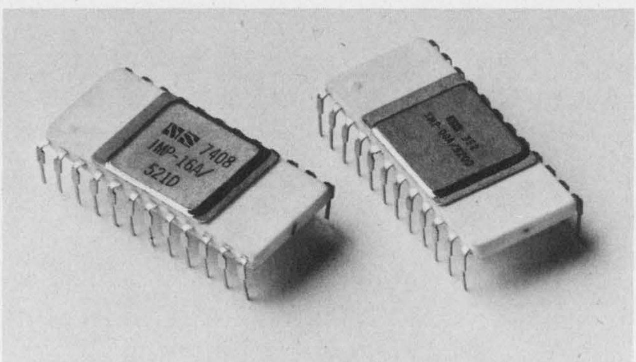
National's building blocks are the Register and Arithmetic Logic Unit (RALU) and Control and Read-Only Memory (CROM). Together they contain all the gates and flops you used to have to wire together to build your own processor.

The thing that does the work.

RALU.

A 4-bit slice of the Register and Arithmetic portion of a general purpose computer.

In one 24-pin package using standard +5V and −12V supplies



we've crammed all of the following: seven general-purpose registers, a status flag register, an arithmetic logic unit, an I/O multiplexer, and a 16-word LIFO stack that improves speed and performance while conserving main memory. The RALU number is IMP-00H/520D.

The thing that tells the other things what work to do.

The only trouble with RALUs is that they don't understand English. Or even the zeros and ones that you feed into the microprocessor.

CROMs do understand zeros and ones.

They're souped-up ROMs that translate your binary instructions into operational commands. A single instruction to the CROM triggers a series of commands to the RALUs.

CROMs are currently available in three varieties:

A standard-instruction 16-bit CROM, IMP-16A/521D, with 43 instructions.

An extended-instruction 16-bit CROM, IMP-16A/522D, that speeds up processing with 17 additional powerful instructions including divide, multiply, double precision add/subtract, etc.

And an 8-bit CROM, IMP-8A/520D with 38 instructions.

You can buy the RALUs and CROMs in these set numbers: IMP-16A/500D: 16-bit standard set; IMP-16A/502D: 16-bit extended set; IMP-8A/500D: 8-bit standard set.

THE CARDS

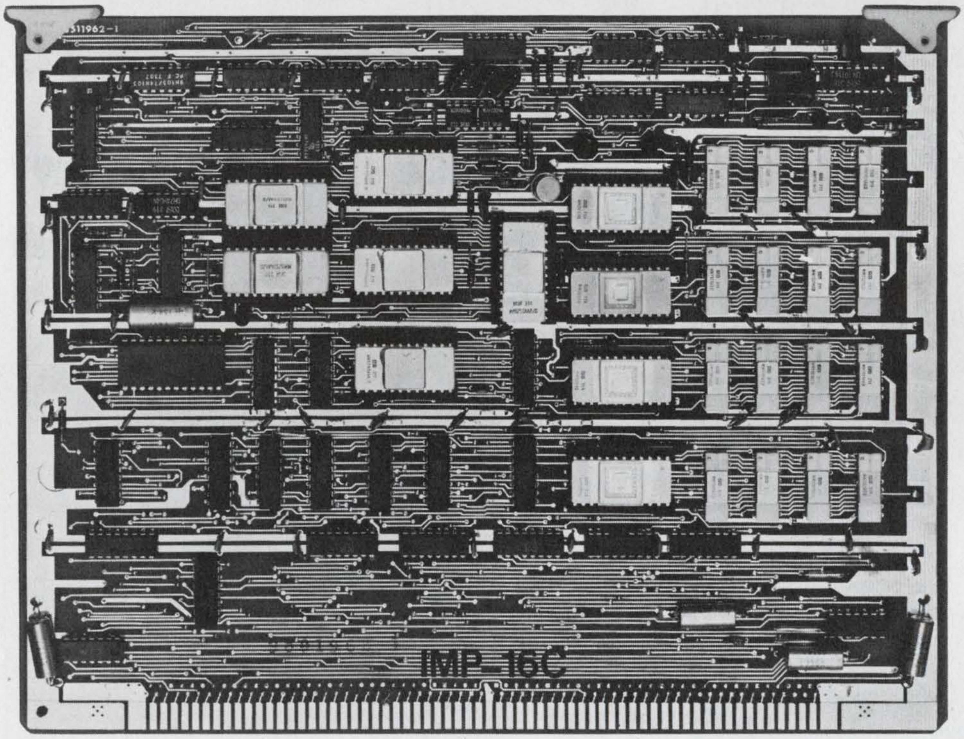
For people who want to save time, National offers its "ready-mades."

Complete, fully-debugged 8 and 16-bit microprocessors on 8½ by 11 inch p.c. cards ready for your application program.

Our big ones.

The IMP-16C is a 16-bit microprocessor built around four RALUs and one or two CROMs.

The one-CROM version has a standard-instruction-set CROM and an empty socket for another (IMP-16C/200). Add the extended instruction-set CROM and you've got the IMP-16C/300.



The IMP-16L/300 card is similar to the 16C/300, but we optimized it for high performance applications with a Direct Memory Access bus controller and multi-level interrupts.

Our little one.

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A flexible, low-cost, self-contained processor and controller containing two RALUs, an IMP-8A/520 CROM, and provisions for the addition of a second CROM to expand the instruction set.

If 8-bits is your thing, you'll find some things here to turn you on: 8 addressable control flags—control jump multiplexer provides 16 programmable branch conditions. Eight-bit buffered-data-out bus. Memory addresses 16 bits wide to provide a memory address range of 65,536 bytes. On-card memory expandable to 2304 bytes, consisting of 256 bytes of read/write memory and up to 2048 bytes of read-only memory (ROM/pROM).

But whether you go for 8-bit or 16-bit, cards or chips, the question is, what are you going to do with them once you've got 'em?

Please turn the page.

THE BOXES

The advantages of the whole microprocessor thing lies in the fact that it is standard hardware designed and built for you to *program* to your specific application.

Our boxes help you do that.

They're program debugging and prototyping systems, providing everything you need to develop and test both the interfaces and application programs.

Each box includes a microprocessor card, programmers control panel, peripheral interfaces, memory, power supply and chassis.

Box #1

The IMP-16P.

A microcomputer for use with the IMP-16C microprocessor cards. With a Teletype®, the IMP-16P provides all equipment necessary for the immediate evaluation and use of the IMP-16C (both 200 and 300) cards and chips.

Box #2

The IMP-16L.

A prototyping system for the IMP-16L/300 card. (And if you're starting to get confused by all the different numbers, the chart on this page should help unconfuse you.)

The basic IMP-16L and options provide an unusually versatile tool for developing a variety of OEM equipment, software, and full-scale processing systems.

Box #3

The IMP-8P.

For 8-bit fans this is the prototyping tool for the IMP-8C card. Like the others, IMP-8P puts all you need for hardware and software development all in one box.

What goes with what.

	CROM Types:	# of RALUs	Cards:	Boxes:
standard 16-bit	IMP-16A/521D	4	IMP-16C/200	IMP-16P/204
extended 16-bit	IMP-16A/521D IMP-16A/522D	4	IMP-16C/300	IMP-16P/304
extended 16-bit with DMA	IMP-16A/521D IMP-16A/522D	4	IMP-16L/300	IMP-16L/304
8-bit	IMP-8A/520D	2	IMP-8C/200	IMP-8P/208

So that's our basic hardware. Our boxes, our cards, and our chips. But we're not quite through yet...

THE WORKS

National wouldn't leave you out on a limb. We support our hardware with software, firmware, and accessories that help make the whole thing easier to apply.

The assemblers.

What we have here is a communications problem.

RALUs don't understand what binary instructions are talking about (so we have CROMs to act as interpreter). And CROMs don't understand what human beings are talking about.

What's needed in the latter case is an assembler, which is a computer program that automatically converts English to binary language (something CROMs can understand). You just feed the program language and the assembler program into the computer and out pops the computer language.

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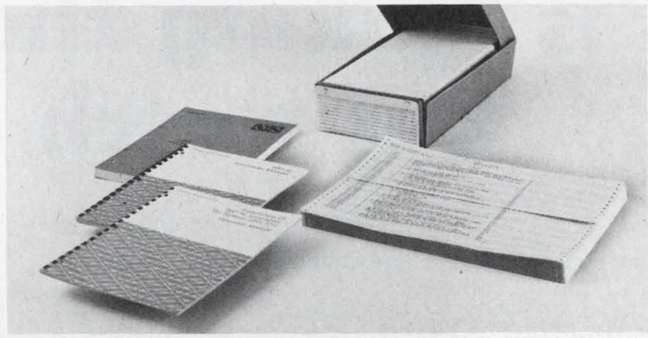

ware debug routines...utility routines, etc.

And there's also a passel of support hardware such as card cages, memory cards, extender cards, prototyping cards, peripherals, plus training courses to make you an expert in a hurry.

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2

NATIONAL

See us at Booth #753 National Computer Conference in Chicago.

Take-your-pick software is making the mini mighty, but watch out—it costs

Jim McDermott, Eastern Editor

A "smorgasbord" of operating software and application systems developed by both manufacturers and users is giving today's minicomputers power usually associated with the larger computers. But with the advances have come problems.

The operating software—a collection of interrelated programs that tell the individual computer elements how to interact—provides the intelligence for the machines so they can perform tasks. These tasks, defined by software application systems, range from the monitoring of a simple industrial process to real-time, multiple-user, foreground-background operation.

But one problem is the high cost of preparing, debugging and executing the application programs. This cost has widely outstripped that of the minicomputer mainframe. The software for a typical system may cost 10 times the original investment in hardware, according to Philip Stein, minicomputer consultant at the National Bureau of Standards, Washington, D.C.

Michael A. Ford, vice president of General Automation, Inc., Anaheim, Calif., agrees.

Software—the programs and routines that run a computer—are stored on media like paper and magnetic tape. Magnetic discs, cartridges and cassettes plus punched cards are also used.

"A month of programming," Ford says, "can cost as much as a minicomputer. And you can buy a whole computer system for the price of one programmer's services for a year. Moreover salaries are rising, while the cost of computer hardware is falling."

Efforts under way to cut costs

There is a genuine effort in the minicomputer industry to cut costs by providing system software that requires less programming time. Evidence of this is the growing quantity of both off-line and real-time software with higher-level languages like Fortran and Basic, which are easier to use than the machine-oriented assembly-language programs. While hardware costs are higher for real-time, higher-level languages, because more memory is required, that expense can be offset by reduced programming costs.

For example, Van Diehl, product manager for the Hewlett-Packard Automatic Measurements Div., Sunnyvale, Calif., points to many years of controversy between the proponents of assembly languages and those of higher-level languages.

"It's still going on in some quarters," he notes, "because with assembly language you can develop shorter and faster programs with a minimum of memory. But with the price of 4-k of core down to a few thousand dollars, it's hardly worth saving a couple thousand words of core when, to do that, you have to spend three to six man months more programming in assembly language. For the cost of a highly sophisticated programmer for this period, you can buy not only the 4 k of core but another computer."

Picking the best software for the job can be very difficult. Software specs can mean different things to the hardware-oriented designer and the software salesman. Robert Oakley, product manager of computer systems for Varian Data Machines, Irvine, Calif., says:

"There is a type of specmanship and there are interpretations of terminology in the software area that exceeds the exceptions and differences in the terminology used for computer hardware. For example, because one manufacturer says he has a Fortran software compiler doesn't mean he has the same one as a competitor. There are a number of different specifications for Fortran compilers. And not investigating this can be costly.

"A user may have a system which runs Fortran, and he wants to upgrade to a newer system. If he isn't knowledgeable about the differences in the various Fortrans offered, he could buy a computer which he thinks meets his needs. But he'd be in for a shock."

For other high-level languages, like Basic, RPG or Cobol, a number of nonstandard modifications can be a trap, Oakley points out.

How can the designer protect himself? Andrew Breslin, applications analyst for Computer Automation in Irvine, takes a pessimistic view.

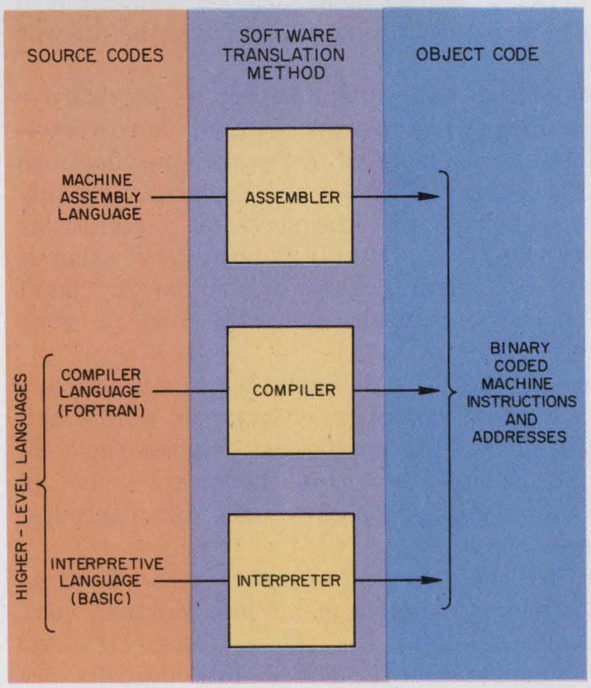
"There is no way that someone who is not familiar with software can protect himself from

Software code generation and translation

Programs for computers can be written as a binary code that the machine can directly accept and use. But generating programs in this fashion is impractical because it is a very difficult and time-consuming task. Instead, coded terminology of differing levels of complexity have been devised for easier understanding and manipulation.

The first improvement on binary coding is in the form of machine instructions that are small groups of letters and numbers, called assembly language. These groups are decoded in the computer by a software package called an assembler. The output of the assembler—binary-coded machine instructions and addresses—is directly usable by the machine.

To get the computer to do much of the routine work involved with programming, higher-level languages were devised. Instructions in these languages are written in the form of statements. Depending upon their complexity and the machine task which they are to perform, they are translated into machine code by compilers or interpreters.



an unscrupulous salesman," Breslin says. "If you decide he's giving you a snow job, get rid of him. If not, listen to him."

R. Stockton Gaines, technical staff member with the Institute of Defense Analysis, Princeton, N.J., insists that the hardware designer, to protect himself, should learn something about programming. "It's an effort to learn," he points out, "but once you have, you're better off in many situations than calling on someone else. And at least you can communicate with vendors."

Gabe d'Annunzio, marketing services manager for Prime Computer, Natick, Mass., says that the application of software to hardware can be simplified by a new approach. "Instead of looking at each element of software as an individual item, with individual specifications and qualifications, put the software into the total system concept," he suggests. "Evaluate it on the basis of total system performance."

Software and hardware incompatibilities will show up more easily under the system-analysis concept, d'Annunzio insists.

"We suggest you look at software from two viewpoints," he says. "First, much system software now offered is three or four years old in its basic design. But it's attempting to support new minicomputers that, from a hardware standpoint, are probably less than six months old. A principal problem here is, 'Does the system software even know that many advanced features exist in the new machines they're trying to run?'"

Surprisingly in many cases, the software doesn't, d'Annunzio notes.

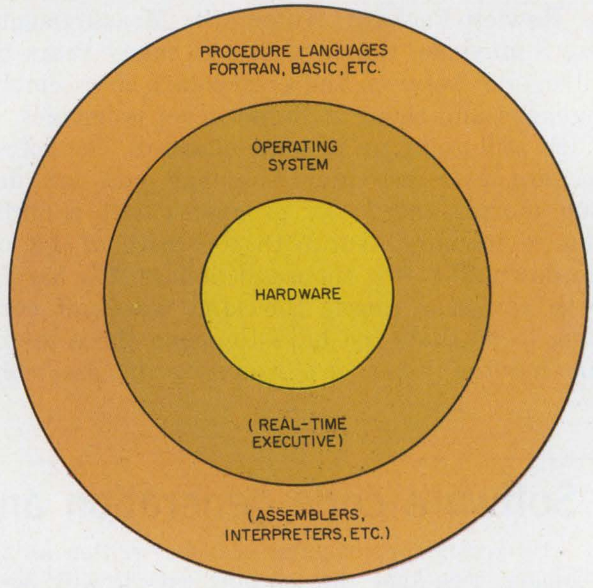
A second major aspect for the mini system designer to consider, d'Annunzio says, is whether the computer manufacturer has built features into the hardware to make it more responsive to the software. In many cases, he says, the answer is no.

"Neglecting the system aspect of software—the fact that it has to work with the hardware—and looking at isolated software specifications doesn't tell a thing," d'Annunzio warns. "For example, if you look at the specs on a particular Fortran compiler, you only determine whether it produces a Fortran code or not. What you don't know is how it works with the rest of your system."

Some 99% of all minicomputer manufacturers offer a Fortran compiler, d'Annunzio points out. But significant differences exist between the compilers, he says—not within the compiler but in how the compiler makes use of computer features.

For instance, some computers offer floating-point arithmetic hardware. While Fortran compilers are available for those systems, several don't generate code that will automatically use that hardware.

Low-cost software development systems, like this 980A system by Texas Instruments, support users who do not need large, disc-based computers.



For industrial real-time minicomputer applications the buyer not sophisticated in software should be sure, says Van Diehl of Hewlett-Packard, that the software elements of the outer circles are also provided by the minicomputer vendor.

On the other hand, d'Annunzio says, if the Fortran compiler can use floating-point hardware, there is this basic question: How easily can it do it?

For example, different mini vendors put the floating-point hardware in different places in the computer. Some treat the floating-point processor as a peripheral device and hang it on the input-output bus of the computer. The vendor will tell you what the floating-point add time is —the time it takes to add inside that unit—not the overhead time necessary to address the floating-point processor as a peripheral device, bring the information in, put it in the memory and then produce the results.

Some vendors, including Prime Computer, treat the floating-point processor as a central processor. It's directly linked to the CPU, and memory-reference instructions are used to access the floating-point unit. Which means that you can use direct addressing and call the instructions automatically from the Fortran compiler.

Another point that may be concealed by software specsmanship is lack of file-structure compatibility. With various vendors offering large memories and disc-operating systems, it's now possible to have the minicomputer process large data files. And the larger machines can create programs for smaller ones in their line.

But with some computers the file structure used by the disc-operating system when it develops a program is incompatible with the file structure used when that program is run by a real-time operating system. This means that the files must be reformatted by a programmer, and this takes time and money and adds the risk of mistakes.

Some minicomputer manufacturers, following IBM's lead, provide a file structure that is compatible with all the software systems for the company's line of machines.

File compatibility reaps benefits

An advantage of such complete file compatibility, according to Richard Farwell, marketing manager of software systems for Data General, Southboro, Mass., is that programs can be developed by real-time, disc-operating systems for later use in stand-alone operating systems or in stand-alone, core-only, real-time operating systems.

"Our paper-tape formats, magnetic-tape formats, cassette formats and disc formats are fully compatible," Farwell says, "As a result, a Data General user can start with a small—perhaps a stand-alone—system and do program development. By extending the system with core or disc, it can be expanded to a larger system without reprogramming what's previously been done."

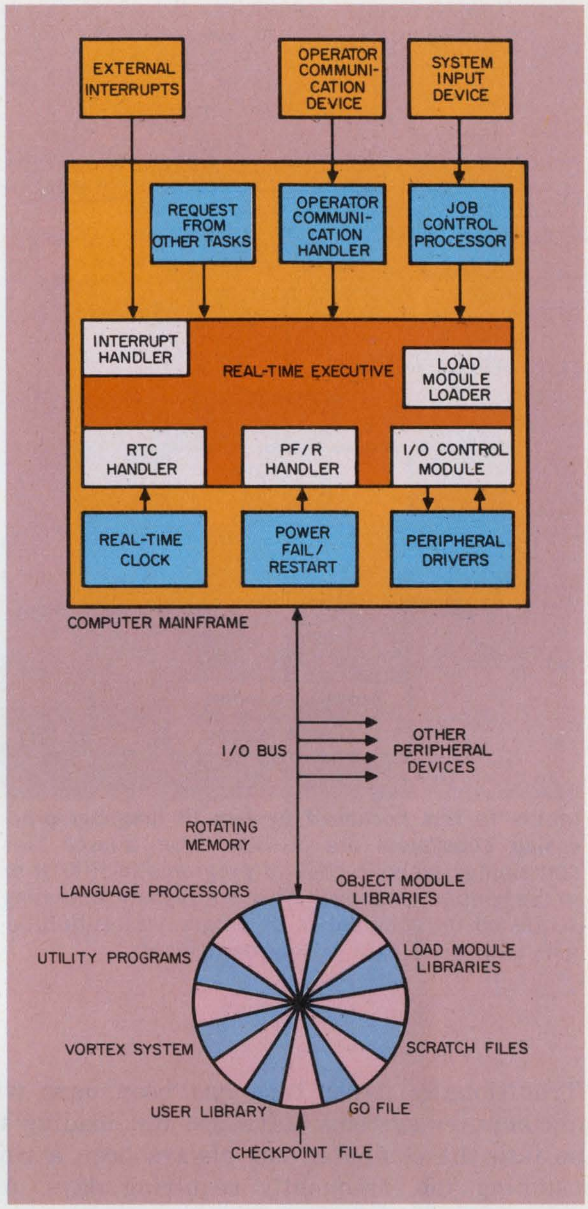
With some disc software operating systems, the space on the disc is not allocated to individual files. The customer must identify the file locations himself, at considerable programming time and expense. In other systems the disc-base allocation is provided automatically and referenced by name as well.

The problems of compatibility have been of considerable concern to Digital Equipment Corp.

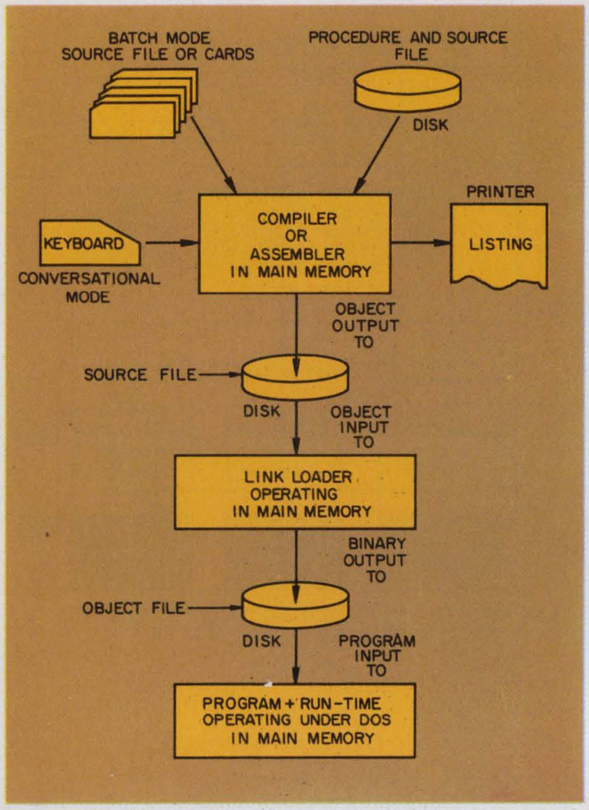
"While it's been difficult, if you've written a user program to move from one system to another in the PDP-11 line, we've taken positive steps to remove those difficulties," says Peter van Roekens, manager of PDP-11 medium and large development.

"The problem has been software. But in the operating systems coming out now there are compatible paths, so the users can move programs from one system to another. We have several systems that are now compatible. They require only a relinking of programs to go from one to another, van Roekens points out.

"Part of a new series of systems that are coming out—some have been already released—have both compatible user interfaces and compatible file interfaces."



A powerful real-time multitasking operating system, Vortex II by Varian Data, provides foreground/background processing capability, program overlays and simplified I/O operations. Rotating-memory file management is incorporated in the software.



Inputs to this Lockheed System III language-processing subsystem are provided from source files containing symbolic code of programs in RPG II or in assembly language. The subsystem operating sequence for compilation or program execution begins with disc, card or keyboard inputs.

Traditionally paper tape has been used with minicomputer systems software. But loading the tape into the computer has always been a time-consuming job, frequently requiring days. And if there is a mistake in the program, it's necessary to return to the beginning of the program reel and do the program all over again.

As a result, many companies now offer disc systems, which can be loaded in minutes. But discs aren't as safe as paper tape. There's always the possibility that the disc will "crash" either through mechanical failure or sloppy programming.

For example, the program may access a file when it's not supposed to be accessed. Some vendors take the attitude that if the user makes such a mistake, lottsa luck. Others provide system software that makes checks. Some of this software can help identify a file that has crashed and also help reconstruct a destroyed file.

Questions to ask here are: What has the vendor done to ensure the integrity of the file? What will he do to bail you out once you've made a mistake? Is it going to take a couple of days to reconstruct the file from cards—or can you go in in-line and do the job?

There are several levels of minicomputer software, and the level selected depends upon the size of the machine and its task, notes Andrew Breslin.

Usually, says Breslin, you can execute programs on most any machine—although that isn't always true—but it frequently takes a large-scale minicomputer to compile the programs. For example, a basic mini will have a small memory of 1 or 2 k—which is nowhere near enough to run a Fortran compiler. However, the compiler's output—the compiler code—can be run on the small computer.

Not all systems will let you mix Fortran and assembly languages, and that can be critical—for example, in process control. It's necessary to distinguish between the ability to run and the ability to run usefully. An assembler that can just barely run in a 4-k memory may not be able to assemble a large enough program to be useful.

And you want to make sure that the language will be able to support the required peripheral devices. "For example," says Breslin, "we have a Fortran compiler that we sell which will run on as little as 4 k. But it doesn't support a line printer or a card reader."

The minimum of software needed for any job, Breslin says, must include a language translator that accepts a program statement written in mnemonic code. For example, statements like "HALT" or "LOAD A" might be used to instruct a machine to load one of the registers. The language translator converts these statements into "object text." Also required are software loaders—programs that take object text and put it into the machine in a form suitable for running the machine.

Translators, Breslin says, come in a variety of forms, particularly assemblers, compilers and interpreters. Assemblers and compilers produce code, or machine-language programs that are executed on the computer in binary form. Interpreters—a Basic-language interpreter is a prime example—produce an intermediate language that is closer to machine language. And this intermediate language is, in turn, interpreted by yet another program called the "run-time" program.

Breslin points out that the compilers and assemblers—which produce ready-to-run code in machine language—execute the program considerably and with less memory than the interpreters do. On the other hand, the interpreters provide a much easier alteration of the program once it's done.

For industrial-control applications, interpreters are not generally used, Breslin notes. More common, he says, is the assembly language, which is a one-to-one representation of the machine language. The assembly language, he adds, calls for a higher level of programmer's skill than Fortran—a one-to-many conversion—does. One Fortran statement produces many machine-language statements and instruction. Fortran and assembly language account for the vast majority of all minicomputer programming, Breslin says.

Most people approach the development of minicomputer software by first trying to determine the language that the program will be written in, says David Waks, vice president, Applied Data Research, Princeton, N.J. But he continues, there are at least two questions that must be answered before the language step: How are you going to get the system debugged and running? And what kind of a computer are you going to use to get the program working?

Choosing a computer language

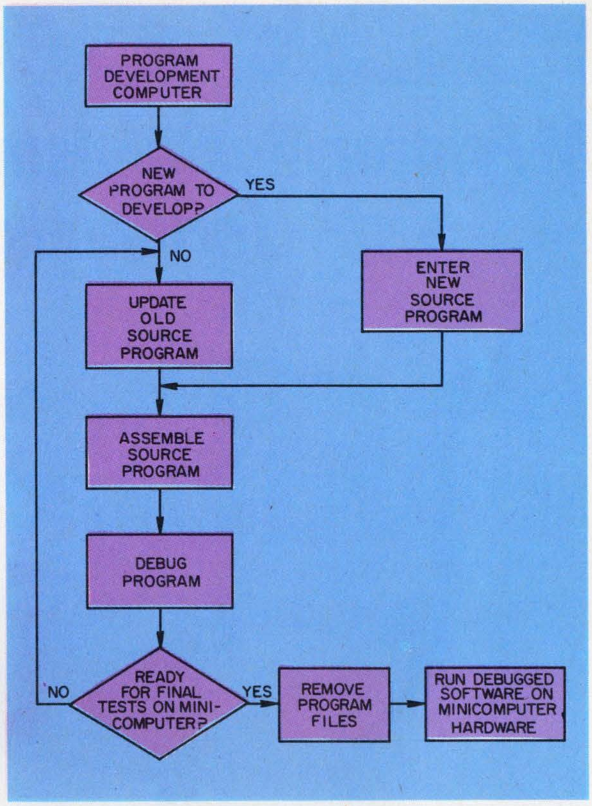
The choice of language and the choice of systems approach is ultimately going to be governed by how you get the system working. From there, the choice of language follows. It's a question of what language or mixture of languages you're going to fit into that operating environment.

Minicomputers today are all essentially the same, Waks says. The prices, the features and what you can do with them are comparable. "But when I choose a machine for an application," he stresses, "I choose it on the basis of the degree of software support I get from the manufacturer, because it costs a fortune to develop the software. Take a typical operating system. No manufacturer has an operating system out that has cost him less than $200,000—probably closer to a million—to build. No one has a working, field-tested Fortran compiler that cost less than $50,000 to $100,000."

Many minicomputer manufacturers recommend that a purchaser use the machine on which he's going to perform his system tasks to develop the program as well. But in a real-time environment, Waks feels, this is "the worst possible choice.

"The computer configuration typically chosen to run in a real-time environment," he says, "is not optimized for program development. It's optimized for the application problem. To be optimized for program development, it has to have a disc; it almost necessarily has to have a line printer, and it probably has a high-speed paper tape.

"And it's got to have a fair amount of core in order to run the various computer utilities. Also, it has to be big enough to support an operating system that's going to run the program generation systems—the macroassemblers, the Fortran compilers, or whatever. For example, if you're talking about a Nova computer, you're committed to a 24-k machine with a fairly large disc and line printer.



Minicomputer programs can be efficiently developed on large, time-shared systems. System flow for Mimic, a software development system by Applied Data Research, is shown above. The Mimic console language enables simulation of a host of minicomputers. Mimic runs on a DECsystem-10.

"You can size your mini to the application if you're going to use some other machine for program development. But if not, the machine must be large enough for the latter task."

To reduce the programming time required by the higher-level languages, some larger minicomputer systems incorporate software that performs what is termed "global optimization."

The key to this system is a multipass compiler that makes the code more efficient by recirculating the program elements several times through the compiler. Many of the program revisions routinely done by the programmer to optimize a program are performed rapidly by the machine.

Data General uses global optimization in its Nova systems.

"With global optimization," says Farwell, "a multipass compiler looks at the total program as it is compiling it and resolves any common references to variables and to pieces of code that are common to multiple parts of the program. If the same calculations are made in multiple places in the program, the global compiler pulls them out and only calculates them once." ■■

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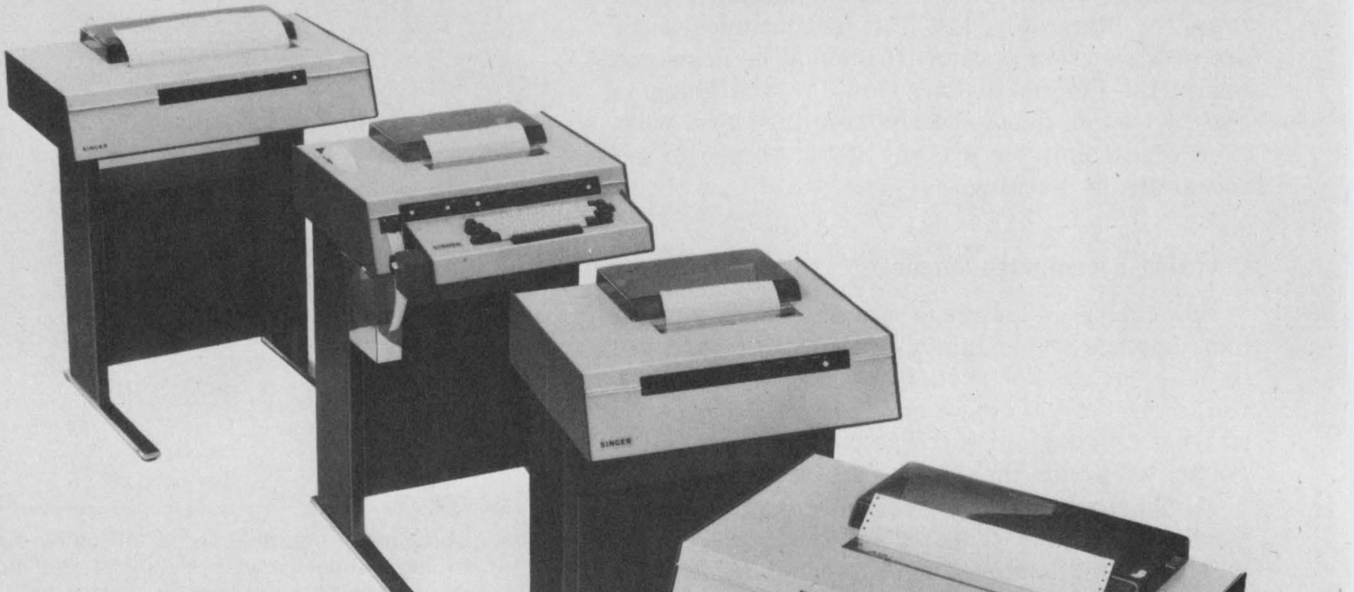

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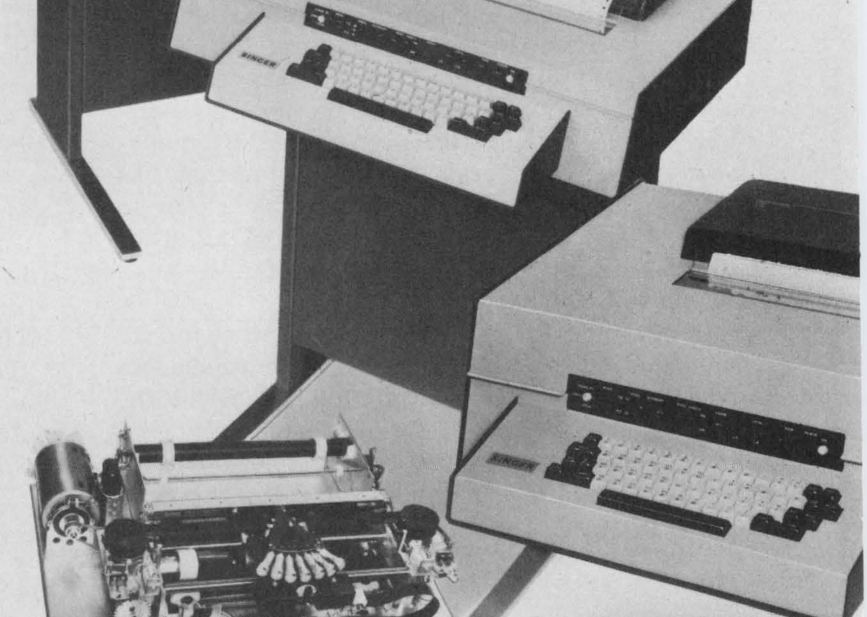

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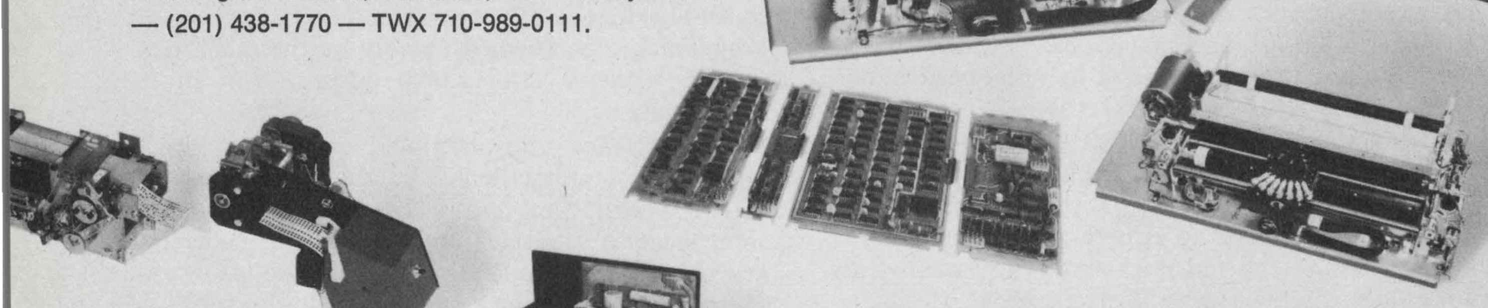

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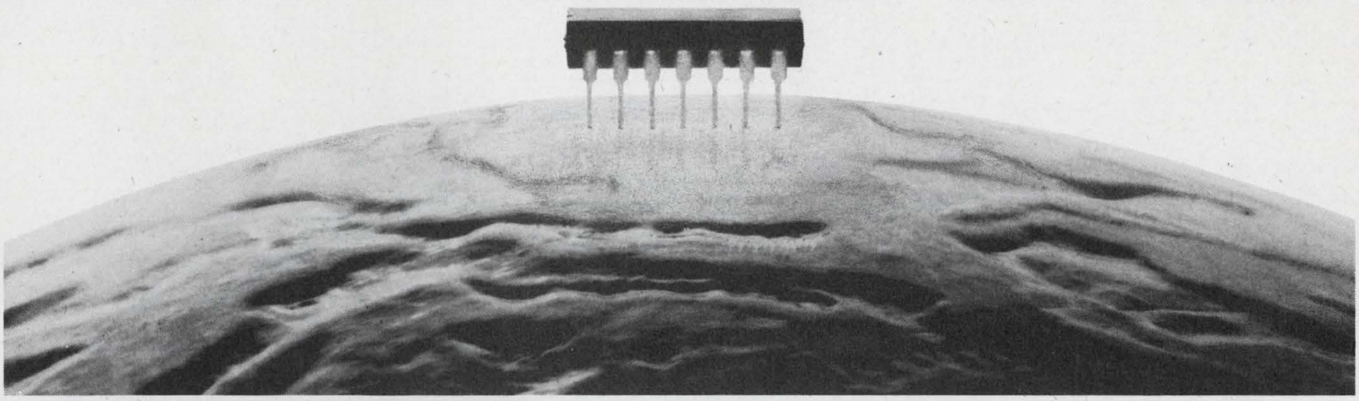

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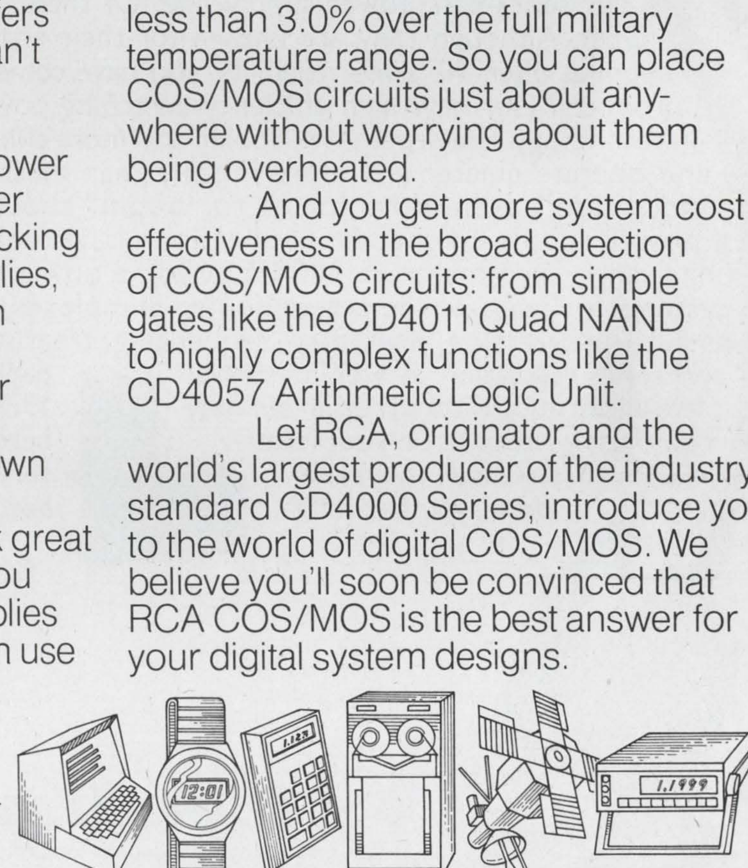

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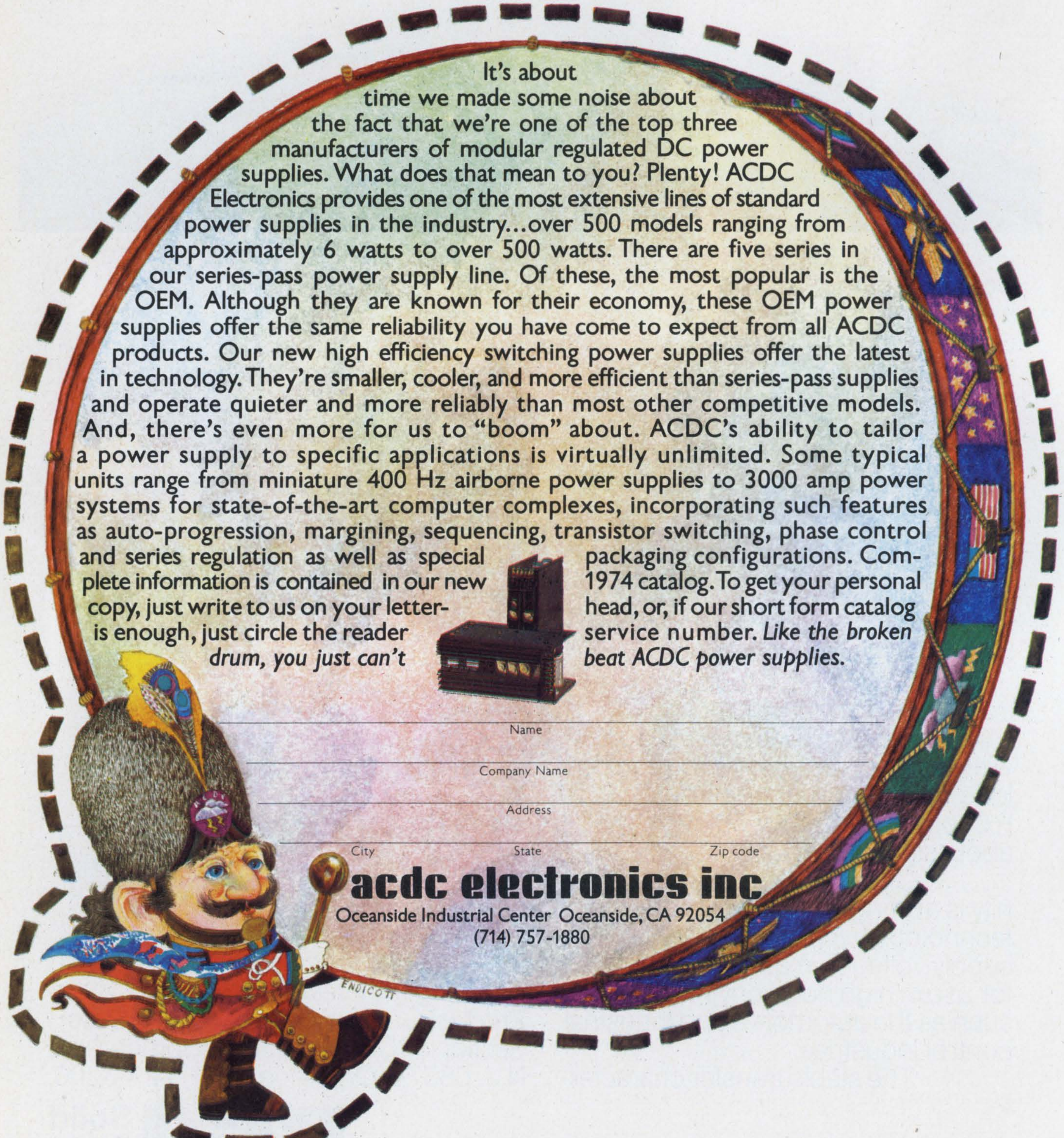

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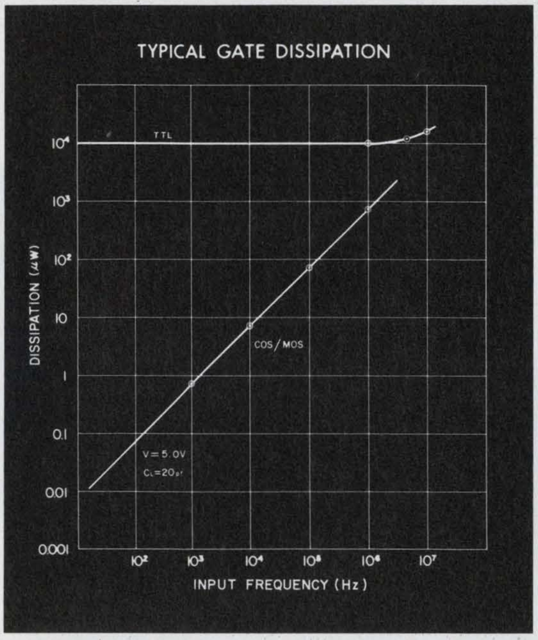

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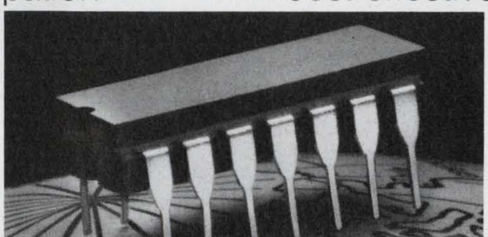

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Microprocessors showing promise in test equipment, but haven't made it big yet

Stanley Runyon, Associate Editor

Though powerful, the microprocessor hasn't quite made it yet in test and measuring instruments. Most microprocessors are currently finding homes in commercial, OEM and computer-oriented products—such as traffic-control systems, blood analyzers, data-entry terminals, point-of-sale terminals, check processors and automatic typesetters.

Exactly what is it that has kept the microprocessor—a glamour product if there ever was one—from being more prolifically used in test instruments? Several reasons.

For one, it's relatively expensive. While the CPU by itself may cost under $100, the hardware cost can zoom when all the needed memory, I/O devices, clocks and other ICs are added.

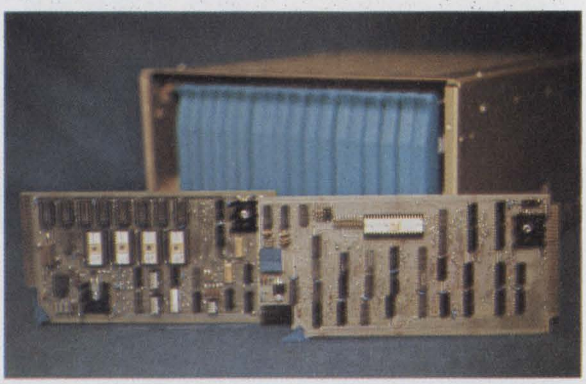
For another, the microprocessor's relatively sluggish data cycle limits its use in all but low and medium-speed applications.

Add to these limitations the minimal software support now on hand, then top it off with a lack of familiarization among designers used to hard-wired logic. (And don't forget that, up to now, only two vendors offered them.)

Rethinking design habits

All of this points to a time delay, probably two to three years, before the microprocessor surfaces as a major circuit element—a time delay during which prices must tumble, performance must rise and engineers must learn to design with software rather than hardware.

It's true, however, that practically every major instrument manufacturer has bought one. But they've been purchased only for evaluation and not for a specific instrument. Thus, at least for most instrument vendors, the microprocessor is a solution looking for a problem.



Process Control Systems' general-purpose interface, the Series 2000 (background), uses the Intel 8080 as the heart of a micro-CPU module.

Right now, probably the only measuring instrument with an internal commercial microprocessor is Boonton's Model 76A Capacitance Bridge.

In this automatic, programmable unit, an Intel MCS-4 microprocessor controls the various front-panel, display and I/O functions, as well as digitally controlling the bridge balance and computing the unknown capacitance, conductance, Q factor and dissipation (D).

On top of this, the 76A automatically corrects all predictable bridge errors, autoranges over 0 to 2000 pF and digitally displays the results.

Boonton's solitude isn't to suggest that the microprocessor—that is, a general-purpose MOS or bipolar LSI CPU on a chip, surrounded by ROMs, RAMs, I/O devices or other ICs—isn't being applied. It is. But the viable products merge into a trickle rather than a torrent.

And even though it's a sure bet that the next few years will bring microcontrolled DVMs, synthesizers, sweepers and other instruments, it's not so sure that the microcontroller or microcomputer role will be played by a commercial microprocessor.

One reason for this is that some potential customers, big companies like Hewlett-Packard, have opted to design their own hardware or firmware to implement the concept of a microprogrammable processor. Or they are building what can be termed a specialized microprocessor.

And, of course, the role of a built-in digital controller, calculator, processor or data shuffler can be, and is being, filled by ROMs, RAMs, PLAs and random logic—all rivals to the commercial microprocessor.

Examples are HP's 3330 frequency synthesizer, which has an internal digital processor, and the Tektronix' 7704A Digital Processing Oscilloscope, a unit that can perform calculations on its input signals.

And Computer Automation, a well-known minicomputer vendor, offers a one-card mini with a rather complex MOS/LSI PLA (which some people mistakenly label a microprocessor).

Because of this functional rivalry, the definition of a microprocessor is often confused. There's little doubt that, more and more, the word microprocessor will come to mean the MOS/LSI—or bipolar—component and not the microprogrammable processors currently being implemented in MSI, SSI, and with minicomputers or even large-scale computers.

It should be noted that some commercial microprocessors—such as National Semiconductor's GPC/P and the AMI 7300 (from American Microsystems, Inc.)—are microprogrammable.

Illustrative of the microprocessor concept is the Model 400 graphic-display system built by Adage Inc. of Boston. Because microprocessors of the commercial variety couldn't handle the fast I/O required by the refreshed CRT graphics, Adage built its own microprogrammable display processor.

To get the speed, Adage couples fast Schottky TTL MSI with either a high-speed bipolar RAM or a fusible-link pROM, depending on the configuration. The result: a processor with a multiplication time of 240 ns.

In contrast, Iomec, Inc.—a Santa Clara-based firm—was able to use the Intel MCS-4 in its Porta-verter line of remote data-entry terminals. The big difference, of course, is that data entry is a relatively slow job.

Terminals: A natural home for microprocessors

For Iomec, the commercial microprocessor appears to have been a godsend. When it became apparent that the Porta-verter's original LSI hard-wired logic chips weren't going to be delivered on time for Iomec to meet its delivery commitments, the company was able to replace the chips with off-the-shelf microprocessors at about the same cost.

And not only did the microprocessor fulfill the terminal's original design goal; it allowed Iomec to offer such extras as special character keys, operator prompts, error correction and unattended operation. Even with all options, Iomec says its price is two to eight times less than that of intelligent terminals.

One intelligent terminal that was conceived

A microprocessor not only controls various front-panel display and I/O functions of Boonton's 76A Automatic Capacitance Bridge, it also computes C, Q and D, and corrects for bridge errors.

from scratch with a microprocessor as the central control unit is the Microterm series from Digi-Log Systems, Horsham, Pa.

Because of the microprocessor and the Microterm's modular design, Digi-Log reports, designers with unique terminal requirements can just about write their own specs. Such features as display formats, code structure, baud rate, keyboard format and editing can be personalized if custom-written software is combined with selected hardware modules.

To get the identical capabilities with a hardware design, Digi-Log estimates that 600 to 700 ICs would have been needed.

Applications such as Iomec's and Digi-Log's—in which the microprocessor replaces hard-wired logic or minicomputers—now dominate the product scene and are likely to do so for the next few years.

In a blood analyzer built by Helena Laboratories of Beaumont, Tex., for example, a microprocessor bumped hardware to provide more complex, faster and more accurate data handling—in a smaller package yet at less cost.

The analyzer, through the microprocessor, performs mathematical and operational routines on raw data received from a sensor and gives a printout, in medical units, of blood protein content.

In still another application, four PC cards were knocked out by Intel's 8008 microprocessor in a computing integrator built by the Autolab Div. of Spectra-Physics.

This remote data-entry terminal—the Porta-verter from Iomec, Inc.—offers intelligent operation. Credit goes to a four-bit microprocessor.

Designed expressly for chromatographic data processing, Autolab's System 1 can replace a general-purpose mini or a programmable calculator. Autolab notes these benefits with the microprocessor: The design was simplified, the instrument shrank, reliability went up and costs were reduced.

How did Autolab and Helena save money by

A 'micro' what?

What's a microprocessor? Confusion seems to result when the prefix "micro" is plugged into the front end of a word. And no wonder. Generic names are few, and vendors like to coin words to describe their "unique" products. Here is an attempt to clear the confusion:

Microprocessor: An LSI central processing unit (CPU) on one—or a few—MOS or bipolar chips. Along with arithmetic functions, the CPU may perform input/output (I/O) jobs and may contain a scratch pad or other memory. To form a working system, at least one external ROM, RAM or other memory device is usually used with the CPU.

Microcomputer: Microprocessors are sometimes called microcomputers. But so are "small" computers—such as bare-bones minicomputers, built on one or a few PC cards. Minicomputers built around a commercial microprocessor are often called microcomputers.

To make things worse, computers that use microprogramming are sometimes referred to as microcomputers, regardless of the size and packaging of the CPU.

Microprogrammed processor or computer: The term "microprogrammed" refers to any computer whose instruction set is not fixed but can be tailored to individual needs by the programming of ROMs or other memory devices. Consequently whether the computer is a mini, midi, maxi—or a microprocessor—theoretically it can be microprogrammed.

Microcontroller: Another all-purpose word, this can mean a microprogrammed machine, a microprocessor or a microcomputer used in a control operation—that is, to direct or make changes in a process or operation. But there's a narrower definition, more in keeping with the prefix, in which microcontroller refers to any device or instrument that controls a process with high resolution, usually over a narrow region.

substituting microprocessors, while others point to their high cost?

The answer, of course, depends on what the microprocessor replaces. For simple jobs with few components, random logic is less expensive. But at the other extreme, if the microprocessor shoves a minicomputer aside, the cost savings—as well as the volume reduction—can be substantial.

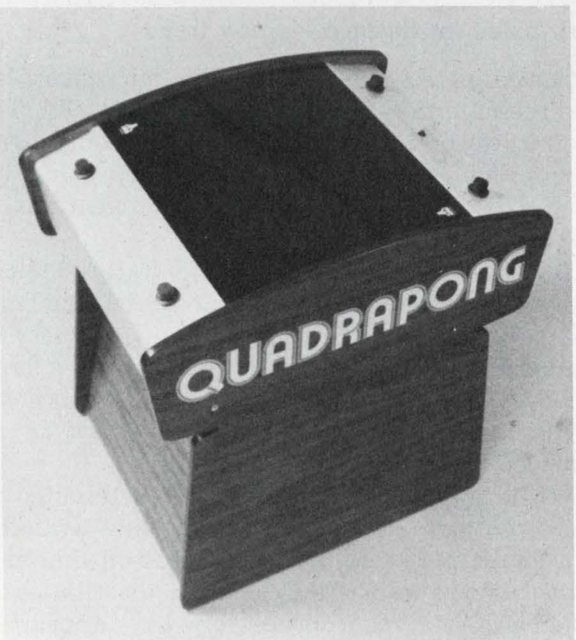
Micros vs minis and other hardware

Dr. Robert E. Jackson of Applied Computing Technology, Irvine, Calif., offers this rule of thumb to determine the cost tradeoff between random logic and microprocessors: A 50-IC system costs about the same as a microprocessor plus 20 interface ICs. Included in the rule are parts cost and the cost of handling, testing and interconnections.

Does the microprocessor's inroads into minicomputer territory worry minicomputer vendors? Not yet. Punch for punch, the microprocessor—at least at present—is no match for the mini in speed, word length, memory capacity, number of instructions, computing power and software availability.

But where the mini is being used as a 50-mm cannon when a BB gun will do, watch out. In dedicated control applications that don't need complicated calculations, the microprocessor can fill the need for a programmable device; a mini here would be overkill. Where a mini is used primarily to compute but a built-in computer with low power consumption is preferred, a microprocessor may slip in.

The Microterm series, built by Digi-Log Systems, are microprocessor-based, intelligent terminals that can be customized to a user's specs.



Microprocessors bring sophistication to video games, such as Atari's Quadrapong—a hockey-like diversion for four people.

Road traffic controllers, such as the Model 901 from Multisonics of San Ramon, Calif., are applications in which microprocessors may also replace minis. The job is so easy for a mini that it loafs half of the time. Buried in the 901 is Intel's 8008 microprocessor. This 8-bit unit—coupled with 14 pROM pages and other memory—forms the heart of a computer that, though invisible to the user, optimizes traffic flow in many separate intersections.

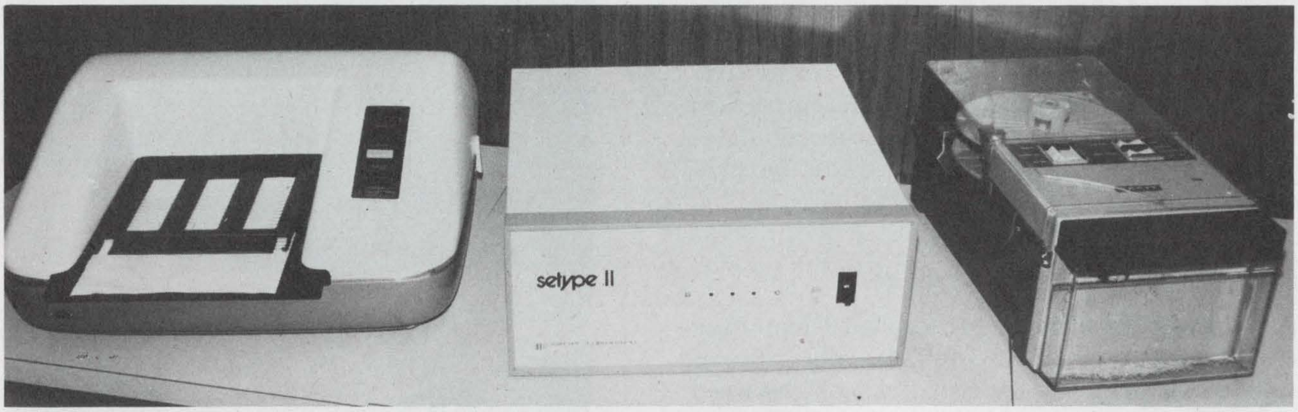
The advantages of the microprocessor approach here? Foremost, the manufacturer can tailor the system to individual applications by first changing the software and then just plugging in new ROMs. Other benefits include a significant size reduction and easier troubleshooting and maintenance.

Micros turn up in minis

Apparently the minicomputer makers aren't too concerned about a potentially serious microprocessor threat. In fact, one mini vendor—General Automation—has just unwrapped a 12-bit *microcomputer* that uses a silicon-on-sapphire (SOS) microprocessor made by Rockwell International.

General Automation defines a microcomputer as a full system computer on a board, with the processor on a single chip.

Digital Equipment Corp.—the largest mini manufacturer—also appears to view the micro-



By replacing a minicomputer with a four-bit microprocessor, Data Type Corp. was able to cut costs and slim down the size of its newspaper-oriented optical page reader—the DFR 300.

processor as a friend and not a foe.

DEC has unveiled a dedicated control system built around a microprocessor—the MPS Series. Consisting of five modules, the MPS can be built into terminals, process-control systems and other insrumentation.

Thus we can anticipate a three-way rivalry for equipment space—with microcomputers getting squeezed from below by microprocessors and from above by bare-bones minicomputers.

However, some engineers feel that just as the introduction of the mini spawned entirely new applications, rather than cut into the applications of medium and large-scale machines, so will microprocessors and microcomputers.

But what will happen as microprocessors grow in complexity, speed and power, and the line between micro and at least the low-end mini begins to blur? Perhaps we'll see a vertical shift, with minis creeping into applications now dominated by the medium and big computers.

In the meantime newly conceived products—like the Staid Corp.'s Datacash, a point-of-sale terminal—will use microprocessors instead of hard-wired logic. And many existing products will no doubt convert to microprocessor-based designs to compete.

In Staid's case, an MCS-4—coupled with pROMs—allowed the company to build a terminal that is easily tailored to a customer's needs. Datacash—primarily intended for restaurants and cafeterias—has 110 keys, each of whose legends can be changed on site with a peg matrix, plus six function keys for special applications. And the unit keeps a running inventory of each key strike. With hard-wired circuitry, Staid says, 30 TTL cards would have been required.

One company that has already converted an existing product—at the expense of a mini—is Data Type of Miami. The company's DFR 300 optical page reader started out with either PDP-16s or NOVA 1200s as the code-translator controller.

But, says Data Type, the PDP-16 costs substantially more than the MCS-4 that replaced it, and the NOVA 1200 was three-quarters asleep on its job as a start-stop controller, error detector and buffer.

At present the MCS-4 controller portion of the page reader, which reads font for the newspaper trade and functions as a terminal in the graphic-arts, has been designed as a separate, retrofit package to replace the mini directly. Future models, however, will have the microprocessor built in.

Distributed intelligence—a new trend

Some applications enable the microprocessor and the mini to work together symbiotically. This appears to be the case with the Telecontroller—a programmable, front-end data-communications processor built by Action Communications of Dallas, Tex.

Instead of replacing a mini, an Intel microprocessor in the Telecontroller freed the computer to take on more work. The microprocessor, which serves as a message switcher in a high-speed binary interface, efficiently handles the high-speed data and then passes it on to the mini.

With an intelligent function distributed in this way, more computer core becomes available, and many more terminals can come on line to be served by the mini. Thus look for distributed intelligence—via microprocessors—to appear in more and more new terminal systems and to be retrofitted to existing systems.

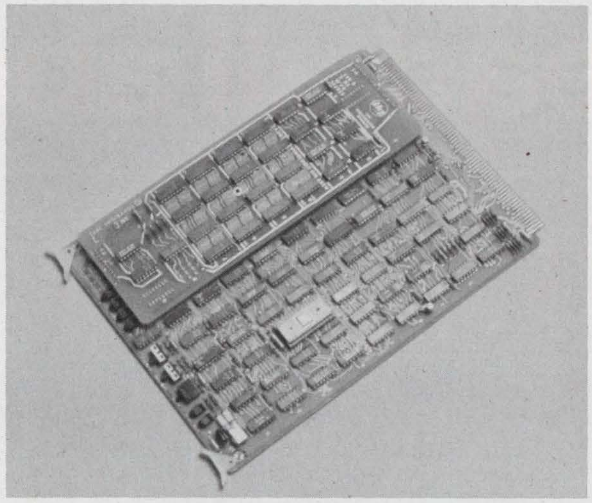
One terminal supplier that will probably be doing both is the Digital Systems Div. of Texas

Instruments. TI sees the microprocessor as an opportunity to give its customers a "rubber" terminal system—one that can grow as data-processing functions change.

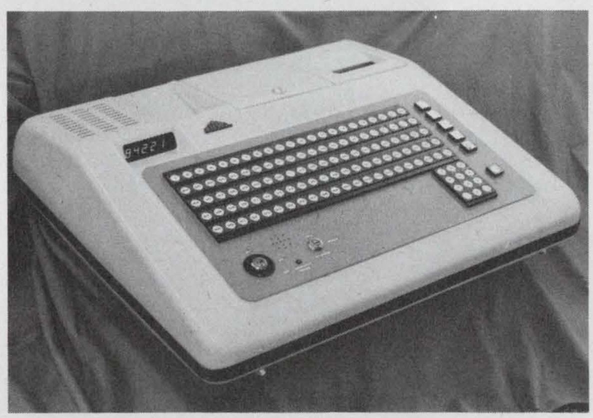
Intelligence was redistributed in still another interface—the Series 2000, by Process Control Systems. In this general-purpose process-control interface, a micro CPU and memory were designed to slip in and, in some applications, replace a mini. Built around the 8-bit Intel 8080—the first n-channel MOS microprocessor—the interface can be used as a down-line satellite of another computer or as a stand-alone data-acquisition system. In the latter case the interface bumps the computer.

By building in the microprocessor, Process Control Systems not only saved hardware dollars, but cabling costs in remote processes were also considerably reduced. For example, Ford Motor Co. uses a number of the interfaces at carburetor-flow tests stands. Here the micro CPU serves as a satellite to a down-line Interdata 70, and it multiplexes the interface data to the computer. In a similar application, the Buick Div. of General Motors puts the interface at its assembly line in a torque-monitoring system.

In the torque monitor, the micro CPU converts parallel data to serial and funnels the information stream into a dual-conductor cable. The cable then carries the data downstream, where it is finally dumped into an HP 2100 mini. Another interface, between the computer and the cable, reconverts the serial stream to parallel data.



General Automation's LSI-12/16—an 8-bit automation microcomputer—is built around the first silicon-on-sapphire microprocessor.



Staid Corporation's Datacash—a microprocessor-based point-of-sale terminal for restaurants—keeps an inventory of every key strike.

Other microprocessors surface

The 8080 microprocessor used by Process Control Systems in its interface is Intel's newest and most powerful unit and is sure to boost the semiconductor company's competitive lead time even more. Because of the lead, Intel now dominates the market in terms of available microprocessor-based products.

But National's IMP-16C microprocessor and GPC/P MOS/LSI system kit are being built into prototypes and may soon pop up in such applications as aircraft control systems, flight-status indicators, analog computers (strangely enough), nuclear instrumentation and symbol generators.

And, of course, the other semi houses aren't sleeping—AMI, General Instrument, Electronic Arrays, Motorola, Signetics and Western Digital will all have general-purpose units available soon. RCA has already announced the first CMOS microprocessor, which it expects to offer initially on a sampling basis.

With all this activity in microprocessors, it's only natural for a designer to ask: Is there one in my future? The answer: Inevitably, yes. In the meantime, though, designers are more likely to run into one at their opthomologist's, at the butcher's or at their favorite watering hole.

At the eye doctor, look for Coherent Radiation's Dioptron—an optical instrument that measures and analyzes the eye's focal characteristics and prints out the results.

At the meat market, check for the butcher's thumb on a Toledo digital-computer scale—a unit that converts weights to prices, prints labels and displays unit price, weight and total price.

And at the bar, try to beat the gal standing next to you at a new video game, from Atari, in which a cat chases a mouse through a constantly changing maze. If you lose, the game—but win the lass—thank the microprocessor. ■■

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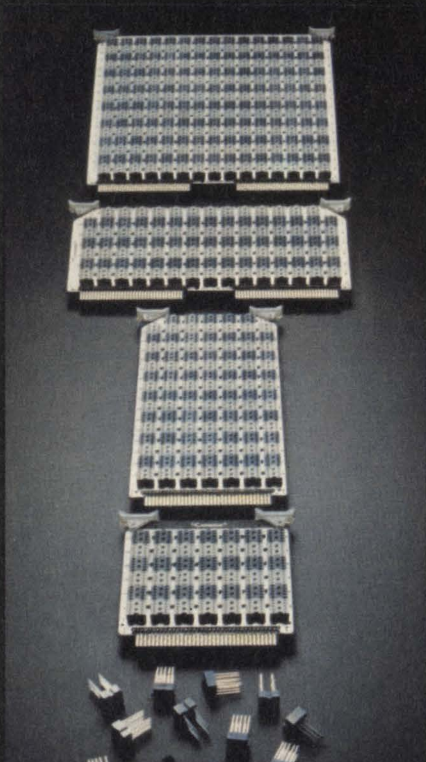

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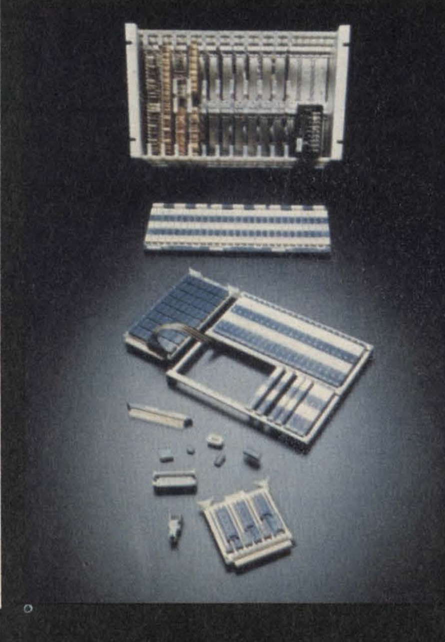

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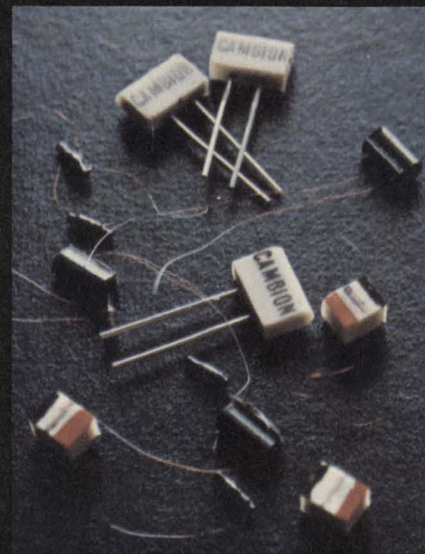

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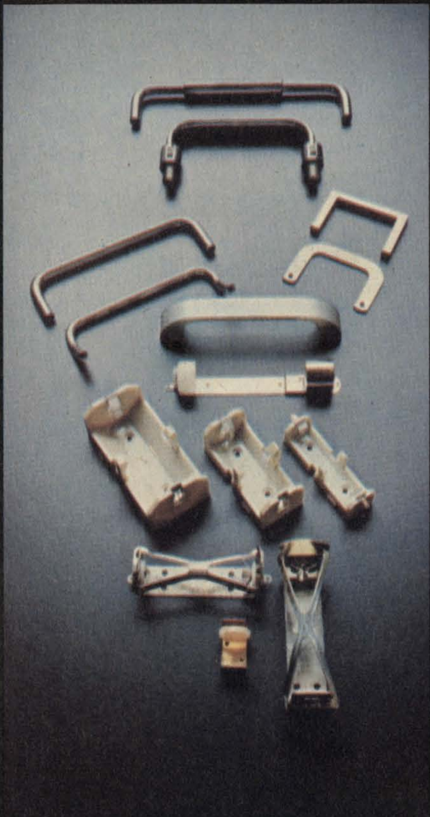

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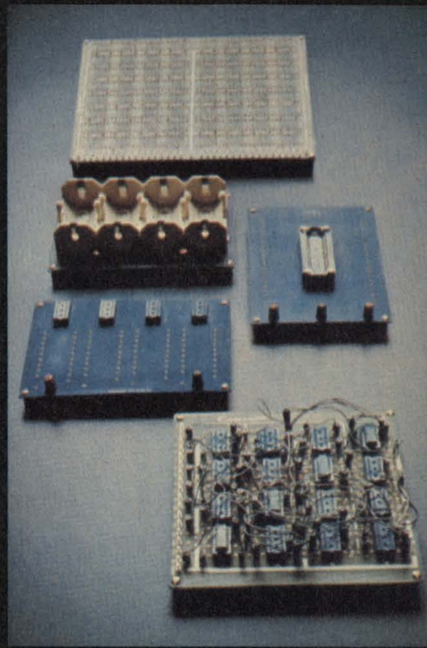

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How to be a top designer and remain a designer, despite corporate lures

John F. Mason, Associate Editor

How many creative engineers build something great, get trapped in a maze of marketing strategy and never get back to creating anything else?

Far too many, James E. Thornton decided early in his career of designing super-computers. And, taking matters firmly in his own hands, he has, with a few minor delays, shrewdly steered a course through such corporate snares ever since.

So far, so good. But what happens now? Thornton's future course isn't 100 per cent clear. But whose is?

Thornton had little soul-searching to bother him when he reached that fork in the road that eventually every engineer must face: Should he go into administrative work or try to make it as a creative designer? Thornton chose design without batting an eye, and he's never questioned the choice.

Today at 48, he has five big machines to his design credit, and feels he has time for two or three more. Whether the forces in the world of giant computers will allow him that many, he doesn't know. But so far his formula has worked, and it may see him through whatever lies ahead.

"Some people—good, creative designers—manage to be part of only two, or maybe just one, project in an entire lifetime," Thornton says, looking slightly distressed at the thought of such a waste.

Designing a big data-processing machine can take from four to five years, he explains, and if you get pulled into market strategy meetings, sales briefings and modifications to the product for its 10-year life, you've shot 14 or 15 years.

"How many 14-year periods does a man have"? he asks rhetorically. "Two"?

Even if you escape the corporate marketing trap, he notes, you can still become obsolescent. While you've been working on one project for five years, the state of the art has moved on. You need a good year just to catch up before tackling another big job.

What are the sirens along the way to lure a creative engineer to beach his future as a designer and become a sales-briefing artist?

"Job security," Thornton says, "and opportunity."

He speculates: "Let's say you finish a big five-year job. Everybody's happy. But your company isn't ready to launch another big project right away. . . . You can spend your year getting caught up with new technology, hoping that meanwhile a new program will emerge. You can try to change companies, or you can become a consultant."

Thornton thinks a moment. "Or maybe you just sit tight and sweat it out a little more."

His own record is enviable, and he attributes it to two things: He decided early in the game what he wanted, and he stuck to his goal. And, second, he had some degree of luck: He happened to work for companies that launched big projects in relatively quick succession. And his projects didn't all take five years.

Thornton's first design job was Engineering Research Associates' 1103, the first commercial scientific computer. It took three years to design.

His next project took only two years. It was Univac's Naval Tactical Data System computer. (Thornton hadn't changed jobs. Univac had acquired Engineering Research Associates and Thornton along with it. He didn't even change desks.) The naval computer was designed quickly, Thornton explains, because transistors had suddenly become available.

"Switching to transistors was no problem," he recalls. "The transistor was so powerful that we were able to build a very competitive, uncomplex machine, and we built it quickly."

Subsequent machines haven't been that easy to design, nor has the time between two generations been so brief. Going from vacuum tubes to transistors was a jump that automatically clobbered its predecessor, competitively speaking. Since then succeeding improvements in technology haven't been that dramatic. They don't categorically outmode everything else.

Right after the tactical-data computer was delivered to the Navy in 1958, Thornton moved from Univac in St. Paul, Minn., to Control Data Corp. across the river in Minneapolis. There he had plenty of exciting work to do for the next 15 years. It was always innovative because the company's approach to beating the competition was to build machines that would outperform their predecessors. Other companies took the opposite tack, following a big machine with a smaller version that was cheaper. IBM often takes the middle course, building a middle-aged machine and then moving out in both directions, a bigger one and a smaller one.

James E. Thornton, now a consultant, has five big data processing machines to his design credit and believes he's good for at least two or three more.

Thornton's first machine for Control Data, and the third of his career, was the 1604, a system that introduced a number of new features. Seymore Cray, a senior design engineer with whom Thornton would collaborate closely and successfully for almost 12 years, was already six months into the design of the machine when Thornton arrived. But Thornton developed an important feature for the 1604—the floating point, which has survived steadfastly and is now almost standard on all kinds of data processors, including pocket calculators.

Thornton is proud of another important innovation that emerged in the 1604 program—the interleaved magnetic core memory. Although Thornton gives Cray credit for originating the idea and "having the strength to carry it through," he did help with the design and feels it's been a milestone in data-processing machines.

Luck helped in the design of the 6600, Thornton says. "We had expected to use the germanium transistor, but at precisely the right moment Fairchild announced the silicon planar transistor, so we used it."

This permitted much higher packaging density, substantially higher basic speed of the subsystems and an allowable heat that would not have been possible with germanium.

The high density unexpectedly spawned yet another innovation. "We were afraid the density wouldn't tolerate an air-cooled system," Thornton says, "so we went to Freon, which turned out to be a major factor in the machine's design."

Freon became more than just a way to cool the machine. It allowed such precise, selective temperature control throughout the system that the machine could be operated at greater speeds than had been planned. Another advantage to Freon is that it's quiet.

But the most important innovation in the 6600, Thornton says, was the addition of 10 small processors, called peripheral processing units, for the I/O processors. "For these processors," he recalls, "we built a software system that allowed them to really manage all the I/O, all the channels and, in a way, the central processor. So for the first time, we had the beginnings of what we think of today as a real system structure of the large central machines."

In mid-1960 Thornton restated his determination to be an innovator rather than an admini-

The case for the super machines

Why big computers? Won't several smaller machines do the same thing? The answer is no if you're talking to people in the scientific community or the Defense Dept. The intelligence is too fragmented in a group of minis, they will tell you. You need only one big central processor. And you only get that in a very big machine.

Other advocates of the super processors are in the aerospace industry. How else can aerodynamicists simulate a giant swept back aircraft wing they want to design except with a gigantic computer?

Many government agencies need big machines for the vast amounts of data they must handle: the census bureau, meteorologists, and the groups that collect earth resources data from satellites.

But the biggest users of the big processors are still to come, and are still unidentified, according to James E. Thornton, designer of five large, elaborate machines with a sixth in the works. "Every time we've built a new machine it's created new markets—markets we hadn't expected," he says.

This really big influx of users, he predicts, will probably join the crowd in a fairly simple, inexpensive way—via a time-sharing arrangement. They will plug into a vast network that ties their small terminals to a giant central machine.

The network concept is absolutely essential in thinking about large machines of the future, Thornton believes—"not only about how they will be used, but how they should be designed." In the past, he explains, large specialized machines were built as stand-alones. Future large, specialized machines will be built as part of networks operating in unison with intelligent terminals, with minicomputers somewhere along the line and with other large specialized machines.

To support these networks a number of new products must be developed, Thornton says, adding: "We're not even coming close to providing for such systems yet." The terminals and modems that go onto telephone lines, for instance, are all "relatively low-grade things, and in no sense do they appear to be what's ultimately needed," Thornton says.

"We're already beginning to see on-line storage as the way to operate," he continues. "People are using more discs now than ever before—at least three to four times greater than expected."

Why? People want to put information on a

strator. He and Cray asked to be separated from the corporation, administratively and physically. Such a request could have caused waves, because the company was new and probably not ready for the departmental specialization they wanted. They asked that a laboratory be set up strictly for design; it would have nothing to do with marketing. Control Data complied.

A year later—and this move was mainly Cray's idea—the two designers really asked to get away. They wanted a place in the woods. Trees, birds, lakes—the works. They'd take along a small group of talented, free-thinking engineers who would come up with a computer that would outperform the 1604. Again, Control Data came through.

The result was a laboratory, about as rural as you can get, in Chippewa Falls, Wis. Most of the design work for Control Data's 6600 was done there.

Cray liked living in the woods, and he's still there. But Thornton and his wife and their seven children began to miss St. Paul. This, plus a decision by both Cray and Thornton to build two variations of the 6600, caused Thornton eventually to go back to town. There he developed a cheaper version of the 6600, with less performance: it was called the 6400. Cray, staying on in Chippewa Falls, developed a unit with more performance, first called the 6800 and later the 7600.

Thornton added a feature to his 6400 that he found satisfying. "To give it redundancy and more power," he says, "I built one 6400 with two disc and leave it there. They don't want to put it in and out through tape or punched cards. And they're storing more data.

"We have people now in large sites that have not just 10 spindles of discs but hundreds of spindles," Thorton says. "This represents a trillion-bit storage. And the only processor that can manage capacity like that is the large scientific processor. The large machine is here to stay. What's needed is specialized peripherals to back it up."

Already designed for a network system is Control Data's Star 100. "This machine will depend on a network," Thornton says. "It doesn't have any I/O functions in it, and its peripheral system is fairly rudimentary."

One feature used in Star, and also in other powerful machines that might set trends for the future, is pipelining. Separate functional operations are broken down into steps that are taken sequentially, in the manner of an assembly line. Because the steps are independent, one may be started while another is still in progress.

Illiac, NASA's huge computer by Burroughs, takes the opposite tack. It uses multiple processors in a structured way. "They all do the same functions in parallel," Thornton says, adding, "but at this stage both Illiac and Star are relatively unknown. They are two different structures. And we don't know yet whether either is going to be a really powerful machine, useful for a general class of activities or not."

Thornton sees a big future for virtual memory. He says: "This is a very fundamental concept that's been very slow in getting to operational status, and will take even more time to really arrive. Star uses a large-scale, brute-force virtual memory—a technique that is highly appropriate for networks."

central processors instead of one. They were both coupled to the same memory. I had designed some latent control logic in the memory to allow for the additional processor, and it worked very well."

Thornton then asked management if they'd like such a design. Yes, they said, but how long would it take? It was very gratifying, he recalls, that he could tell the company it was already done. This version of the 6400 was called the 6500.

But Thornton paid for leaving the woods. Within months he was so involved with the manufacturing, engineering and marketing of the 6600 that he hardly had time to work on the 6400. Finally he got another designer to work with him, "and inside of 18 months we had the new machine ready to operate."

But Thornton's administrative demands continued to grow. At one point he found himself directing five Control Data groups throughout the U.S. One, in Arden Hills, Minn., is still developing the Star 100 computer. Thornton is no longer involved with the Star project, but he and three other engineers originated the machine, and he was very much a part of it for a long time.

Of Star, Thornton says: "The machine is about two years late, because it's had design problems. It contains more than 100,000 ICs. The system is unusual, and it's going to be many years before it's really understood. But when it is, it's going to have a very significant impact on the large-machine business."

But Thornton was losing sight of his original goal. "I felt my strengths weren't there, in all that administrative work," he says. "I needed a narrower and more creative environment. While running labs was interesting in some ways, running a lot of labs wasn't. So about a year and a half ago I began to fill my key spots with people who could take over. And by early 1973, I was out of a job."

Thornton requested a leave of absence from Control Data, became a consultant and took on Control Data as his only client. He is working on a project that he started for the company while he was still an employee.

How is this working out?

"Well, it's the other extreme," he explains. "I'm working completely alone. My current project is big and it's interesting—as well as proprietary—and I can't talk about it. But who knows when Control Data will initiate another job of this scale"?

Thornton pauses as he considers his future. "I could stay on as a consultant and troubleshoot projects for other people who are in a jam. I solve other people's problems very well, but that's not creative."

Thornton studies the clear, bare white wall of his office in St. Paul as if he will find the answer there. "What I really should do," he says, "is maneuver toward a smaller, structured technical activity. I have managerial aptitude in a structured climate.

"Yes," he says, now satisfied with his decision. "I think that is my solution."

His reason for this compromise makes great sense as Thornton's decisions apparently always have. "It's impossible for one man to keep up on all the new semiconductor technologies as they emerge," he says. "These kids coming out of school have got more real understanding now by direct training than we ever had. Alone you get obsolescent." ■■

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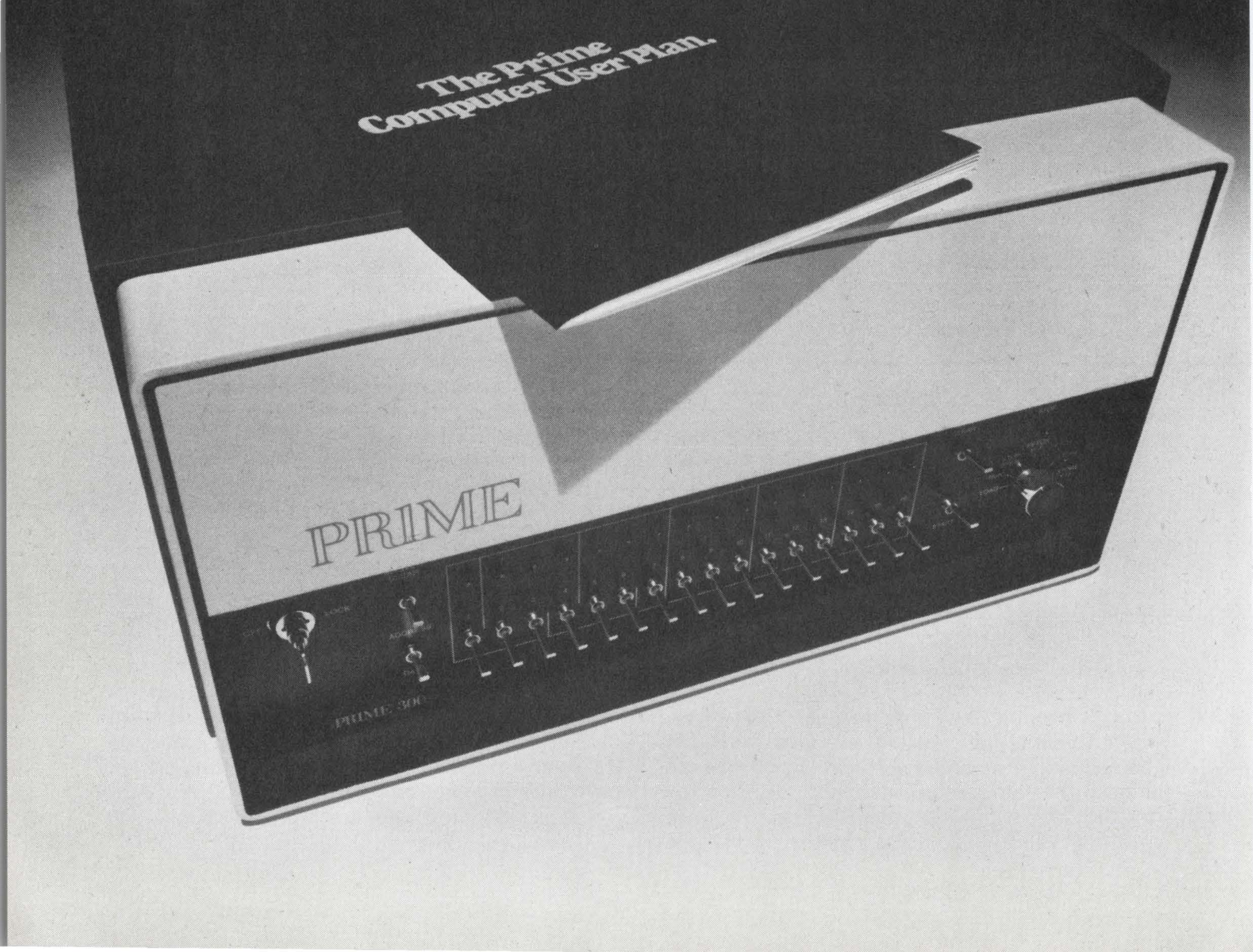

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	• Automatic Program Load From Input Devices (PTR, TTY, CR, MT, Disk)*
Prime 200 Central Processor (1 board)	• Memory Byte Parity
	• Processor Byte Parity
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Prime 100 Central Processor (1 board)	• Virtual Instruction Package (VIP) – automatic trapping of unimplemented instructions and substitution of functionally equivalent software subroutines.
	• 8-Channel Programmable DMA
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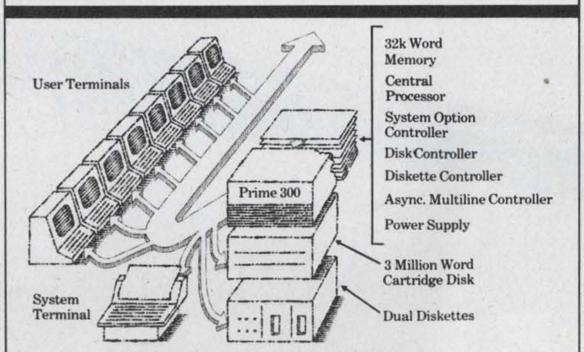

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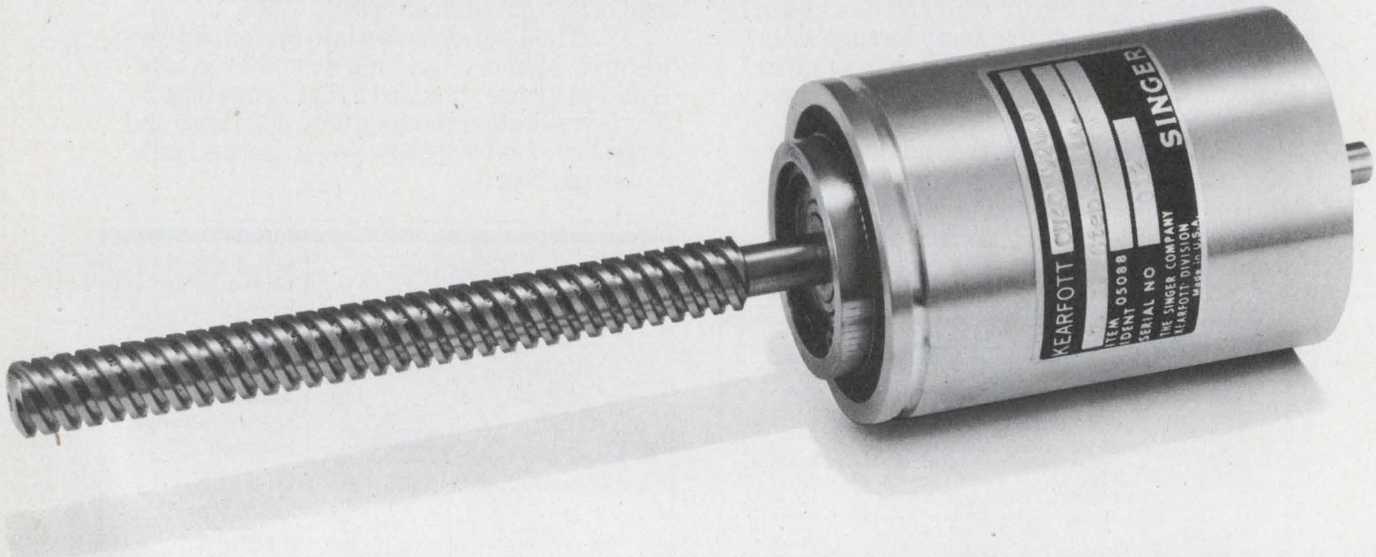

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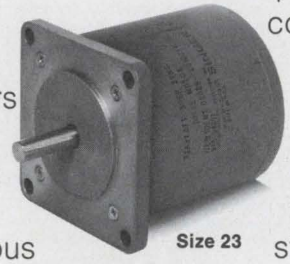
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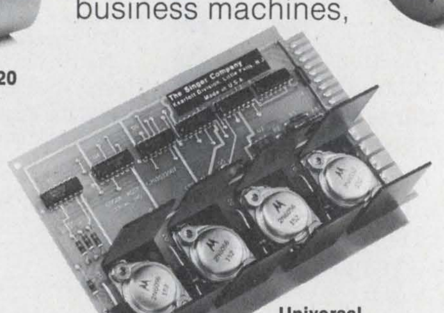
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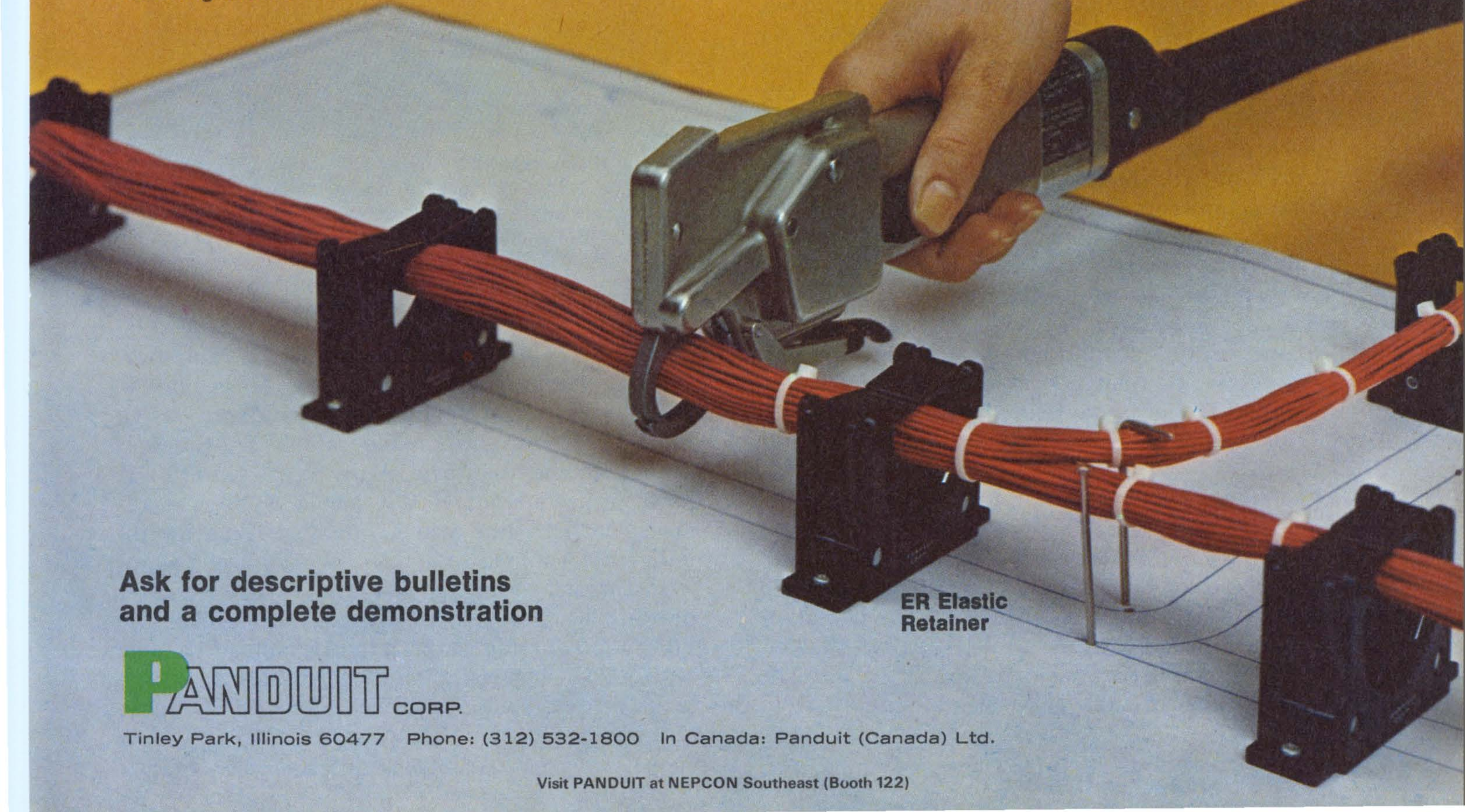

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Smarter terminals join with floppy-disc drives to stretch data capability

David N. Kaye, Senior Western Editor

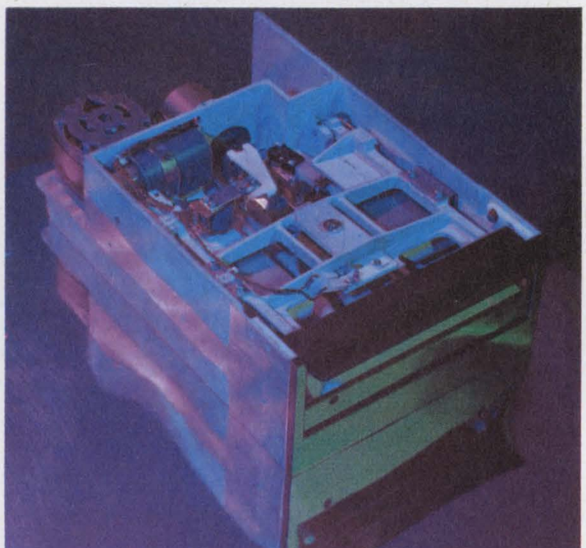
A new-product explosion is occurring in computer peripherals. It centers on intelligent terminals and flexible, or floppy, disc drives.

Intelligent terminals are usually CRTs with keyboards and built-in processing capability, including memory. Floppy discs, which look like 45-rpm records, use a coated Mylar medium and provide from 0.5 to 5 million bits of random-access data storage. By combining the two products, users are getting a powerful distributed computer system.

Intelligent terminals are getting smarter all the time. Faster and more powerful processors are being incorporated. More memory is being added. And software approaching that developed for minicomputer systems is being offered.

So many other peripherals are now available for intelligent terminals that the capabilities of the terminals are nearing those of stand-alone minicomputers. The floppy-disc drive gives the terminal random access to a large amount of data stored locally—data that previously had to be stored by a large host computer remote from the terminal. As a result, the host computer might not have to be so large any more.

None of this would be practical if the disc drive were not relatively inexpensive. It can be obtained, including a controller, for less than $1000. And it's getting cheaper all the time.



This IBM-compatible drive, the Orbis 74, has a unique option that uses a slotted shaft to set electronically any type of disc sectoring that is desired if the IBM mode of operation is not required.

Introducing the smart guys

Is it a computer terminal, a minicomputer with display and keyboard built in, or a sophisticated desk-top programmable calculator? The boundary between these categories is getting hazier. The intelligent terminal can be any or all. The only requirement that makes it a terminal is that it must be able to communicate with a computer.

Wang Laboratories, Tewksbury, Mass., builds the System 2200, originally introduced as a sophisticated programmable calculator. Since it is programmed in Basic, many users think of it as a minicomputer. But it has a 300-bps asynchronous data line which qualifies it as an intelligent terminal.

Intelligent terminals fall into two basic categories. The first type can emulate or replace the IBM 3270 intelligent terminal. It must be able to work in clusters of many terminals around a large central computer. The software for these terminals is usually predetermined by the manufacturer. The operator at the terminal rarely does more than enter and edit data, seeking a reply to a relatively simple question from the host computer. The terminal formats and condenses the data before it's sent to the host computer. This makes processing by the host more efficient. Also the display gives the operator a choice of predetermined data-entry forms to guide his data input. In addition the terminal checks the input data for errors and allows for several forms of data editing at the terminal prior to transmission.

The second type of terminal is user-programmable. It can always be programmed at the keyboard, sometimes in a fairly high-level language. It can do most any problem that the operator can feed it. Sometimes the terminal can do some of the necessary processing by itself. The terminal initiates a call for assistance from the host computer when necessary. Thus, this type of terminal can be used often as a stand-alone minicomputer.

IBM's 3270 terminal is the most widely used intelligent terminal in the field. It is intended for data-entry systems with up to 32 terminals in a cluster to an IBM host computer.

IBM terminals predominate

There are more IBM 3270 intelligent terminals in use than any other type. The terminal, made by the IBM Data Processing Div., White Plains, N. Y., is designed to operate either by itself or in a cluster of up to 32 terminals. It provides local data-transfer rates of up to 650,000 characters per second and remote line speeds of up to 7200 bps. The terminal operates with either a System/360 or System/370 host computer. Terminal programming can only be done at the host computer.

Emulators for the 3270 are offered by several companies. They include Delta Data, Cornwells Heights, Pa.; GTE Information Systems, Stamford, Conn.; Olivetti, New York, N. Y.; Raytheon Data Systems, Norwood, Mass.; Sanders Associates, Nashua, N. H., and Sycor, Ann Arbor, Mich. In most cases, these terminals can replace a 3270 directly, and they offer more capability at a lower price.

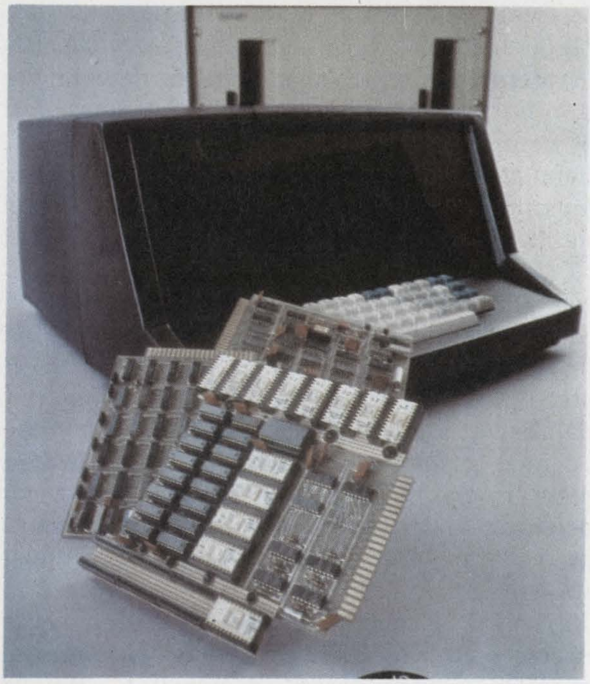
A good example of an IBM 3270 replacement system is the Raytheon PTS 100. The remote processing and memory are in a single console that feeds up to 96 display stations. The display station is a CRT with deflection electronics and a keyboard. Everything else is at the central processor. It is a TTL processor with multiple port MOS random-access memory (RAM). The displays are refreshed from a section of the RAM. The RAM has an 800-ns memory cycle time. The processor is expandable up to 64-k bytes of storage.

According to Alan Geller, manager of minicomputer engineering at Raytheon: "An interesting feature of our system is that any peripheral controllers that we use can cycle-steal from the main processor and do not need any additional processing in them."

An alternative approach to 3270 replacement is represented by the Sanders 8170 interactive terminal system. Here the user can program the terminal at the keyboard. Included are such things as user-definable special function keys and a built-in microprocessor with memory. Up to 600,000 bytes of information can be stored on a digital cassette recorder. Screen sizes of up to 1920 characters are offered. Since each terminal in a cluster has its own processing, a central processor is not needed away from the host computer.

Most terminal companies strongly favor programming the terminal directly. As Ephraim Gitelman, vice president of engineering at Computek, Cambridge, Mass., points out: "You have to give control of the problem to the guy sitting at the terminal. If not, his effectiveness is greatly decreased."

Computek produces an extremely versatile intelligent terminal, the Model 200. It features a TTL processor with up to 8 k of semiconductor RAM. The processor has a fast 1.3-μs instruction time that is accomplished with an overlapping instruction fetch and execution. The basic architecture of the terminal is dual-bus, with one bus for instructions and the other for



Dasyn's 101 universal terminal uses single-bus architecture and an Intel 8008 CPU to provide considerable flexibility. A variety of memory boards and I/O interface boards and peripheral controller boards can be plugged into the bus.

data and input/output (I/O).

The display shows 200 characters in an 80-character-by-25-line format, in which each character is formed by a 14 × 20-dot matrix. Typical is 5 × 7 or 7 × 9. This large matrix allows for better character formation than that of any other terminal on the market. Random-access display refresh uses 2 k of 10-bit characters. Two of the bits are used for such things as blinking, blanking and intensity control. The terminal sells for $7500, including 8 k of RAM.

Most intelligent terminals not of the 3270 type are much smarter and more flexible.

Lowest in cost of the intelligent terminals is the 8025 from Omron Systems of Sunnyvale, Calif. It sells for $2350 with 2 k of semiconductor memory. Its architecture is a single-bus type in which the CPU, memory and I/O interface boards all plug into a common data bus. This setup is found in many of the terminals on the market. It can be readily expanded with more memory and additional I/O interfaces.

Billy W. Goodner, manager of systems engineering at Omron, notes that it is even easy to add additional CPUs. In this way the terminal can become a multiprocessing system. Omron does not yet do this, and several other companies are talking about adding this capability, particularly in situations where there is no host computer.

Omron's terminal uses the Intel 8008 microprocessor as the basis for its CPU. This terminal is expandable to 16 k bytes of memory. As with most terminals, an RS-232 standard interface is available along with other schemes. The data rates available go up to 2400 bps in an asynchronous mode and 9600 bps in a synchronous mode.

Another low-priced terminal is the SB2 from Beehive Terminals, Salt Lake City, Utah. It sells for $3295, with 2 k of semiconductor RAM. It also uses a CPU based on the Intel 8008 and displays 2048 characters on a 12-in. CRT. Lines of text in memory can be displayed on the CRT in pages, and flipped from one page to the next and back, or the text can be shifted one line at a time up or down in scroll fashion. A repeating control key on the keyboard allows scrolling of as many lines as desired in either direction.

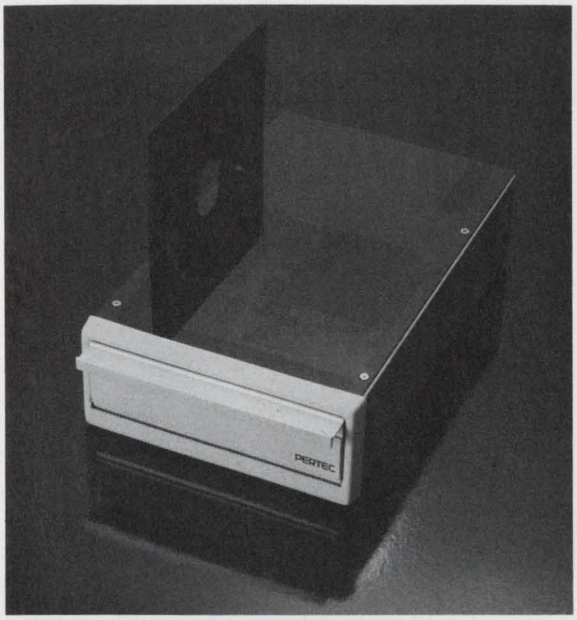
Harvey Girard, head of engineering at Beehive, is not sure that most applications of intelligent terminals require a full-blown CPU. "We are looking at developing an LSI sequencer or programmed logic array for future terminals," he says, "that, while not as powerful as a general-purpose microprocessor, will be cheaper and more efficient at performing many of the jobs that an intelligent terminal must do."

Two more companies that base intelligent terminals on the Intel 8008 microprocessor are Digi-Log Systems of Horsham, Pa., and Dasyn of Santa Ana, Calif. Tom Emory, vice president of engineering at Digi-Log, points to the company's Microterm as a flexible terminal that can be configured to any custom need. Microterm uses a 7 × 11-dot matrix to form characters and has an expandable single-bus structure. Programming is in Intel assembly language. Almost any terminal feature that is desired can be incorporated. Prices start at $1800 for a very simple terminal, Emory says.

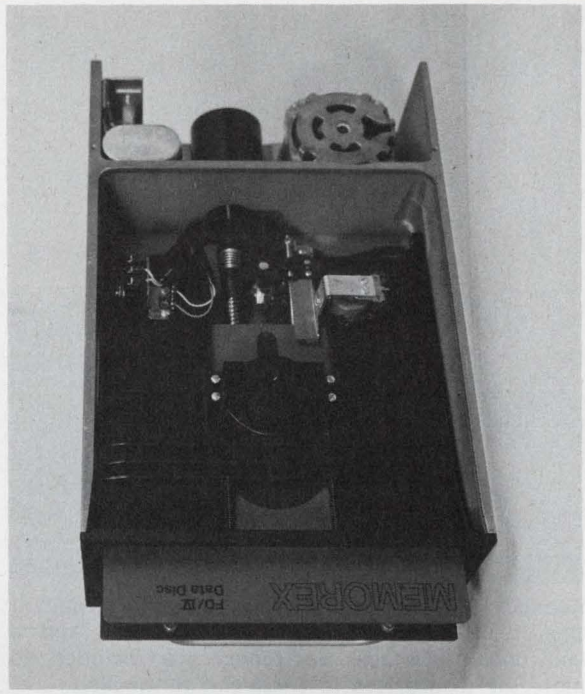
Dasyn makes the Model 101 universal terminal. It is also single-bus, and it rivals the Digi-Log in versatility. However, it is sold as a standard unit with many options, while Digi-Log sells on a custom basis.

More powerful intelligent terminals that rival larger minicomputers in capability come from companies like Datapoint, San Antonio, Tex.; Sycor, Ann Arbor, Mich.; Four-Phase Systems, Cupertino, Calif.; Incoterm, Natick, Mass., and Sanders.

Datapoint makes a series of terminals—the 1100, 2200 and 5500—that the company calls computers. They range in price from $8000 to over $50,000. Each is based on a TTL central processor, with MOS memory and external bulk cassette storage. Both assembly and higher-level languages are available, and the units can work either by themselves or in clusters. William L.



The smallest, lightest and cheapest IBM-compatible drive is from Pertec. The D0330 is also the only totally dc driven drive. All others use an ac motor to spin the disc.



The most widely used non-IBM floppy-disc drive is the Memorex 651. More than 3000 of these are in the field. The drive uses a disc with a thicker coating, for longer life.

Borgerding, director of engineering at Datapoint, notes that the company has already shipped systems with multiprocessing capabilities, while others are just talking about doing this. Many different types of peripherals work with the Datapoint terminals.

Sycor's Model 340 has a fast 1.25-μs TTL processor and a dual-bus architecture. One bus is for input to the terminal and the other for output. This terminal also has a direct memory-access feature. It contains 8 k of control memory ROM and 8 k of MOS RAM. Screen refresh and system buffers use 1 k of the RAM. A user application language called TAL allows easy data editing and data validation at the terminal as well as simple programmability for other functions. This terminal sells for about $6600.

Floppy disc: Low cost, bulk storage

Intelligent terminals and minicomputers need a low-cost, random-access, bulk-storage medium. Hard discs have been the best means to date—that is, if you don't mind spending a few thousand dollars. If a few hundred dollars sounds more attractive and access time is not extremely important, floppy discs are the way to go. While still an immature technology, with a variety of approaches to choose from, floppies have proved themselves and are being used by the standard-maker, IBM. Since any computer peripheral that IBM makes becomes a de facto standard, floppy-disc drives are divided into two camps: IBM-compatible and others.

When used as a peripheral for an intelligent terminal, the choice will usually be IBM-compatible. In this way the terminal can be used as a key-to-disc data entry system and the discs can be run on any IBM-compatible drive regardless of location. The drive also serves the terminal as part of a disc operating system, providing about 1.95 Mb of random-access storage. Most IBM-compatible drives have a track-to-track access time of 10 ms.

All IBM-compatible drives have an average latency (time for disc to rotate 1/2 revolution) of 83.3 ms, a data-transfer rate of 250,000 bps and a recording mode of double frequency, and they use the same medium for storage. The medium is a 7.88-in.-diameter, 3-mil-thick Mylar disc with a large hole in the center. This disc contains 77 recording tracks of which one is an index track containing all of the format coding and library information for the disc. Seventy-three are data tracks that come preformatted with sector address marks, data marks, cyclic redundancy coding and a track address mark. Two tracks are spares, and one is being reserved for some future use by IBM.

Each track is divided into 26 sectors, and each sector can contain 128 bytes of data. The disc also contains a physical hole that can be sensed optically to indicate the beginning of each track or the location of the track address. Most manu-

Kennedy Data Systems' KDS-28 contains a pair of Century Data Systems floppy-disc drives and a controller. Interface electronics are included to mate the disc drives to Datapoint terminals.

Sanders 810 intelligent terminal has a 12-in. cathode-ray tube with 1920 characters. It can support up to eight "dumb" terminals with its processor, and it sells for $6900.

facturers feel that the disc is good for at least one million head passes over any given track.

Donald Taylor, product manager on the D0330 flexible-disc drive for Pertec in Chatsworth, Calif., says: "Our tests indicate that the IBM disc is good for at least five million passes per track."

The discs cost $8 from IBM and less than $5 in large quantities from some of the other suppliers, the largest being Memorex of Santa Clara, Calif.

Many companies have introduced IBM-compatible drives, including Century Data Systems, Anaheim, Calif.; Control Data, Hawthorne, Calif.; General Systems International, Anaheim, Calif.; Innovex, Bedford, Mass.; Memorex, Orbis Systems, Costa Mesa, Calif.; Pertec; Potter Instruments, Melville, N. Y.; Shugart Associates, Sunnyvale, Calif., and Sycor. Their drives are compatible with that in the IBM 3740 data-entry terminal.

The most compact and least expensive of these drives is the D0330 from Pertec. It measures 3-1/2 × 8-3/4 × 14 in. and weighs 10 pounds. It sells for $475 in 200 quantities. Most of the other drives are at least 20% larger, 20% more expensive and weigh 50% more. The Pertec drive is also completely driven from +24 V and ±5 V. All other drives use an ac motor to rotate the disc, and practically every drive has different dc requirements.

Next smallest of the drives is the Model 210 from Innovex. It measures 4.3 × 9 × 14-in. but weighs 15 pounds. As with most other drives, it can be mounted in any orientation for incorporation into a system. This drive is unique in that it is a sealed one, with filtered air passing over the disc to increase media life by preventing dust from jamming between the head and the disc. All IBM-compatible drives have the read/write head in contact with the disc. The head is moved across the disc by a dc stepper motor, which, in all cases execpt Pertec's, steps at one track per step. Pertec uses three steps per track for higher accuracy.

Shugart Associates has more IBM-compatible floppy disc drives in the field now than any other manufacturer. Called the Model 900, their drive has very few adjustments, and head penetration is referenced to the body casting for ready interchangeability of heads in the field. The Shugart head is a proprietary design that uses no epoxy in the recording gap area. Even under extreme temperature variation, nothing can expand beyond the head surface to scratch the disc. Most other manufacturers claim that this is not a problem, as long as the drive is used within the specified temperature limits—typically +10 to +40 C.

Since the recording head is in contact with the disc during operation, all drives provide a means of unloading the head from the disc, either when the disc is being put into or taken out of the drive and during an idle condition. This is accomplished with a controller command to the drive. This command is usually given if the disc has revolved about five times without a read, write or seek command. In most drives the pressure pad that holds the head to the disc is retracted by a solenoid. In the Pertec drive, the head is also physically retracted about 30 mils from the disc.

The non-IBM world

Most popular of the non-IBM-compatible drives is the 651 from Memorex. More of these drives are in the field, says Keith Plant, director of OEM marketing at Memorex, than all other manufacturers' drives with the exception of IBM. The 651 uses a different type of disc than the others. It appears to look the same, but it has an 80% thicker coating than the IBM disc and will wear longer. Also, it is permanently subdivided into 32 sectors, with holes spaced along the disc. The maximum capacity of this disc is 2.1 Mb of formatted data. All other characteristics of the drive are similar to the IBM-compatible drives.

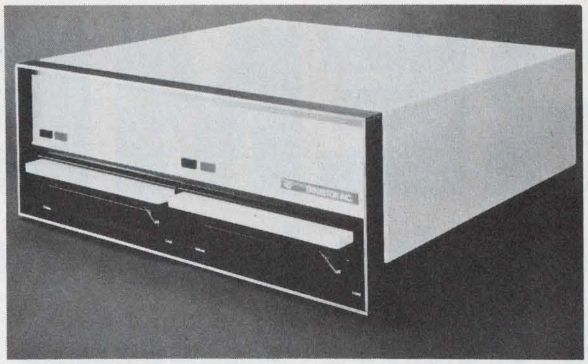
Three drives are very different from all the rest. They are made by Innovex; Dynastor, Denver, and Intelligent Memory Systems, Newport Beach, Calif. All three use heads that are not in contact with the disc for long life. The Model 110 from Innovex uses a recording medium that is a square plastic frame with coated Mylar stretched across the frame. A circular section of the medium is used as the recording surface. The frame does not move; rather the head rotates in a circular path over the surface. It also moves in and out for random-access operation.

The head is moved by a rack-and-pinion mechanism and rotates at 390 rpm for an average latency of 77 ms. The average access time of this drive is 208 ms, with a track-to-track access time of 6 ms. With eight sectors, the capacity of the drive is 1.22 Mb. This drive sells for $620 in quantities of 200.

Plastic cartridge is used

Dynastor uses a plastic cartridge containing a free-floating, thin Mylar disc. When the cartridge is inserted in the drive, the disc is removed and spun up against an aluminum base plate. The flying head is controlled by a servo-driven, cable-pulley assembly to the proper disc track. The disc is rotated at 3600 rpm for an average latency of 8.33 ms. But the track-to-track access time is 100 ms. However, the head can move across the entire disc in 320 ms. The data-transfer rate is 2540 bps. With 32 preformatted sectors, the usable capacity of the disc is about 2.2 Mb. In a single-drive configuration, called the Model 30, the drive sells in 200 quantities for $650. In a dual-drive configuration, called the 40, the price is $1115 for 200 units.

Similar in concept to the Dynastor drive is the Model 300 from Intelligent Memory Systems. The difference is that while the Dynastor drive uses a moving head, this drive is a fixed head-per-track type. With 16 tracks and 32 sectors, the capacity is 0.5 Mb. The average access time is only 16.7 ms.



Two fly-head disc drives are contained in the Dynastor Model 40. Each disc has 32 sectors and can store about 2.2 Mb of data. The transfer rate on this drive is 2540-k bits per second.

This drive, according to Kjell Hovik, vice president of Intelligent Memory Systems, is aimed at minicomputer real-time operating systems. The entire drive consumes only 5 W of dc power and 10 W of ac. The cost of the drive in 200 quantities is only $375. A version of the drive is also available with up to three fixed discs.

All of the other non-IBM compatible drives are similar to the Memorex 651 with a variety of small improvements. One of the more novel features is an electronic sectoring scheme from Orbis. According to J. V. Howell, vice president of engineering:

"We use the IBM reference hole to give us a track start reference pulse, and we have a slotted disc mounted on the drive shaft. The slotted disc has 256 holes that can be sensed by an optical coupler. Once the track starts, we count 128 pulses between every hole on the slotted disc. This divides the disc into 32,768 pulses per revolution. These pulses can be used to set any number or size of sector that is desired." This feature is an option on the Model 74 drive.

The floppy and the terminal joined

With the addition of a controller/formatter, the floppy-disc drive can be married to an intelligent terminal. The first terminal manufacturer to do it is Sycor. Dieter Heidrich, director of product development, reports: "We have developed our own floppy-disc drive and married it to our 340 terminal. It is an IBM-compatible drive that can accommodate two discs at once with a fast 2.5-ms, track-to-track access time." ■■

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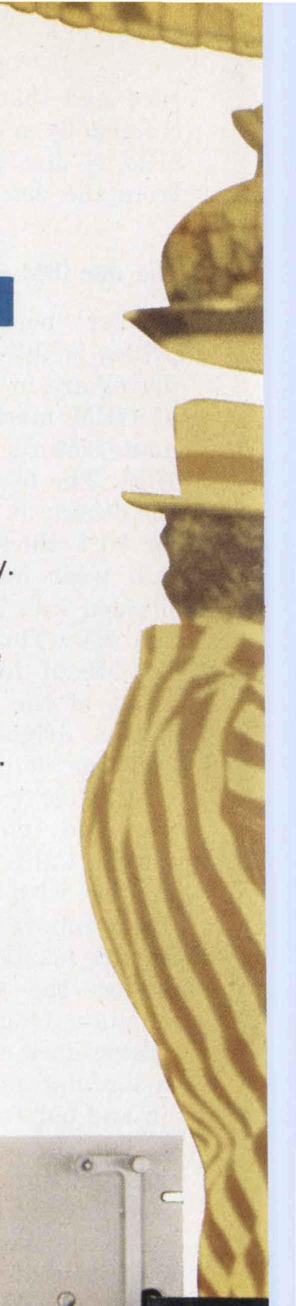

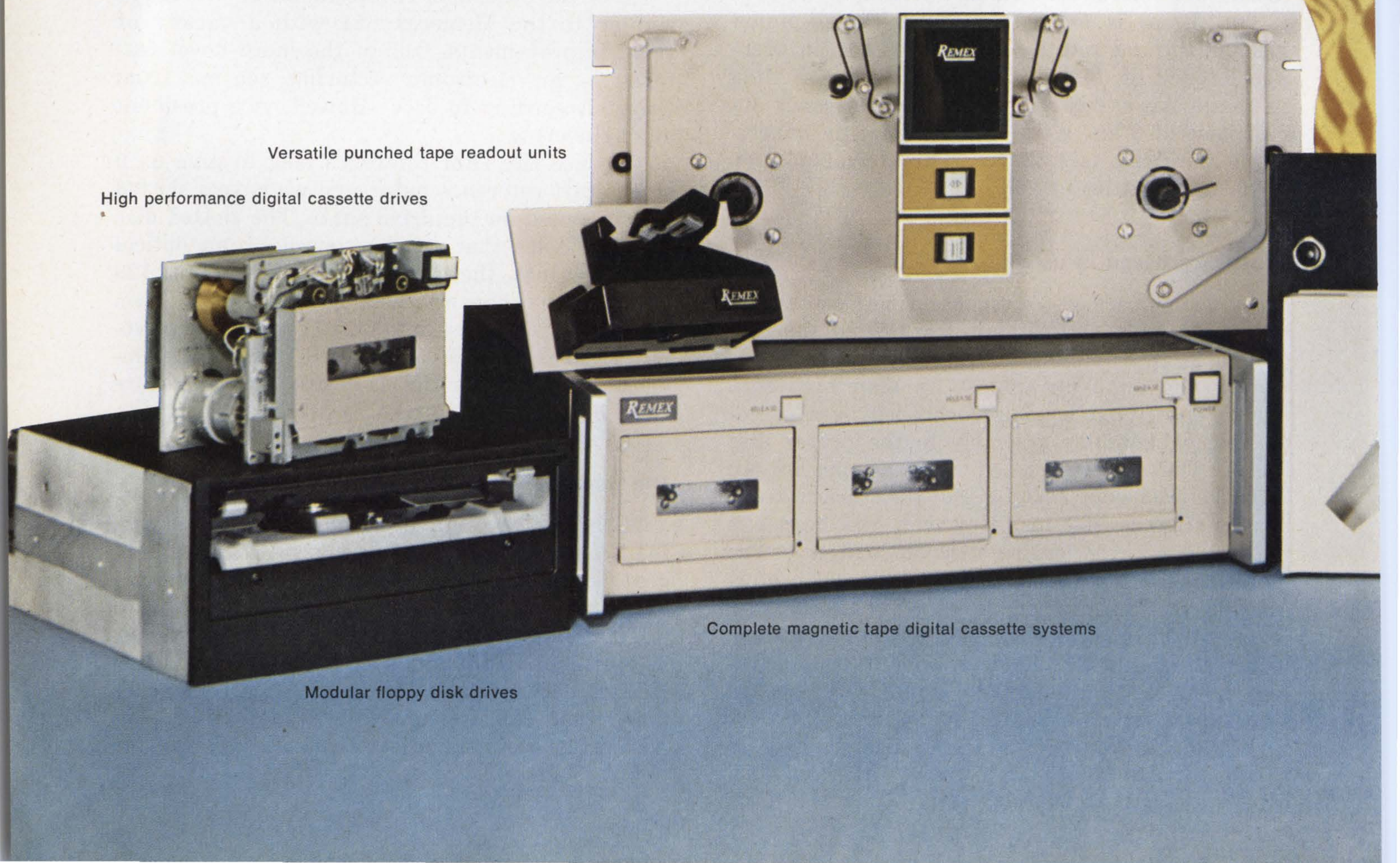

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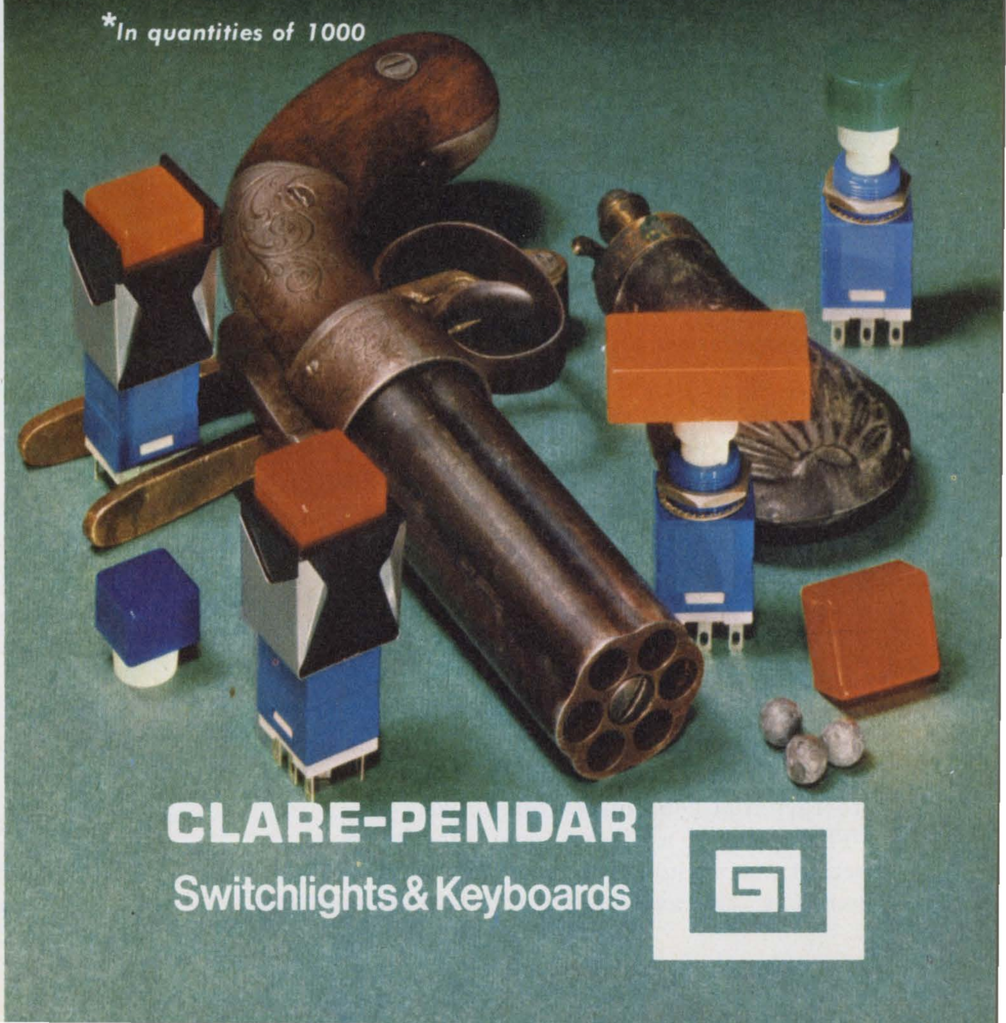

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Minis, minis everywhere, when it comes to control of industrial processes

Northe K. Osbrink, Western Editor

Without the minicomputer, computerized industrial process control might easily have remained a novelty for rich corporations. The large computers of the 1960s were expensive, and they also had to be modified for process control. Most companies were reluctant to use them unless the machines could also be programmed to perform a variety of other plant functions.

But what a difference a mini makes. Today there are minis on the production line . . . minis in the quality-control test area . . . minis in the warehouse . . . hierarchies of minis. Not-so-expensive minicomputer systems are working efficiently in applications ranging from the control of machine tools and oil and gas pipelines to concrete and asphalt production and weaving looms.

For harsh environments, Rolm minicomputers, produced to MIL specs, offer up to four times the MTBF of commercial counterparts.

Two major classes of computers

There are two major classes of industrial process control. The first is the traditional, continuous-flow process found in a chemical plant, refinery, pipeline or power-distribution system. The second, the intermittent (or step) process, encompasses everything else—batch processing of materials and production lines or, with a little stretching, machine-tool control.

A computer finds very little difference between the various processes; much that applies to one process applies to another. The differences are in the hardware required outside the central processor—the input/output interfaces, operator interface and communications links.

The speed of a process computer is not as important as reliability, hardware and software flexibility, the availability of software and programming languages, and I/O interfaces.

In addition the process-control computer should have power-failure protection and a priority-interrupt structure. The former assures that the data and programming are not lost if power is lost. The latter structure—either hardware or software—assures the safe shutdown of machines or processes in case of failure.

For testing and control jobs

One application of computers to industry today is the automatic gauging and inspection station.

In a high-capacity industrial plant, such a test system can operate with little or no human supervision. An example is the new Digital Tire Uniformity Optimizer Computer System, designed jointly by Electronic Associates Inc., West Long Branch, N.J., and the Akron Standard Corp.

The system force-tests tires, and it controls the grinding of rubber from them to achieve uniformity in the tires. The delivery of tires from a waiting station, their testing, grinding, grading, marking and delivery to a pick-up station—all are guided by the computer. The computer control is based on the Electronic Associates Datapacer 16-bit mini, with 32 k of core memory. All required test parameters and machine-control instructions are stored in software tables, so tires can be custom-fashioned to the requirements of a specific automobile suspension. In addition to testing tires, the system collects and displays statistics on the results, enabling changes to be made in the tire-production process.

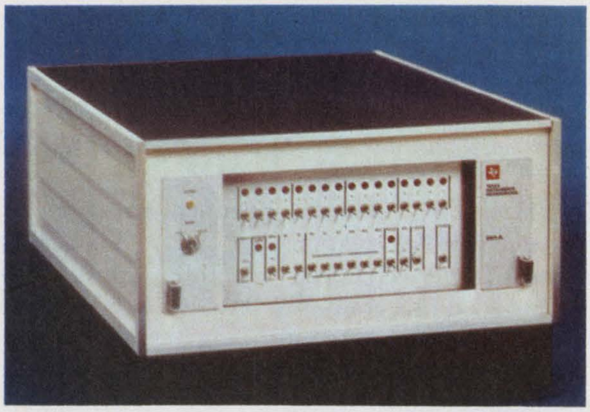
Computer control of industrial machines is a direct outgrowth of digital numeric control, which relied on hard-wired controllers or paper tape readers. The computer-controlled system eliminates the time and expense of paper-tape generation and handling, as well as the need to modify a hard-wired controller program to make production changes. With a computer in the system either controlling the machines directly or providing the program for the control, productivity rises. The program for any number of controllers can be stored and recalled whenever needed.

Lawrence W. Delong, product manager for computer control systems at the Allen-Bradley Systems Div., Highland Heights, Ohio, says: "Our Model 1795 computer system can maintain a parts program in its bulk memory and feed up to 16 programmable controllers. The computer can simultaneously monitor the machines for parts counts, cycle times, machine failures and jam-ups, and relay statistical data to a higher-level computer. Perhaps most importantly, it can also be used to perform parts-program editing and modification."

A Western Electric plant in Massachusetts uses a DEC PDP-8 minicomputer to monitor and control several coil-winding stations. The stations are supervised by PDP-14 programmable controllers. This is an example of the industry trend toward the creation of computer hierarchies.

A hierarchy of computers is formed when an on-floor computer is used to deliver data to a higher-level supervisory machine. The availability of computers of varying sizes—inexpensive and capable of collecting data from other computers and sending data to them—has led to increasing use of the computer hierarchy in industry. Ron Roberts, manager of special systems marketing and development for General Automation, North Hollywood, Calif., explains:

"The technology of a computer hierarchy is to have a direct link from a process [satellite]



Designed specifically for industrial automation is the Texas Instruments Model 960A minicomputer. A wide selection of interface modules and a special machine architecture are available.

computer to higher-level [host] computer—which in many cases can be another mini. The important thing is to reserve control of the machine or process locally, without depending on the host computer to control the process directly. That way failures are localized. If the host computer goes down, the satellite will keep the process going. And, in some cases, if the process computer goes down, the host can tell it where to begin when service is resumed."

One way to establish a computer hierarchy in a plant that is automating gradually is to use similar minis for both the satellite and host functions. The satellite computers are installed first, and when the amount of information handled becomes enough to warrant it, one computer is upgraded to a host function. F. G. Seeberger, manager of manufacturing automation for Texas Instruments, Houston Tex., notes:

"Some of our customers have had good success using our Model 960 computers to automate an industrial plant. First they use a single 960 to control a simple task—but buy it with a disc, so they have in-house software development capability. Then they add other 960s doing other tasks, and finally upgrade the disc-equipped 960 to host—and replace its original position with a new, smaller unit. The host computer has many uses as a data collector, a real-time source of factory information for management and also for software development."

In the Canadian Interprovincial Pipeline Network, a Digital Equipment Corp. System-10 computer acts as host to 44 PDP-8 minis. The latter are at pumping stations along the 1900-mile oil pipeline. Each mini controls several large pumps and monitors flow, viscosity, station environment and electricity consumption of the pump motors. DEC says that a 30% savings in electricity use was achieved on the pipeline during the first year of operation.

Minis go with the environment

Once the decision is made to use a computer in industry, most engineers tend to worry about the reliability and suitability of the minicomputer in the traditionally severe factory environment. The usual concerns are interface between computers and operators, interface between the computer and machines and the effect of electrical interference, harsh temperatures and vibrations on the computer.

The interface between process computers and operators is almost universally CRTs or typewriter terminals. As one engineer at Leeds & Northrup, North Wales, Pa., explains it: "We are using computer consoles with graphic recorders, CRTs and printers. Most factory personnel are readily able to pick up the operation of a console—and we can provide a training program if the customer wants."

The discrete lamp-and-switch-control panel—so long connected with industrial control—is not very common in computer installations. Computer and systems suppliers generally agree that it is expensive to design custom panels for each plant installation, and they are concerned about possible excessive maintenance. In addition a lamp panel does not provide for easy modification if the system needs changing, and it displays only a relatively limited amount of data. Computers, on the other hand, can generate a great deal of data and be modified simply.

Some industries still require the old panel concept, though. Peter L. Andersen, director for the Electronics Div. of Phoenix Engineers, Orange, Calif., explains: "Our field is automating concrete and asphalt batching plants. We initially tried to use a CRT terminal but had to drop it. We discovered that many of the operators, with many years' experience, were unable to adapt to using a terminal. Also, many of our customers wanted to minimize any retraining of operators. Now most of our systems have operator-control panels, and the computer remains practically invisible."

Andersen does point out, however, that sometimes the display capability of such a panel is too limited and he is forced to go to a computer terminal.

Conversational English preferred

Another way to avoid confusing the operator is to have the computer "talk" to him in conversational English. It's easy to program a computer to talk an operator through his process, step by step, designers say. It takes a lot of

Automated batching systems by Phoenix Engineers are built around Cincinnati Milacron 8000-series minicomputers. Phoenix adds its own interfaces and software, using 8-to-24-k bits of memory.

memory space, but memory is cheap—certainly cheaper than having to bring in an engineer to run things.

The interface between computer and machine has been greatly simplified by the large variety of modules and corresponding software available from mini manufacturers. Most computer systems will accept analog, TTL, HTL and various switch-closure signals—both ac and dc. Most manufacturers are well aware that noise may get into the computer via signal inputs, and many use optical isolation in their modules. According to Roberts of General Automation:

"Optical isolation is the modern solution to receiving signals from electrically noisy environments. In the past we had to use complex filter techniques. Through the use of signal conditioning and programming techniques, input signals can be pulled through some very nasty noise."

Environment no problem

Most minis—particularly that breed of ruggedized machine designed for industrial use—can easily stand up to industrial plant temperatures and vibrations. And the elimination of wired connections in the machines, as well as better knowledge of materials and manufacturing, has made them relatively dust and fumeproof. As long as they are supplied with a flow of air—even approaching their upper ambient temperature limits—most will perform well.

In severe cases of power-line voltage fluctuation or transients, it may be necessary to condition the power line being fed to the computer. Minicomputer power supplies are very tolerant of line noises and voltage fluctuations, and modern digital circuit design makes computers much less likely to "see" noise anyway. The problems are usually associated with the power fed to rotating peripherals, such as drum or disc memories or tape drives. For that reason, most industrial installations do without them and rely on core memory when possible.

Energy conservation a new field

A new industrial market is emerging because of the current interest in energy consumption: energy demand and monitoring. In a typical case, a large steel mill using arc melting furnaces buys electricity at reduced rates, so long as its consumption remains below a contracted level. As soon as energy use in the plant approaches the penalty level, a minicomputer produces an alarm or shuts off loads. If the mini is fully supplied with process information—what furnaces are in what stage of their process and which are due to be started and which stopped—the mini can adjust voltages and timing to prevent the load from exceeding the contract.

Terence K. McMahan, who has just completed a survey of the process-control field for Frost & Sullivan, market researchers of New York, says:

"The biggest buyers of process-control computers will remain the petroleum and chemical industries for some time—with the biggest growth in the next 10 years being in nonferrous metals and the paper industry.

"The mini has already taken over. With a few exceptions, there will be no significant number of computers as large as the IBM 1800 going in —although the petroleum industry will make some installations using IBM System/370s as central computers." ■■

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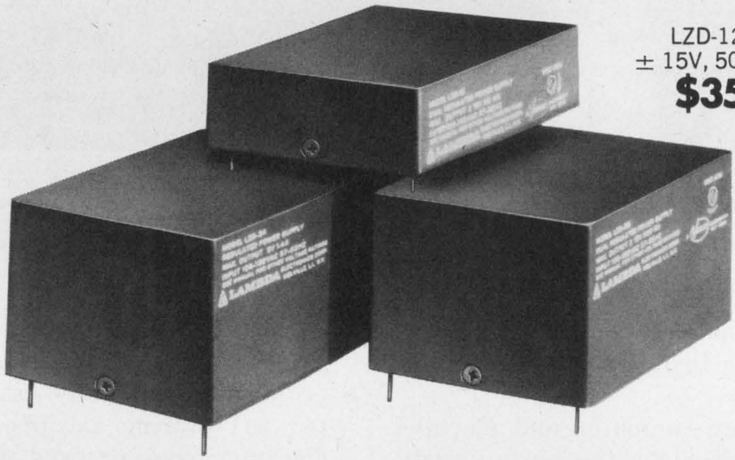

LZ-10 SERIES SINGLE OUTPUT

2½" x 3½" x ⅞"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZS-10	3	317	$35
LZS-10	4	384	35
LZS-10	5	450	35
LZS-11	10	225	35
LZS-11	12	195	35
LZS-11	15	150	35

LZ-10 SERIES DUAL TRACKING OUTPUT

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MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZD-12	±15V	50	$35

LZ-20 SERIES SINGLE OUTPUT

2½" x 3½" x 1¼"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZS-20	10	247	$55
LZS-20	12	268	55
LZS-20	15	300	55
*LZD-22	24	73	40
*LZD-23	24	129	55
*LZD-22	28	84	40
*LZD-23	28	143	55

*Single output ratings for dual output models connected in series

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MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZD-21	± 3	217	$55
LZD-21	± 4	258	55
LZD-21	± 5	300	55
LZD-22	±10	61	40
LZD-23	±10	114	55
LZD-22	±12	73	40
LZD-23	±12	129	55
LZD-22	±15	90	40
LZD-23	±15	150	55

LZ-30 SERIES SINGLE OUTPUT

2½" x 3½" x 1⅞"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZS-30	3	633	$65
LZS-30	4	767	65
LZS-30	5	900	65
LZS-33	10	293	65
LZS-33	12	336	65
LZS-33	15	400	65
LZS-34	3	950	95
LZS-34	4	1180	95
LZS-34	5	1400	95
*LZD-32	24	186	65
*LZD-32	28	208	65
*LZD-35	24	240	95
*LZD-35	28	280	95

*Single output ratings for dual output models connected in series

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LZ-30 SERIES DUAL TRACKING OUTPUT

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MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZD-31	± 3	333	$65
LZD-31	± 4	417	65
LZD-31	± 5	500	65
LZD-32	±10	163	65
LZD-32	±12	186	65
LZD-32	±15	220	65
LZD-35	±10	200	95
LZD-35	±12	240	95
LZD-35	±15	300	95

LZ-30 SERIES TRIPLE OUTPUT

2½" x 3½" x 1⅞"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZT-36	5	500	$70
	±15	50	

NOTES: (1) LZ models are adjustable between the following limits: LZS-10 2.5 to 6V LZS-11 8 to 15V LZS-20 8 to 15V LZS-30 2.5 to 6V LZS-33 8 to 15V LZS-34 2.5 to 6V LZD-12 ± 14.5 to ± 15.5V LZD-21 ± 2.5 to ± 6V LZD-22 ± 8 to ± 15V LZD-23 ± 8 to ± 15V LZD-31 ± 2.5 to ± 6V LZD-32 ± 8 to ± 15V LZD-35 ± 8 to ± 15V LZT-36 2.5V-6V for + 5V output only, ± 14.5 to ± 15.5 for ± 15V output only. Contact factory for current ratings at voltage settings not indicated in the tables. (2) All prices and specifications are subject to change without notice.

SPECIFICATIONS FOR LZ SERIES

Regulation

0.15%—line or load; models LZS-10, LZS-30, LZS-34, LZD-21 and LZD-31 have load regulation of 0.15% + 5mV; model LZD-12 has line or load regulation of 0.25%; LZT-36 line regulation 0.15% (+5V) 0.25% (±15V); load regulation 0.15% + 10mV (+5V), 0.25% (±15V).

Ripple and noise

1.5mV RMS, 5mV, pk-pk

Temperature coefficient

0.03%/°C

Overshoot

no overshoot on turn-on, turn-off, or power failure

Tracking accuracy

2% absolute voltage difference for dual output models only and only for the ±15V output in LZT-36; 0.2% change for all conditions of line, load and temperature

Ambient operating temperature range

continuous duty from 0°C to + 50°C

Wide AC input voltage range

105 to 132 Vac, 57-63 Hz

Storage temperature range

−25°C to +85°C

Overload protection

fixed automatic electronic current limiting circuit

Input & output connections

printed circuit solder pins on lower surface of unit. For model LZT-36 the ± 15V outputs are independent from the 5V output.

Controls

screwdriver voltage adjustment over entire voltage range.

Mounting

tapped holes on lower surface

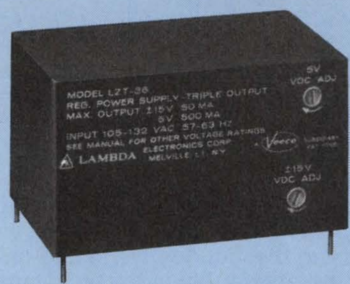
Physical data

Size	Weight
see tables	LZ-10 series 10 oz. net 18 oz. ship.
	LZ-20 series 17 oz. net 25 oz. ship.
	LZ-30 series 24 oz. net 32 oz. ship.

60-day guarantee

60-day guarantee includes labor as well as parts

LZ SERIES NOW AVAILABLE IN NEW TRIPLE OUTPUT MODEL



MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZT-36	5V	500	$70
	±15V	50	

1 DAY DELIVERY 60 DAY GUARANTEE

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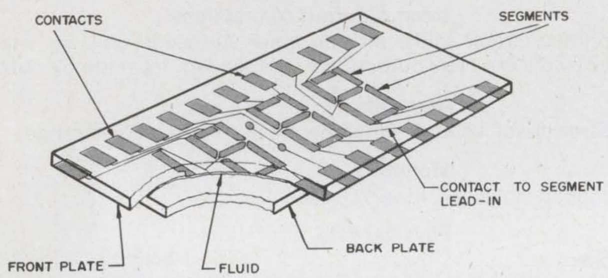
INFORMATION RETRIEVAL NUMBER 56

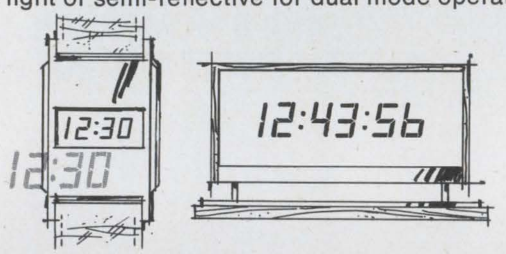
The case for Liquid Crystal Displays

Liquid crystal displays; light emitting diodes; incandescent and flourescent displays and "Nixie" tubes are popping up frequently in circuit designs as the trend to digital readout continues. Each has a purpose and the design engineer should become familiar with all types. We make liquid crystal displays.

The display of the future?
Our display is a sandwich of two plates, joined and hermetically sealed at the perimeters. A space of about .005″ separates the plates, and this is filled with a nematic liquid crystal solution.



When the liquid is not electrically excited, its long, cigar-shaped molecules are parallel to one another in a position perpendicular to the plates. Thus, the liquid appears transparent. Applying an electric current creates ion activity which leads to turbulence and causes the liquid to scatter incident light. The visual effect is that of a frosted glass. LCD's can be made completely transmissive for back-lighting, reflective for ambient light or semi-reflective for dual mode operation.



Producing an image — digital or other — simply requires a conductive surface the shape of the desired image on the glass plate toward the viewer. Current flowing from the conductive image on the front plate through the crystal liquid to the common-ground back plate causes the liquid to change from clear to a frosted appearance in the current-carrying area.

These images are almost always in the form of seven segments that make up the numerals 1 through 0. Energizing the proper segments produces the desired numerals. Lead-ins connect the segments to external contacts on the sandwich (display).

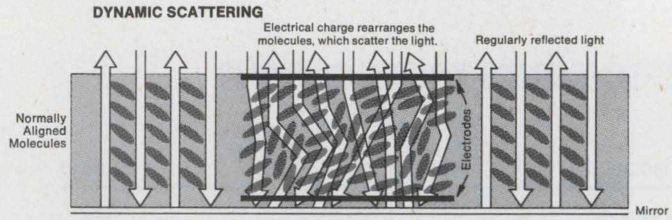
Consider the advantages.
Liquid crystal displays have a number of distinct advantages. Simplicity is the reason for several of these. The elements are few and passive — very little can go wrong with an LCD and this means reliability and long life.

Simplicity means low cost, too — lower than that of most comparable displays. Packaging costs are low because LCD's can be driven directly by MOS and C/MOS circuits. In our dynamic scattering displays very narrow character widths are possible and still provide a good viewing angle — 60 degrees in many cases.

Low power consumption makes the LCD a logical choice where power limitations rule out other display types. Watch type LCD's use only 30 μW, for example, with all segments energized at 15 volts.

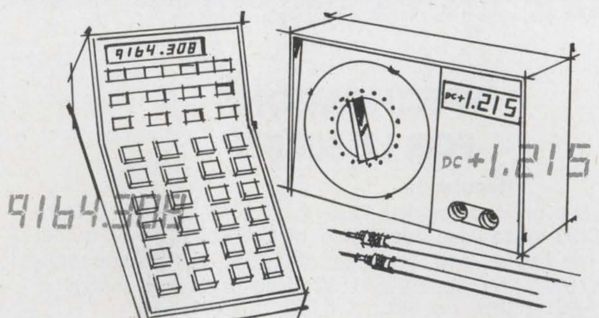
LCD's offer the greatest flexibility of any display type. Several standard displays are immediately available from Hamlin's stock. Special displays with virtually any type of image can be produced with surprisingly low preparation or "tooling" cost. Because of the LCD's simplicity, lead time on specials is only a matter of weeks.

A few limitations.
LCD's have limitations, too. Operating temperature range is one. Liquid crystals slow down and may even cease to function at temperatures below 0°C. Above 50-60°C, crystals go into solution and will not function normally.



Extremes do not damage LCD's. Once the temperature returns to normal, operation is automatically resumed.

LCD's do not generate light, and they are somewhat difficult to read under low ambient light conditions. (Side or back lighting can remedy this.) Visibility under medium to high ambient light conditions is excellent.



In the majority of display applications, MOS and C/MOS compatibility, reliability, flexibility and low power requirement are important considerations. No other display type can match the liquid crystal display on these jobs. They could become the display of the future. And that's the case for the LCD. For specification and application data, write Hamlin, Inc., Lake Mills, Wisconsin 53551. Or call, 414/648-2361. (Evaluation samples are available at moderate cost.)

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9791

INFORMATION RETRIEVAL NUMBER 57

When the questions are about enclosures, Optima has beautiful answers.

Whether packaging small, digital multimeters or a huge, communications center, you need enclosures with structural integrity, access, and versatility. Doing their job and doing it well.

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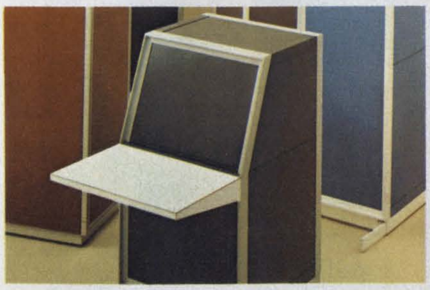


Sales Appeal

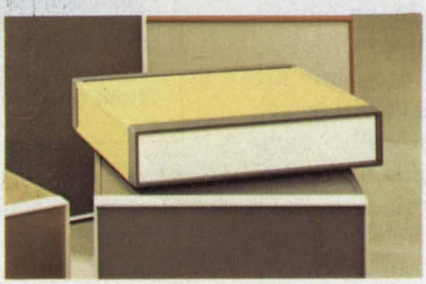
The first ten seconds of display for an electronics unit focus simply on its style, color and finish. They won't break a sale—the equipment inside does that. But they can sure help make one.

- Is an industrial designer with packaging skills involved?
- Can you get the superior vinyl finishes so much in demand today? Or woodgrains? Or special textures?
- Is a total range of designer colors on hand?

Versatility

An important sales tool is the ability to adapt to the changing needs of a client.

- Does a source offer hundreds of configurations to choose from? If, for instance, your client is thinking vertical rack, but wants the operator seated, can you offer a console-desk?
- Does a client need a ventilating grille? a blower? stabilizers? Wouldn't drawer slides help his operations? What about writing surfaces, storage areas, drawers, casters? Are they in production, on line and ready to go?



Customer Service

Are your own needs being served?

- Can you get personal service from engineers, designers, and production people?
- Can you get special applications assistance?
- Does your source have a knowledgeable customer-service representative?

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Computer scheduled manufacturing assures you of top quality control. We finish each unit inside and out with rugged vinyl and assemble them for final inspection—including most options and accessories—right at the plant.

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INFORMATION RETRIEVAL NUMBER 58

Optical data systems find a niche in the world of fast, fast computing

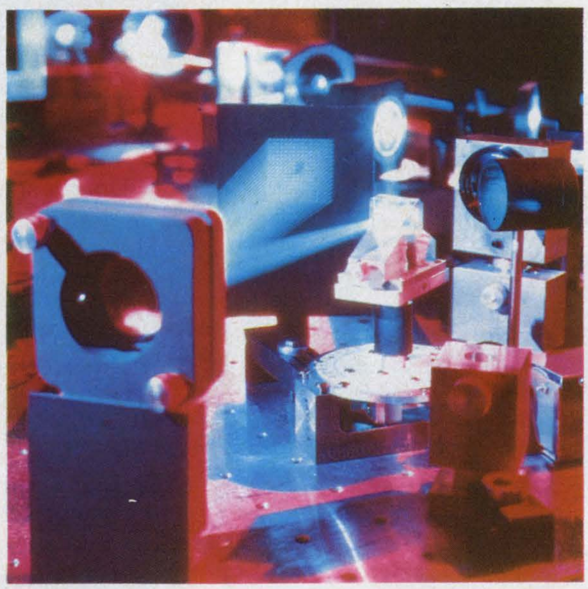
Jules H. Gilder, Associate Editor

Optical techniques for storing, processing and retrieving data are turning up in computer systems, spurred by demands for larger memories with faster access times and more rapid processing of data. Noise immunity and data security have also prompted interest in optics.

Although some optical data systems are commercially available today, work on optical computing is still confined to the laboratory, for the most part.

Development is proceeding in three major areas: memories, processors and peripherals. Optical storage of digital information promises significant improvements in capacity and access times over magnetic discs and tapes, which are currently used for mass storage.

According to Di Chen, a scientist at Honeywell's Corporate Research Center, Bloomington, Minn., magnetic discs and tapes will continue to dominate the mass memory area into the late 1970s. But by then, he goes on, they will reach the saturation point, and new storage technologies will be required to supplement or replace them. Optical memories promise to have capacities and costs equal to those of discs and tapes while achieving speeds that approximate those of random-access memories.



Data beams in this holographic memory from RCA are produced by diffracting laser light off a hologram on which data are stored.

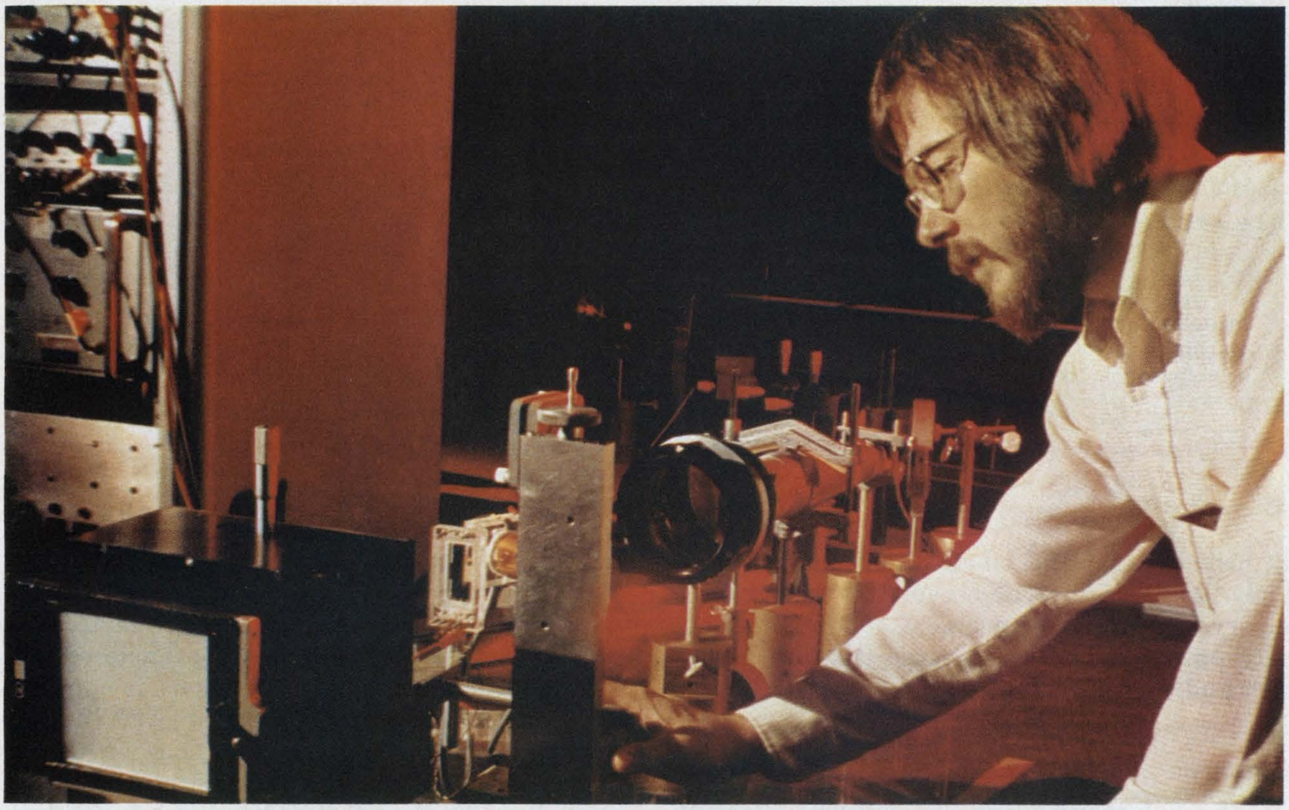
Two major techniques used

Two techniques are being used to store optical data: the bit-by-bit method, which reads out information serially, and the page method, which outputs information in parallel.

The bit-by-bit method is easier to implement, and a commercial system of this type is already available. It is known as the System 190 Laser Mass Memory and is produced by Precision Instruments, Palo Alto, Calif.

The System 190 is an improved modular version of the company's earlier Unicon 690, a trillion-bit memory developed for the Illiac IV computer. The 190 uses a laser to write on a nonerasable storage medium and offers a packing density of over 20 million bits per square inch. This high packing density gives a memory that has a lower cost per bit than any other today—0.0001¢ per bit. Another advantage of the 190's high packing density is that it requires about a tenth the storage space of conventional magnetic-tape systems.

The storage medium for the laser memory is a rhodium-coated Mylar data strip. Information



Optical memories like this one from Sperry Univac are being designed to store up to 10^9 bits of information. When completed, it will have an access time of between 1 and 10 μs and no moving parts.

is stored when a precisely focused laser beam vaporizes minute holes in the metallic surface of the data strip. The laser is modulated so that it is turned on to burn a hole for writing a ONE and turned off for a ZERO. The holes in the data strip change the strip's reflectivity and thus make it possible to read out the stored information.

While the 190 memory offers many advantages, it suffers from the fact that it uses a nonerasable storage medium. Efforts to overcome this problem are under way at several companies. One approach being developed at IBM's Research Div. in San Jose, Calif., uses a rotating glass disc covered with a thin thermomagnetic film.

According to Byron R. Brown, one of the developers of the IBM system, this approach yields a memory that is similar to the standard disc memory. The results of recent experiments, with the reversible thermomagnetic film, notes Brown, indicate that rotating optical memories with storage densities of 10^8 bits/in^2 and data rates from 10 to 25 Mbits/sec appear feasible. By combining these new materials with an improved high-track-density servo system, IBM says it can build an optical file with 1 Gbyte of storage per surface on a 14-inch disc.

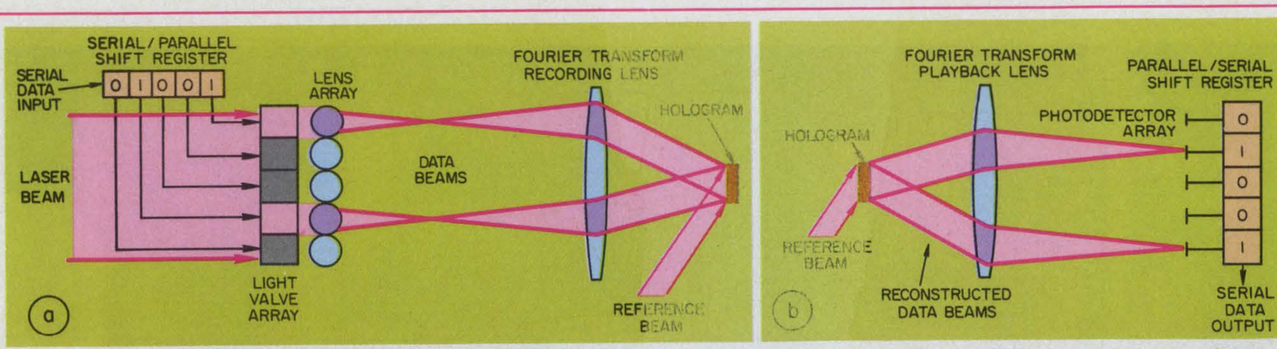
In explaining how the thermomagnetic optical memory works, Brown notes that the material's magnetization is initially all in one direction—normal to the plane of the film. To write in information, the magnetization is reversed locally by application of a thermal pulse—produced by a focused laser beam—and a gross magnetic field that is opposite to the initial field in the film.

To read out information, Brown continues, the same laser beam, operating at reduced power, is used to detect a rotation of the plane of polarization of the light. This rotation of light is known as the Faraday effect, and it results from the local reversals in the magnetic field.

Unlike most other approaches to laser memories, the IBM uses semiconductor lasers that are batch-fabricated in linear arrays. Twenty lasers per array on 100-micron centers are being used.

Brown notes that the IBM memory approach offers the potential of permanent, nonvolatile, semireversible, high-resolution digital data storage. But, on the negative side, the commercial magnetic recording densities are already over 8×10^5 and projected to go to 3×10^7, he says. An optical storage system would be attractive only if it could achieve a density of about 6.25×10^8 bits/in^2. The reason, Brown explains, is it would then be possible to fit a memory with a capacity of 10^{12} bits on a recording surface of only 1 m^2.

Because the bit-by-bit system is less sophisticated than the holographic memory, it is gener-



In holographic memories, serial electronic data are converted to parallel optical data and recorded on a holographic storage medium (a). When illuminated by a laser, the hologram generates data beams. The beams are then sensed by a photodetector array.

ally believed that the bit-by-bit memory will be widely available first. However, the holographic memory appears to be the goal of most developers of optical memories, because it offers higher speed and redundancy of data.

Holographic approach studied

In the holographic memory a page composer converts a block of data consisting of thousands of bits into optical form. The page composer consists of an array of light valves that are opened and closed, depending on the value of each bit. Once the valves are set, a laser beam is applied to the light-valve array. The valves that are open form multiple data beams that strike the holographic storage medium, along with a reference beam, to create a hologram. Since the resulting holograms are small, a new block of data can be recorded simply by repetition of the process on an unexposed area of the storage medium.

According to Honeywell's Chen, a holographic memory with a capacity of 10^9 to 10^{10} bits and page-access time of 10 μsec should be possible.

To retrieve information that has been stored in a hologram, a laser beam is allowed to strike the hologram. This causes multiple data beams to be diffracted from the hologram. These beams pass through the readout optics and are focused to form an array of bright spots that coincide with a photodetector array and that represent the stored data. Each light spot activates one detector element, and the element converts the optical signal into an electrical one.

To get the information in serial form—the way it was originally entered—the detector elements are sampled by a shift register.

A big plus for holographic memories is this: Since each data bit is mapped into a plane grating pattern on the hologram, a slight misregistration of the hologram does not alter the alignment of the data spots relative to the photodetector array. This means that high positional accuracy is not required for addressing. Another advantage of the holographic technique is that information loss due to dust, scratches or other imperfections in the storage media is eliminated. Since each data bit is recorded over the entire hologram area, small imperfections on the hologram will only result in a slightly lower signal-to-noise ratio for all the bits, instead of the complete loss of some of them.

About a year ago two experimental read/write holographic memories were introduced—one by RCA, the other by Harris-Intertype Corp. The RCA unit stores 1000 bits of information on 1000 pages, for a total storage capacity of about a million bits, while the Harris device stores 16-k bits of information on 25 pages, for a capacity of 400,000 bits. Except for the size and number of pages, both systems appear to be similar.

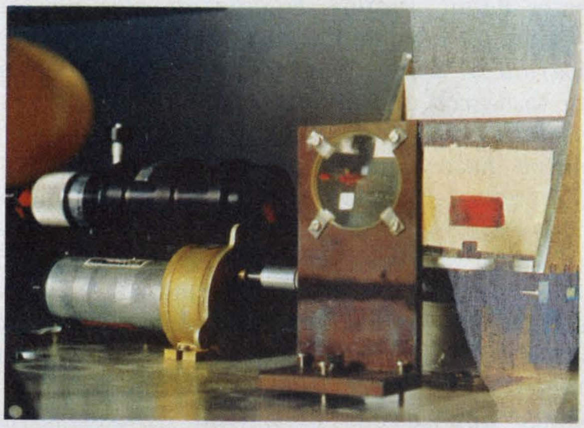
Both use a thermoplastic medium to store the holographic image instead of photographic film, and both are working models. One noticeable difference between the two is the page composer. In the RCA memory, liquid-crystal cells act as the light valves for the page composer; in the Harris unit a ferroelectric ceramic material is used.

According to Wilber C. Stewart, a researcher at RCA's Sarnoff Laboratories, Princeton, N.J., much development work must still be done before a holographic memory becomes practical for mass-storage applications.

"It's easy to build a 1-million-bit memory with a 3-to-4-second cycle time, but a lot tougher to build a memory of 10^{10} or 10^{11} bits with a cycle time of 10^{-4} to 10^{-3} seconds," he says.

Stewart notes that there are five critical areas that must be developed before holographic memories become a reality. The first need is for a reliable laser in the 200-mW-to-1-W power output range. The only laser with that power today, and in the right frequency range, is the argon-

Holographic data retrieval unit fr... to read data stored on 35 mm f... holographic recorder is used to sto...



Optical processors can filter, convolute and correlate analog signals after the signals have been converted to the optical domain.

ion. But it has very poor reliability.

Another need is for a large-capacity—10^5 bits—laser-deflection system. Stewart indicates that acousto-optical deflectors will probably do the job nicely.

One of the most important needs—and probably one that will require the most work is the page composer. It must be fast and have many elements. Lowell D. Overvold, product marketing manager for Harris' Electro-Optics Operation, indicates that PLZT, a ferroelectric ceramic, looks promising but that there are still some bugs to be worked out. One of the problems, he explains, is that PLZT is not a uniform material and not readily available. Stresses caused by the nonuniformity of the material have caused breakage and made it difficult to construct large light-valve arrays for the page composer.

Two other important needs are the photodetector array and a reversible holographic storage medium. It is generally conceded that present silicon technology will be sufficient to fabricate the photodetector arrays. In the area of storage mediums, the most promising material seems to be a thermoplastic-photoconductor sandwich.

In use, such a sandwich is initially charged with a corona discharge to a potential of several hundred volts. The photoconductor alters the potential across the thermoplastic in proportion to the light intensity, and the resulting differential electrostatic forces cause the thermoplastic to deform when it is heated. The deformations are a replica of the original light pattern, and, upon cooling, the pattern is stored as a phase-relief hologram. Erasure, when desired, is accomplished by heating the thermoplastic to a temperature somewhat higher than that used for writing. Once erased, the thermoplastic may be used over again. The principal disadvantages of this material are its slow record and erase times and its limited recycling capability.

While RCA's Stewart maintains that it will take at least 10 years to complete all the developments needed for a good commercial optical memory, Harris' Overvold says that one will be commercially practical in only two years. This will be made possible, he says, by use of a special human-readable/machine-readable holographic memory. Prototypes of the memory use standard 4-by-6-in. microfiche cards to store information.

This digital-storage concept consists of 60 images arranged in five rows of 12 images that contain human-readable data plus a 6.4-mm-wide strip of one-dimensional holograms recorded along an unused portion of the title block of the microfiche. This hologram contains 2.5 Mbits of data, which is the encoded equivalent of 60 pages.

The memory can also operate in a machine-read-only mode, in which case the storage capacity is increased to 37 Mbits. An unusual aspect of this system, and one of the reasons for its early availability, is the fact that it doesn't require a page composer. Instead the system computes the Fourier transform of the block of data to be stored and uses a laser scanner to record these data as a one-dimensional synthetic hologram. The input data rate to the system is fairly low—250-k bits/sec—and thus there is enough time to calculate the Fourier transform. Data are read out of the memory at 500 kbits/sec.

When this holographic memory is interfaced with an automated storage and retrieval module capable of holding between 100,000 and 600,000 microfiche films, it is possible, says Overvold, to construct a mass memory capable of storing between 4×10^{12} and 2.4×10^{13} bits of data. Such a system would be competitive with other mass memories, such as the one made by Precision Instruments.

A different optical memory technique is used by Opto-Logic Corp. of Long Beach, Calif. Its approach involves the use of multiple incoherent light sources, a removable information storage medium for discrete bit patterns and an area photodetector array for the output device.

The storage medium in the Opto-Logic memory is a photographic slide that has a high-resolution, silver halide emulsion, reports Albert S. Jackson, the company's president. Each slide, he says, contains up to 1024 pages of information. The information may either be in the form of bit patterns or actual characters. A separate LED is associated with each page, and when the LED is energized, it projects the entire contents of the page onto a photodetector array.

For an information-retrieval device, such as a read-only memory, the stored pages are selected one at a time when a single LED is addressed. Each of the 1024 pages contains up to 288 bits of information, for a total storage capability of 294,912 bits. The access time for this memory is 80 ns.

Optical systems speed processing

Not all of the computer-oriented optical systems are memories. Optical data processors are being developed with a potential for exceeding substantially the data-handling rates of the fastest digital computers.

The reason optical processors are so promising, notes IBM's Brown, is that they are parallel devices. With optical processors, he explains, it is possible to process simultaneously an entire frame of imagery—whether it contains a hundred bits or a million bits. This contrasts with electronic systems in which information is processed sequentially, bit by bit or in some cases a few bits at a time. To deblur a photograph of reasonable quality with a digital computer takes an hour. To do the same thing with an optical processor takes only a second.

The high speed of optical processors does not mean, however, that they will replace digital computers completely, most designers believe. Optical computers, they say, will be used only in special applications, particularly those involving some sort of imagery. Two of the major applications are in pattern-detection and recognition and image deblurring. These applications are based on the fact that a simple coherent optical system can produce the Fourier transform of an arbitrary two-dimensional function and allow a wide class of spatial filtering operations.

In pattern recognition an optical matched spatial filtering system offers a number of advantages that apply both to two-dimensional and multichannel, one-dimensional signals. Such a system performs a cross-correlation across the entire input field simultaneously, without scanning.

Pattern detection is performed independent of the location of the signals. The locations are preserved in the detection process, and thus correlation peaks in the output plane are geometrically related to the positions of the signals in the input.

Pattern recognition with an optical processor, for example, can be used in aerial reconnaissance to automate several routine photo-interpretation jobs. These include the elimination of badly focused, improperly exposed or cloud-covered imagery. In addition the processors can be used to detect automatically signals of interest and to establish a list of frame and location priorities for the photo-interpreter to investigate in greater detail. Pattern recognition also has application in word and character recognition. A hologram of a word or character is made and used to search an entire page of print. Correlation peaks appear in the output whenever the word or character is present.

In image deblurring, optical processing makes it possible to remove the characteristic contrast inversions that result from a blurred image. This technique can be applied to images that have been improperly focused or to images that have been blurred by movement or even lens imperfections.

Other applications of optical processing include fingerprint recognition, cloud-movement analysis and photographic mapping. In fact, optical processing is useful in most operations that require correlation of two or more two-dimensional patterns.

While the optical processor offers the possibility of ultra-high-speed processing, much work remains to be done on the interfacing of circuits for the optical computer. At present the optical processor's speed is limited by the ability of interfacing circuitry to input and output data.

Fiber optics looks for a place

In the realm of digital computers, fiber optics is being used in peripherals and data communication. One example of peripherals is the Memorex 1603 Microfilm Printer, which combines fiber-optic bundles with light-emitting diodes to produce a device with a printout rate of 10,000 132-character lines per minute. This is nearly 10 times the speed of the IBM 1403 or 1443 printers, with which the 1603 is designed to be used.

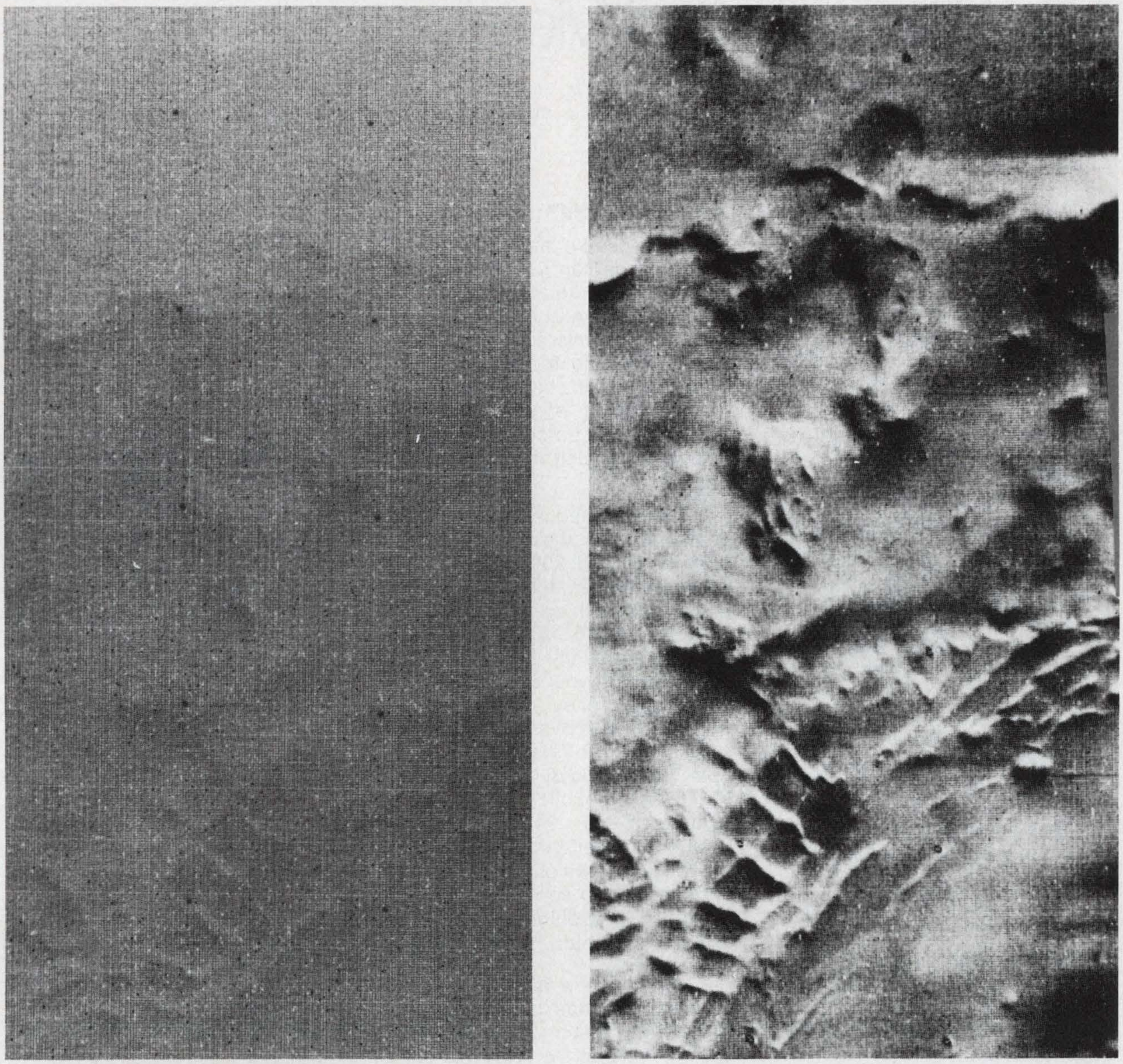


Image enhancement was used on photographs taken by the Mariner 9 spacecraft. The raw photograph (left) of Mars surface becomes clearer after only five minutes of computer enhancement.

Digital signals in the 1603 are applied to combinations of diodes by an electronic translation matrix. Pulsed light from the LEDs is transmitted through the fiber-optic strands to produce a display of alphanumeric characters that is used to expose the microfilm.

In data communications, fiber optics is providing isolation—and thus eliminating electrical noise and ensuring data security. James Mills, marketing manager for the Quadri Corp. of Phoenix, Ariz., says his company's Opticable can be used to transfer computer data over short distances.

Opticable consists of a fiber-optic bundle with a transmitter and a receiver attached to opposite ends of the bundle. Data in electrical form enter the transmitter at one end and drive a LED. At the other end of the cable, a photosensor detects the light pulses and converts them back to electrical pulses. The system is TTL-compatible and requires a 5-V power supply at both ends. The data-transmission rate of the cable varies with length from 0.9 MHz for 100 feet to 5 MHz or better for 10 feet.

Since optical cables do not radiate energy and cannot be easily topped, they are used in applications where data must be transferred securely. ■■

The Place of Clad Metals in Electronics

Science is simply common sense at its best — that is, rigidly accurate in observation, and merciless to fallacy in logic.

— *T. H. Huxley*

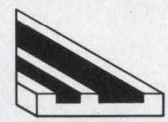
The Gold Saver–I

As the price for an ounce of gold climbs, it becomes increasingly important to utilize this precious metal in the most efficient and economical manner.

One of the ways to save gold is to use clad metals. TMI specializes in stripe-inlay, overlay, and all types of solder cladding. Part I deals with the first method.

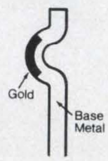
Clad Metals (Stripe-inlay)

Stripe-inlay cladding imbeds a stripe, or several stripes, of precious metals such as gold, silver, brazing alloy, or any non-refractory metal in a base metal with top surface of the inlay flush with the base metal A permanent bond between the two materials is obtained by rolling under high pressure in a bonding mill.



Cladding vs. Plating

There is no single answer to which process (cladding or selective plating) is superior. From a design point of view, cladding has these advantages:

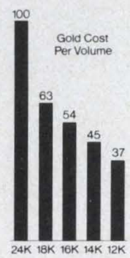


1. It is a wrought surface with a fully dense, non-porous layer, offering superior wearability.
2. Alloys of various elements can be used.
3. It has superior formability permitting forms or dimpling without fracturing the clad surface.
4. Cladding is free of high surface stresses which can cause excessive spring-set.
5. A greater range of precious-metal thickness is possible.
6. Cladding is almost always lower in cost than overall plating.

What Karat Gold?

Perhaps the most significant cost savings can be achieved by using a lower karat gold. Historically, the 24-karat gold has been used for contacts simply because it was available for plating. Clad metals, however, have opened up the opportunity of utilizing alloys having a lower percentage of gold without sacrificing design requirements.

The most frequently used gold combination is the 18-karat gold (75% gold and 25% silver). Recently, however, there has been a trend toward even lower karat gold such as 16, 14, and even 12. Savings are really two-fold: gold costs less if you use less, and since the alloy combinations weigh less they cover more area. As an example: 18-karat gold offers about a 37% gold reduction (compared to 24-karat gold) when taking the lower weight of the alloy into consideration in addition to the cost of gold.



Just how low a karat gold is practical depends upon the particular application. There are several factors that play an important part, such as corrosive conditions, amount of current, number of cycles, and type of wiping action. It seems probable that a large number of applications in the electronics industry would perform satisfactorily with a 14-karat gold.

Dimensions

In addition to the karat gold used, there is another area that permits considerable savings: the thickness and the width of a stripe.

Thickness can range from .00002″ up to one-third of the base metal thickness, with a standard tolerance of ±10%. The present methods for testing thickness include metallography, betascope, weight loss, or etching away base metal. It is important that there is an agreement on the method of testing.

The width of a stripe needs to be no larger than the actual contact area. There is no fracture or peeling while forming or bending in the clad area. This helps to further save gold by avoiding excessively wide stripes.

Write for our "Handbook for Clad Metals" containing comprehensive information for design purposes.

PRECIOUS METAL ALLOY GUIDE

TMI	Designation Other	Nominal Composition Wt. % Essential Elements	Density T. oz./cu. in.
101	24Kt. Gold	99.99 + Au	10.18
102	18Kt. Gold	75 Au, 25 Ag	8.41
103	16Kt. Gold	67 Au, 33 Ag	7.96
104	14Kt. Gold	58 Au, 42 Ag	7.52
105	12Kt. Gold	50 Au, 50 Ag	7.16
106	—	72 Au, 26.7 Ag, 1.8 Ni	8.20
107	W.E. #1	69 Au, 25 Ag, 6 Pt	8.39

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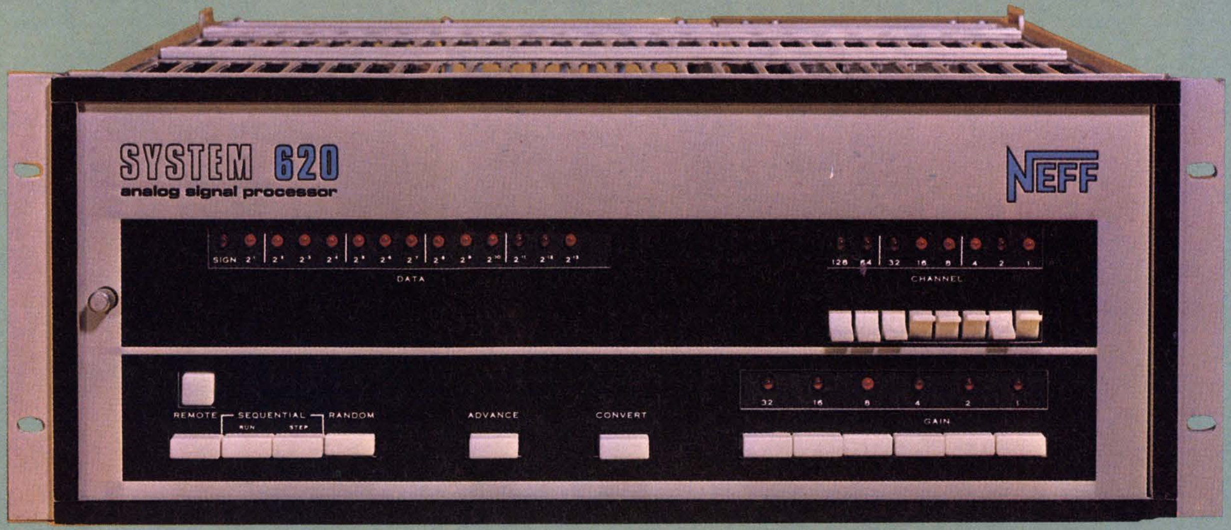

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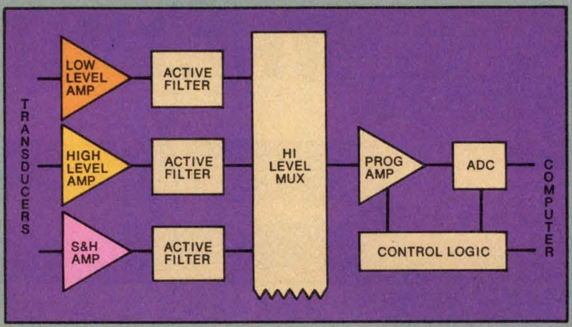

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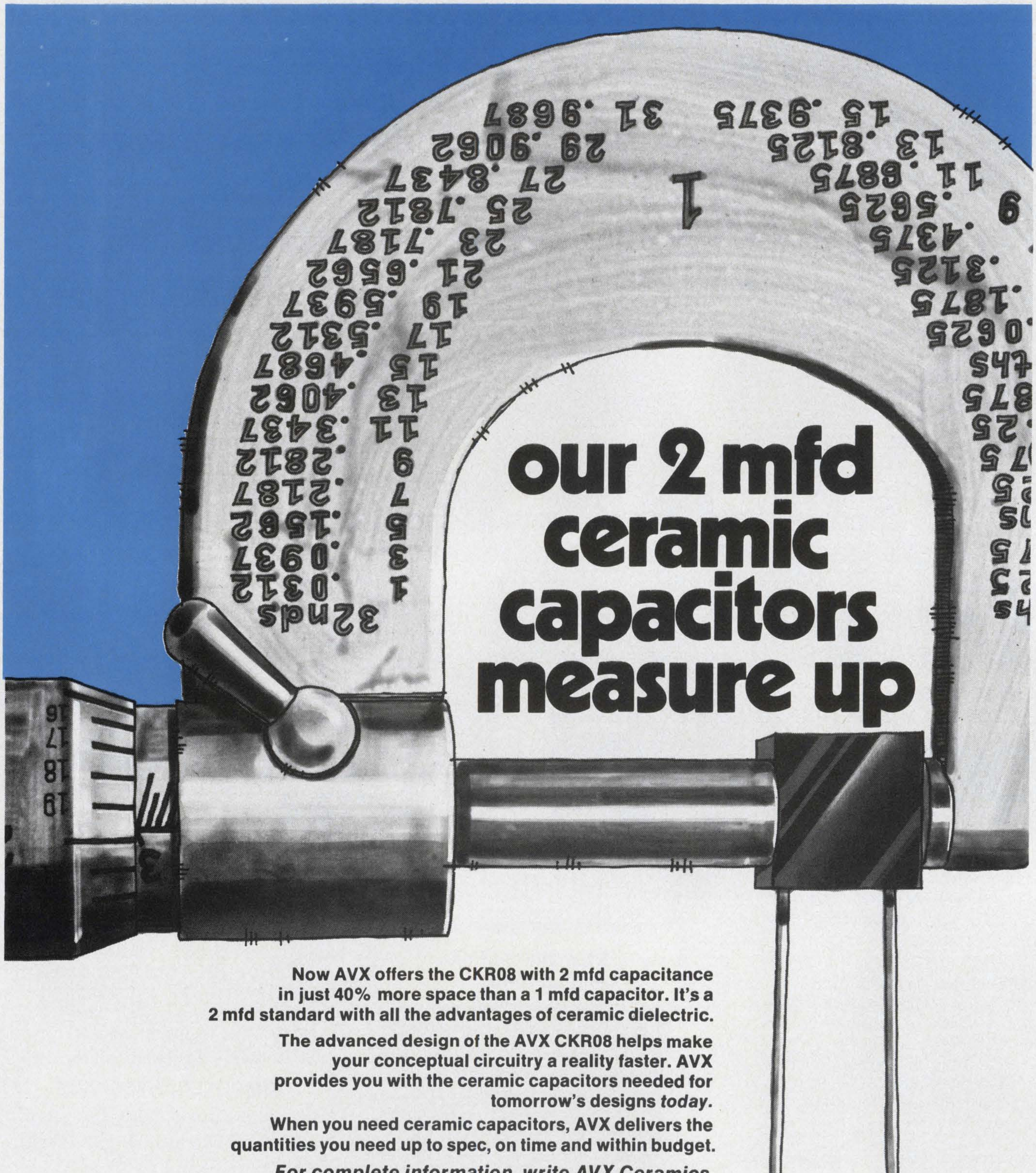
our 2 mfd
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capacitors
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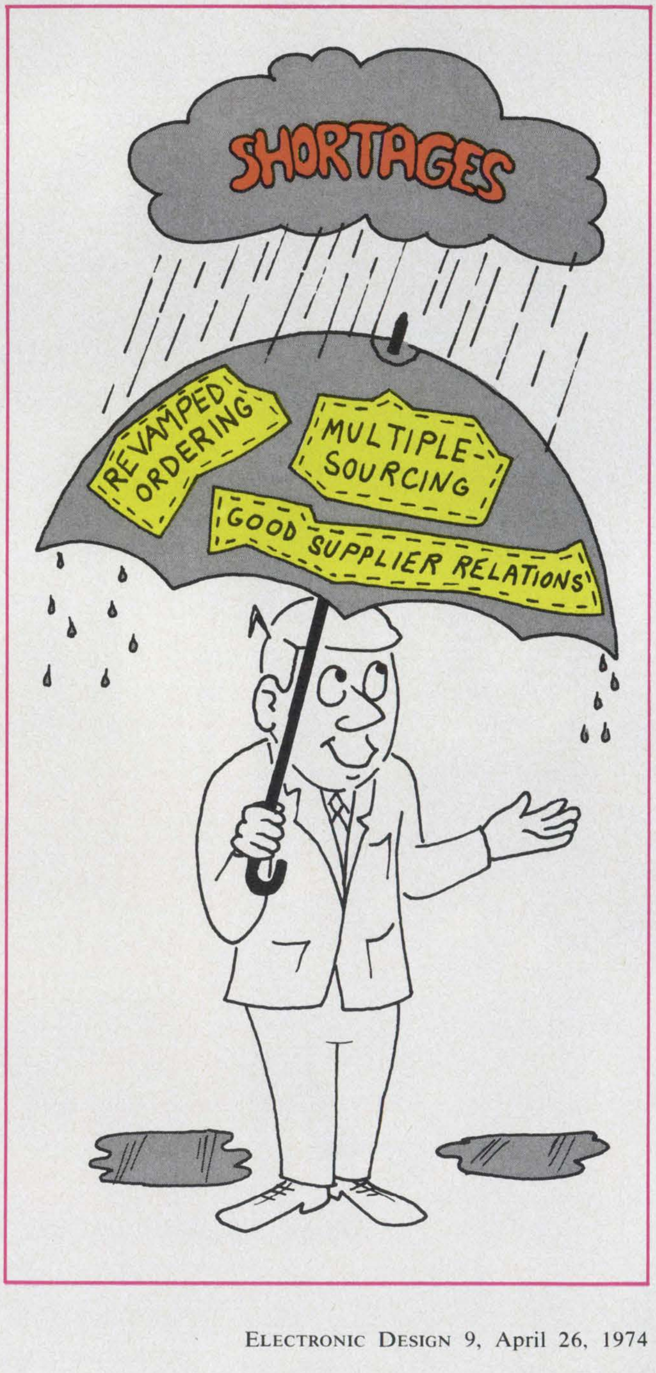
Shortages of components forcing engineers to alter their thinking and designs

Dick Turmail, Associate Editor



Component shortages have created additional responsibilities and longer working hours for computer engineers.

A spot check by ELECTRONIC DESIGN shows that the computer designer must now:

- Spend more time with his purchasing department or in the marketplace to know what components are available.
- Use more substitutes—for example, TTL is continuing to replace DTL, and medium-scale integration is supplanting the older and simpler ICs.
- Design many of the same components into different products so that his shortages won't be as widespread.
- Be more suspect when testing new components, because high demand often means faulty production.
- Travel more to meet suppliers' engineers personally to discuss new and substitute components.

Although computer makers have had to extend their lead times well beyond their usual limit, most are weathering the storm of component shortages by extra planning, the survey found.

Dual and triple-sourcing now

Some computer component users who formerly specified a vendor when ordering from distributors are now dual-sourcing and even triple-sourcing their components. They list metal-film resistors; ceramic, aluminum foil and electrolytic capacitors, and digital ICs as the hardest components to find.

Single-sourcers feel they've built up a reservoir of good feeling with their suppliers, many reporting that their practice of never going back for a second bid, ordering in quantity and well in advance, and paying on time is paying off.

As for the component suppliers, they are no longer waiting to see what will happen to the economy as they did a year or so ago. Lead times on ICs and resistors are beginning to soften now, mainly because suppliers have been investing heavily in production equipment to meet the demand. Some suppliers report shortages of raw materials, including copper, plastics, ceramics, resistor wire and gold-plated leads. But on the whole, the spot check shows, shortages have occurred mainly because suppliers failed to gear up for the demand, rather than because of any scarcity of raw materials.

Forecasting of needs extended

The poll of both computer component users and suppliers turned up responses like these:

"We have no shortages that affect our deliveries," says Pat McGrath, materials manager of Interdata, Oceanport, N.J. "We're still delivering a system in 45 to 90 days—30 days for a CPU—which is pretty much off-the-shelf in the computer business."

He says that about 17 months ago his company extended its ordering policies with a programmed system. It now forecasts component needs up to 14 months, and it gives suppliers solid orders, not forecasts.

"Also we have an advantage," McGrath says. "We use 250 components in six to eight major units—that's a lot of commonality of parts, and that spreads our shortage problems a little thinner." He says that about 18 months ago they had trouble getting printed circuit card assemblies until they tooled up and started making the cards themselves. "Now," he says, "the toughest thing to get is copper, and that's really tough!"

The four components that Texas Instruments' Equipment Group in Austin finds in shortest supply, according to Gene Towry, purchasing manager, are aluminum-foil capacitors (delivery in 48 to 60 weeks), film resistors (25 to 30 weeks), MOS memories (25 to 30 weeks) and digital integrated circuits (30 to 35 weeks).

"We've managed to stay ahead of the game so far," Towry says. "We're using alternate sourcing; we haven't had to delay any of our computer delivery schedules, but our lead times have gone up by about three weeks in the past three months, and we've had to forecast our needs about a year in advance."

Components that have lengthened Digital Equipment Corp.'s lead time have been tantalum capacitors (36 weeks) and aluminum-electrolytic capacitors (30 weeks), MOS devices (32 to 36 weeks), resistors (8 to 14 weeks) and metal film resistors (14 weeks).

"Our shipments to customers haven't been held up at all," says Fred Wilhelm, manager of DEC's Large Computer Engineering Dept. in Maynard, Mass. "We're triple-sourcing and writing longer term contracts. Suppliers want two-year contracts, but we're able to keep them to a year because we have some buying power."

Wilhelm is optimistic, mainly because he hasn't seen any big shortage problems in his area.

"But we've got to plan more in engineering," he says, "particularly in gearing up for new products." And, he adds, "we've really got to make sure that new components are well-tested before we get involved in a long-term contract."

At Dale Electronics, Columbus, Ohio, George Burdine, materials manager, says: "Compared to six months ago, our lead times are getting better. Ceramics and good resistor wire are the materials that make resistors hard to get."

Dale supplies resistors to the computer industry, and recently it has invested heavily in machinery to extend its capacity.

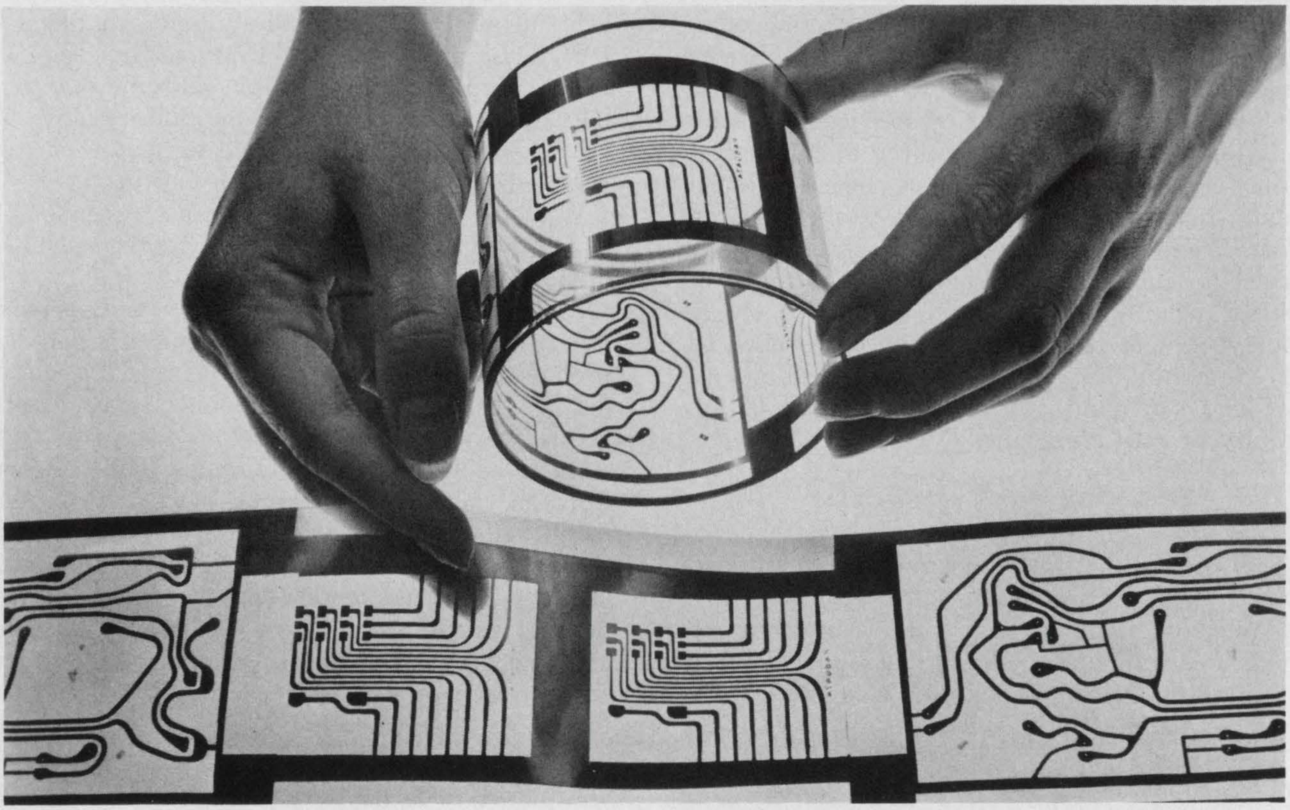
"We've been working night and day, six and seven days a week, to improve our manufacturing ability," Burdine says. "Also, we're negotiating personally with our suppliers all over the country."

Last year metal film resistors had lead times of from 24 to 60 weeks; a year before the average was six weeks. Corning, a major supplier of resistors and capacitors to the computer industry, has already begun a major metal-film expansion program, which, according to a company source, has allowed it to reduce lead times to 32 weeks.

Three years ago Corning expanded to ceramics and has been a major supplier for axial monolithic ceramic capacitors to the computer industry. It is concentrating on miniature epoxy-cased ceramic capacitors for automatic insertion, and reportedly has doubled production capacity in the last year. The company is making a high-volume, low-cost commercial axial line and a commercial radial line.

A spokesman for Hewlett-Packard in Palo Alto, Calif., says that it had to plan well ahead to get semiconductors, high-quality capacitors and transformers. "Our lead times are growing," the spokesman says, "and although we expect them to get worse before they get better, we're not crying. Our suppliers are delivering on schedule—25 years of not going back for a second bid and of paying on time have earned us a spot on the preferred customers' list."

Bill Schwartz, distribution program manager for United Transformer Co., a division of TRW in New York City, says that its purchasing department is planning bigger blanket orders to help get hard-to-find materials, such as plastic



Copper conservation is an objective of this printed-circuit process introduced a number of years ago by Western Electric Co. In the process, copper circuitry is added where needed, reversing the traditional method of coating plastic—also in short supply—then etching away the unwanted metal.

lead wire, copper and the gold-plated leads used on small transformers. The computer industry represents only one part of United Transformer's market.

"We've had to extend our deliveries a bit," Schwartz says. "Our regular catalog pieces at six-to-eight week delivery are now up to eight-to-10 weeks delivery. And custom pieces are up from 10-to-16 weeks delivery."

Stancor, Fort Wayne, Ind., sees the shortage as a boom and realizes that it can't supply both its distributors and its OEM customers and keep everybody happy.

"So we've been soft-pedaling the OEM special transformer business," says the company's general manager, Bob Reigel. "We're a 95% standard stock item, and a lot of our transformers end up with computer manufacturers as the best way to get delivery."

Reigel says his company's inventory is good on standard items and, on the average, he can deliver in six weeks. A special OEM transformer takes six to eight months to deliver. He adds that Stancor's OEM business is growing rapidly.

"On the standard item, we may not always have the transformer model they want," Reigel says, "but electrically and physically it will do the job, in many cases."

Shortages of computer components haven't been critical, IBM reports. According to a spokesman at the Systems Development Div., Kingston, N.Y., components that used to take 30 days to get now take 40 days, but IBM's delivery times haven't lengthened. Component suppliers are asking the company to order earlier, so it's ordering annually instead of quarterly.

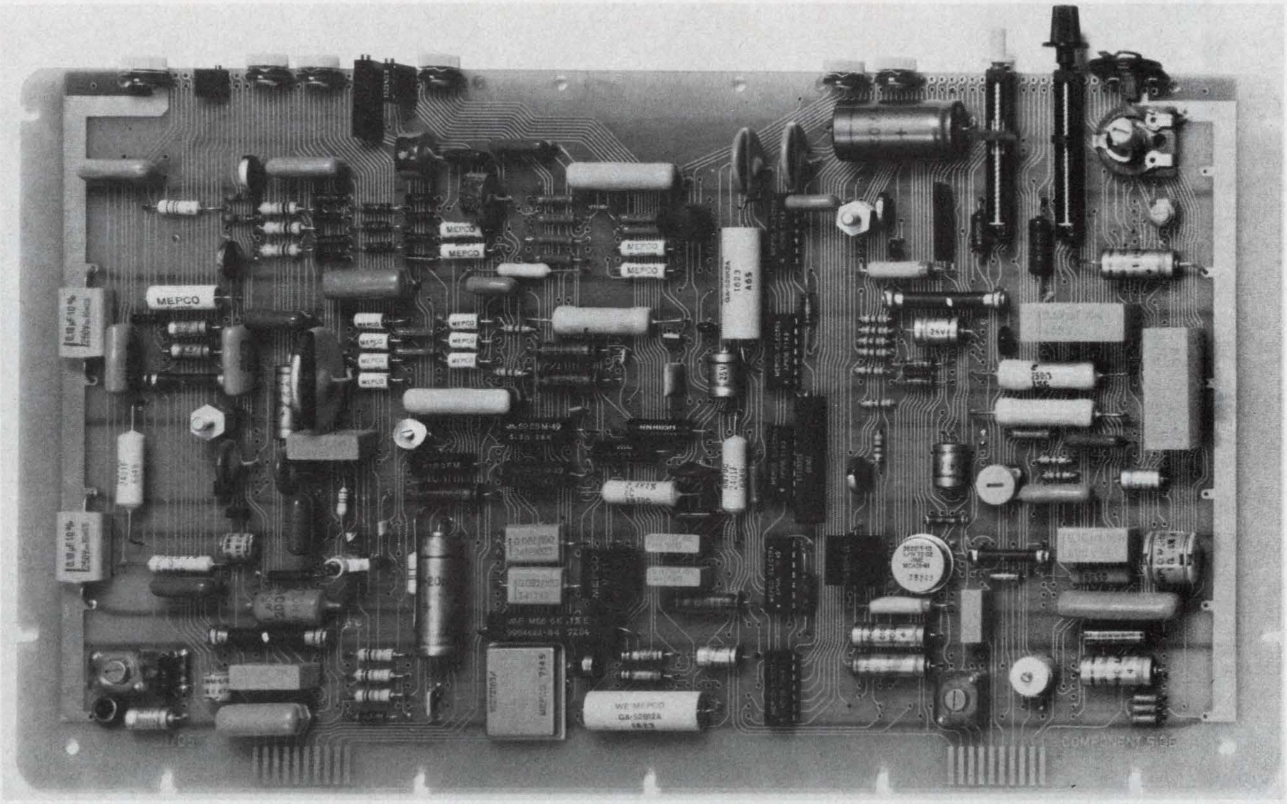
At Xerox Data Systems in El Segundo, Calif., Myles Connelly, group manager for electronic purchasing, lists ceramic capacitors (33 to 38 weeks), ICs (23 to 43 weeks) and TTLs as in short supply. He says that some suppliers are referring his company to standard components or to distributor stock for small quantities.

"That means," he says, "that we must then go through an engineering and quality review, and generally we won't accept that."

What Xerox Data Systems does do is book national contracts 18 months in advance to buy in capacity, and make certain that its engineers meet the suppliers' engineers and design a product that follows the state of the art.

"We're not as concerned about price as we are about delivery," Connelly adds.

A spokesman for Motorola Semiconductor in Phoenix, Ariz., says that it is backlogged in every area. The company keeps careful tabs on mate-



Vital to any computer system are components like these. This circuit board illustrates the Mepco/Electra, Inc., line of resistors, capacitors, thermistors, varistors, DIP networks, and hybrid microcircuits. Some are in various degrees of short supply, as reported by users and suppliers nationwide.

rials, and right now there's a silicon shortage. While there's hardly a scarcity of sand, it appears that the equipment used for converting silicon tetrachloride to purified polycrystalline silicon has not been expanded fast enough to keep pace with the demand.

While Signetics of Sunnyvale, Calif., hasn't recommended any component substitutions, it has tried to recommend the use of MSI to replace numerous SSI parts.

"We use less silicon to accomplish the same function," says Michael Harkworth, manager of corporate marketing, "and it's more economical. But it's a design change, so it's not practical for a short-term pick."

The company makes ICs, logic and memory circuits for the computer industry.

The difficulty in getting silicon wafers has stretched Signetics' lead time, but, according to Harkworth, the company has managed to keep its deliveries on schedule. He says that the purchasing group has maintained good relations with materials suppliers.

"When times were tough, we were the last people to cancel or change orders with our vendors," Harkworth says. "We paid on time at the risk of having a little bit of inventory. Those relationships have paid off, and it helps, too, to give our vendors a year or a year and a half notice of what our requirements are going to be."

Pertec Corp. of Chatsworth, Calif., supplies computer makers with such peripherals as tape transports, disc drives and flexible discs. According to Darrell Lloyd, advertising manager, semiconductors, plastic materials, capacitors, resistors and some fabricated parts, like cabinets, have been in short supply.

"But we think that the shortage is cresting," he says, "because we believe that the pipeline is filled up."

Multiple-sourcing and negotiating with suppliers in person are two of the ways the company has tried to neutralize shortages.

"In some cases we get a faster deliver," Lloyd says, "and in some others we've had to pay a premium in price. We had to pass a 3% to 5% price hike along back in February."

Lloyd says that Pertec asked its customers to plan further ahead so it could, in turn, give its suppliers greater visibility of its needs.

"In November we delivered in 120 days, when 60 was the norm," Lloyd says. "Now we're dropping down to 90 days, but it's hard to say when we'll get back to 60, because business is increasing by 25% per year, and most peripheral houses are experiencing the same things we are." ■■

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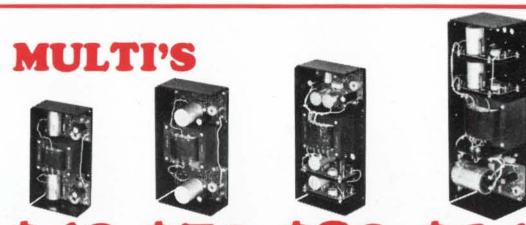

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OUTPUT #2	−12V, 1.5A or −15V, 1.3A	−12V, 3.0A or −15V, 2.8A	−12V, 1.5A or −15V, 1.3A	−12V, 3.0A or −15V, 2.8A
OUTPUT #3	---	---	5V, 6.0A or 6V, 5.0A	5V, 12A or 6V, 8.0A

All outputs are floating; can be connected in any common configuration.
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MODEL	DEPTH	WIDTH	HEIGHT
2K15D-1.3	2.95 in.	7.87 in.	4.00 in.
2L15D-2.8	3.20 in.	9.38 in.	4.88 in.
2R-70T	3.32 in.	11.00 in.	4.88 in.
2S-140T	4.50 in.	15.00 in.	4.88 in.

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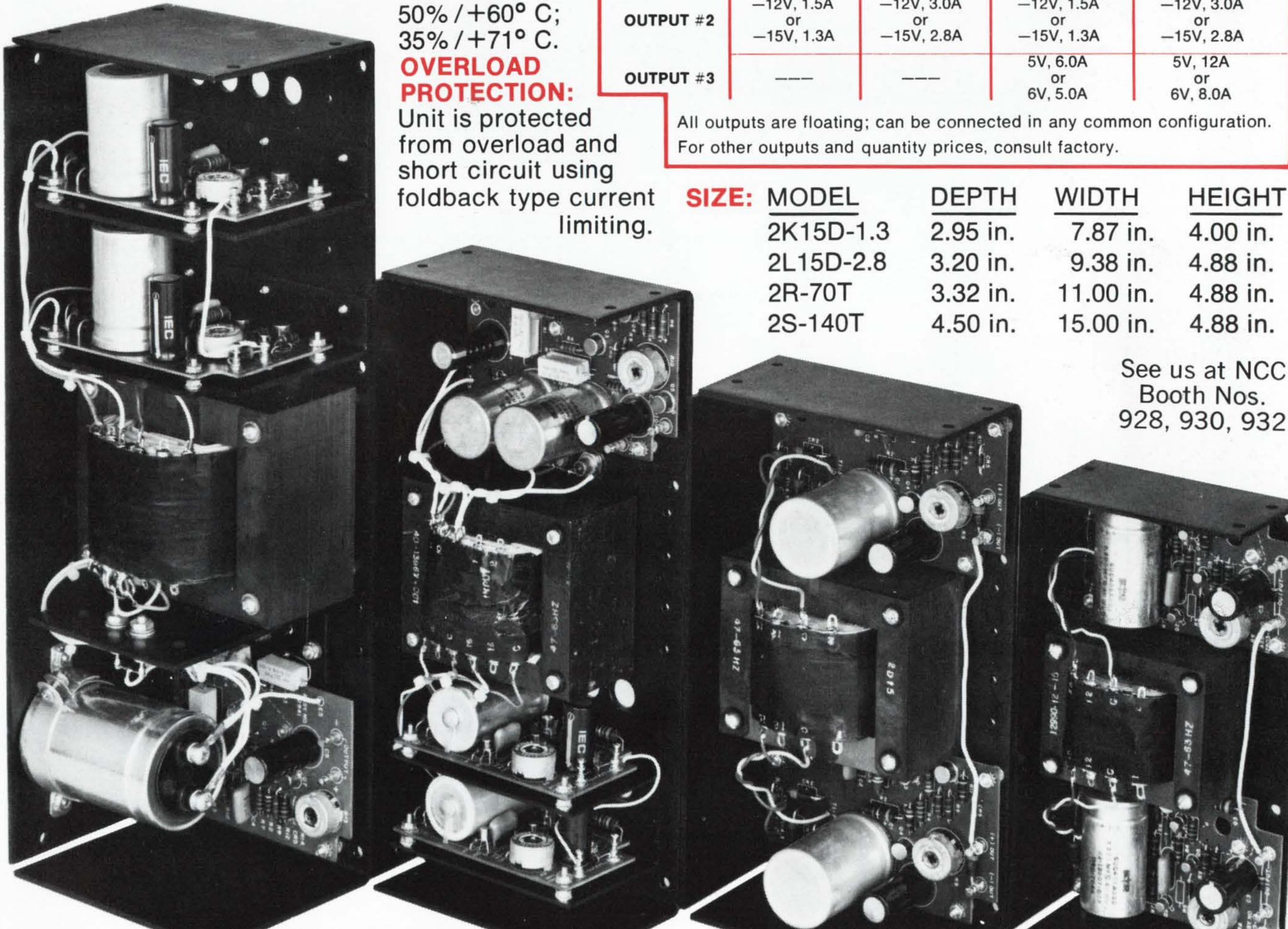

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INFORMATION RETRIEVAL NUMBER 240

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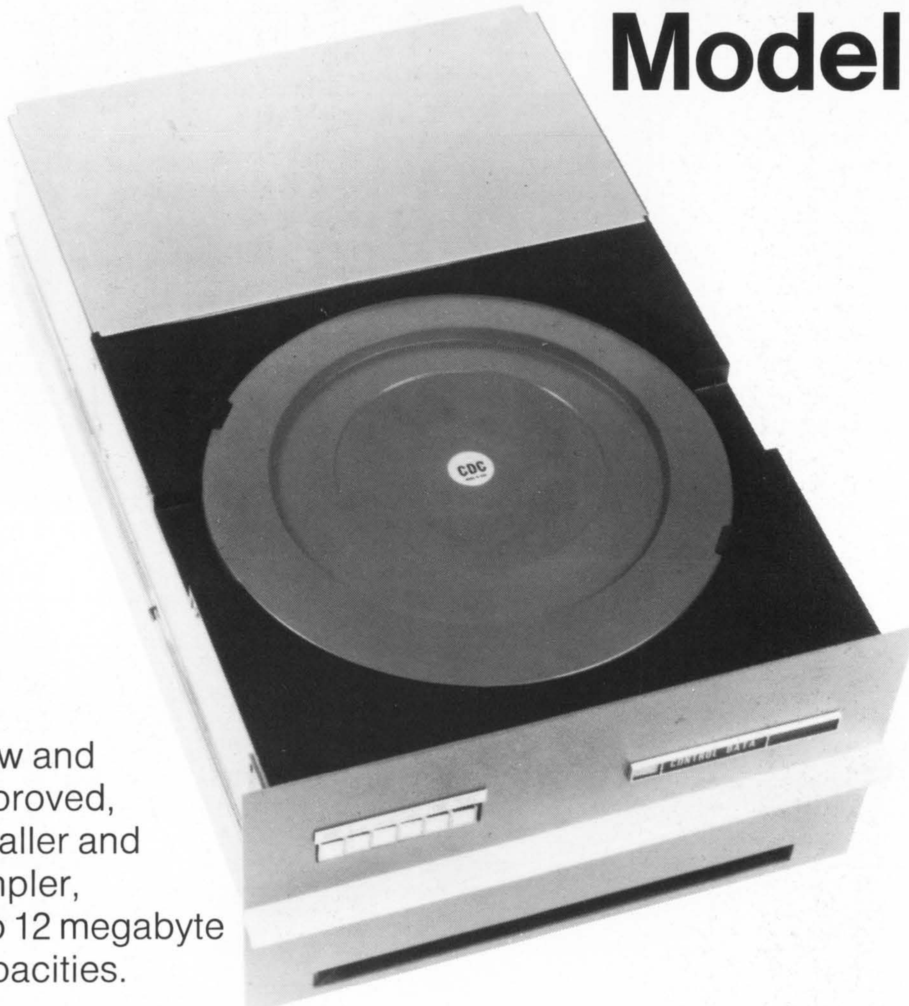

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INFORMATION RETRIEVAL NUMBER 241

Basic microcomputer software: Algorithm for a traffic-light controller illustrates principles that can be used with any MOS/LSI microprocessor.

Last of three articles

How does the basic software for a MOS/LSI microcomputer differ from that for larger computers? Not fundamentally. The differences are in emphasis. With microcomputers, you must give more attention to such things as program size, execution times of critical routines and real-time interactions with peripheral devices.

A traffic-light controller provides a good example of how a microcomputer is programmed for a specific application.

Usually the basic algorithm must be selected first. Then working routines can be identified and common memory specified. A generalized program for coding can be easily adapted to any specific microcomputer.

In the traffic-light controller in Fig. 1, the goal is to feed a maximum number of cars through the intersection in any time period. The maximum duration of a red light for each route represents the primary constraint.

Fig. 2 shows the traffic lights that are visible to cars on each route. The lights are controlled by loading latches, which drive relays inside the traffic-light units. The through-traffic and left-turn parts of the display in Fig. 2a can be set independently to red, yellow or green.

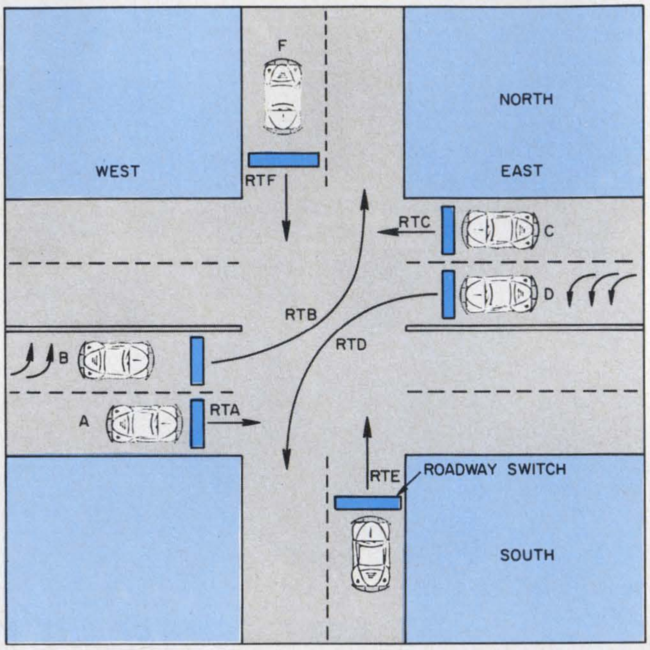
Vehicles that cross switch plates on the roadway actuate switches that can be sampled by the microcomputer. The input port contains six input lines, each of which carries a ONE or ZERO logic signal. Each time an axle passes over a switch plate, the switch toggles and the logic level changes. The logic level is maintained until the next axle toggles the switch.

Assumptions clarify problem

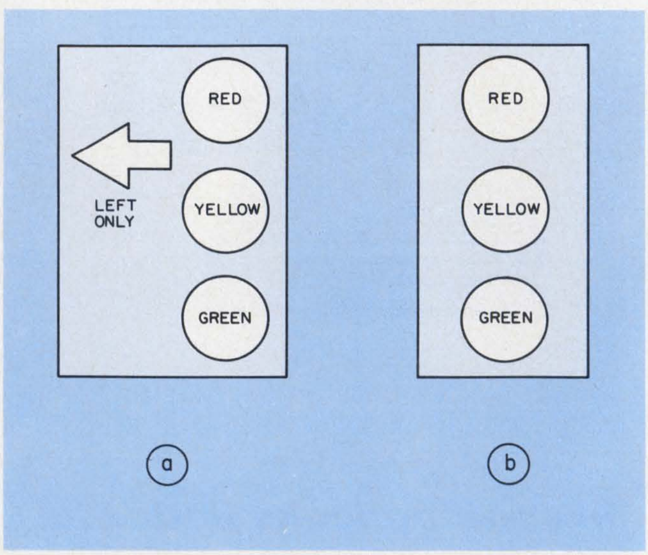
The following six points clarify the design problem:

1. The duration of GREEN signals for each ROUTE must be varied to optimize traffic flow, because traffic varies during the 24-hour day.

C. Dennis Weiss, Ph.D., Member of the Technical Staff, Bell Telephone Laboratories, Holmdel, N.J. 07733.



1. **Traffic-light intersection contains six routes:** four through lanes and two turn lanes. The six roadway switches toggle each time an axle crosses a switch plate in the corresponding route.



2. **Traffic signals under microcomputer control** consist of east-west lights (a) and north-south lights (b). The left-turn signal in east-west lights can be independently set to red, yellow or green.

Since the roadway switches cannot provide information on the length of a queue, the controller algorithm must contain a delay; the number of vehicles crossing a switch during the current GREEN cycle determines the duration of the next GREEN cycle.

2. Two toggles of a switch indicate one car has passed. Vehicles with more than two axles represent, therefore, more than a single car for traffic measurement.

STATES	A	B	C	D	E	F
	ROUTES					
1	0	1	0	1	0	0
2	1	1	0	0	0	0
3	1	0	1	0	0	0
4	0	0	1	1	0	0
5	0	0	0	0	1	1

3. **The five valid STATES for traffic signals.** A numeral 1 entry signifies a ROUTE has GREEN in the corresponding STATE; a zero implies RED.

3. Traffic on a ROUTE should not be measured for the full GREEN cycle. Otherwise an unstable situation would exist. Lengthening the GREEN cycle would let more traffic through. This in turn would require lengthening it still more on the next cycle. Instead use a fixed initial period, BASETIME, during the GREEN cycle of each ROUTE to measure the traffic. Each GREEN cycle must, of course, last a minimum of one BASETIME.

4. The duration of a GREEN for any ROUTE consists of BASETIME plus DELTATIME, both in seconds. To satisfy a MAXREDTIME constraint on the duration of RED for each ROUTE, limit the sum of the DELTATIMES used by all those ROUTES that get GREEN while one ROUTE holds at RED. Also constrain the number of ROUTES that get GREEN while one ROUTE has RED.

5. The only states allowed for the traffic signals are those in which the ROUTES with GREEN cannot interfere with one another. Obviously east-west and north-south lanes cannot be GREEN at the same time. Also ROUTE B and ROUTE C will not be GREEN concurrently. This feature avoids wasted time while cars yield, start and stop.

6. There is enough real time to do the job with a microcomputer. The only possible time-critical task involves a count of toggles of the roadway switches. Assume that vehicles travel at less than 60 mph and that minimum axle spacing is 48 inches. These figures yield a minimum of 45 ms for the time interval between toggles on each ROUTE. Hence a microcomputer is certainly fast enough.

A stable STATE for the intersection is defined by specifying which ROUTES have GREEN; the remainder are RED. Transitions from GREEN to RED occur between stable states.

CONTROL STATE SETS	A	B	C	D	E	F
	ROUTES					
{1,3,5}	1	1	1	1	1	1
{2,4,5}	1	1	1	1	1	1
{2,3,4,5}	2	1	2	1	1	1
{1,2,3,5}	2	2	1	1	1	1
{1,3,4,5}	1	1	2	2	1	1
{1,2,4,5}	1	2	1	2	1	1
{1,3,5}, {5}	1	1	1	1	2	2

4. **Row integers give number of GREEN intervals** for a ROUTE. State sets labeling each row constitute the control sequence for the GREEN intervals.

From point 5, the only stable STATES are those five tabulated in Fig. 3. Note that exactly two ROUTES have GREEN lights in each stable STATE.

Define a valid sequence

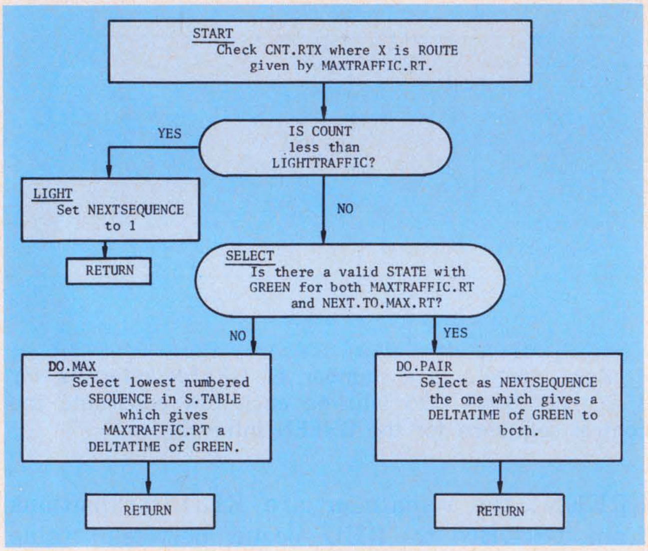
A *valid* sequence of STATES is one in which each ROUTE gets some GREEN time from a cycling of the sequence. Fig. 4, based on Fig. 3, lists sets of states from which valid sequences can be made. Sets {1,3,5} and {2,4,5} are equivalent, minimum "covers" of the table in Fig. 3, or solutions to the classical set-covering problem.[1]

For simplicity, and to satisfy the constraints of point 4, let's establish in advance a repertory of valid SEQUENCES to be used. The ones chosen (Fig. 5) are all those that give a single BASETIME interval of GREEN to each ROUTE and a DELTATIME to exactly two ROUTES or to none.

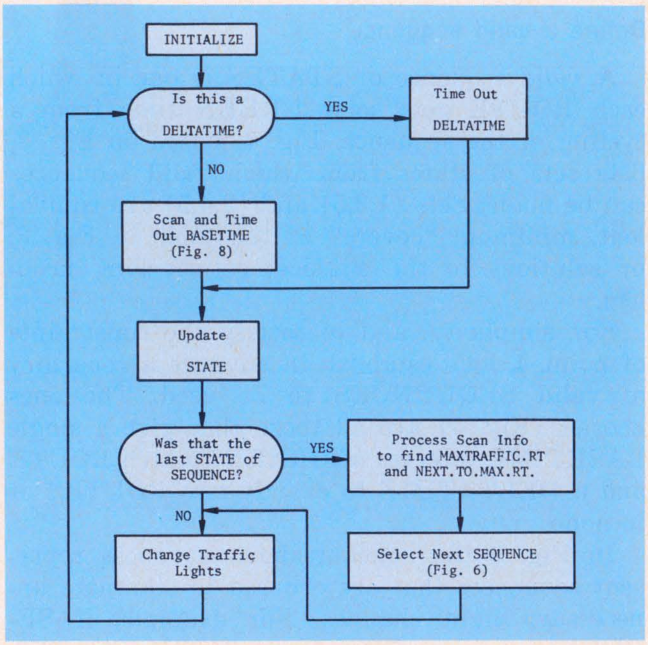
In Fig. 5 the nonequivalent sequences represent sequences that are ordered to eliminate unnecessary light changes. For example, if SEQUENCE3 were changed to STATE1, STATE3, STATE2, STATE5, then ROUTE B would see

SEQ1:	STATE2.	STATE4.	STATE5	
SEQ2:	STATE2.	**STATE3.**	STATE4.	STATE5
SEQ3:	STATE1.	**STATE2.**	STATE3.	STATE5
SEQ4:	STATE1.	STATE3.	**STATE4.**	STATE5
SEQ5:	**STATE1.**	STATE2.	STATE4.	STATE5
SEQ6:	STATE1.	STATE3.	STATE5.	**STATE5**

5. **The ordering of preferred sequences** eliminates unnecessary light changes. STATES shown bold provide DELTATIMES to two ROUTES.



6. **Flow chart selects a SEQUENCE** of traffic-light STATES. Traffic counts for the two ROUTES with most BASETIME traffic determine the selection.



7. **The complete controller algorithm** contains the Select Next SEQUENCE algorithm of Fig. 6.

GREEN, RED, GREEN, RED, resulting in wasted start and stop times. The sequence, STATE2, STATE4, STATE5 is chosen over a sequence based on {1,3,5} so that both east-bound or west-bound lanes will move together.

The algorithm that selects a new SEQUENCE from Fig. 5, based on traffic during BASETIMES of the previous SEQUENCE, appears in Fig. 6. The alogrithm allocates DELTATIMES of GREEN to the two busiest ROUTES, if possible. If this is not possible, it favors the busiest ROUTE in conjunction with a through ROUTE. Also, if traffic is light—the busiest ROUTE has less than a preset threshold—no DELTATIME is allocated, since this would not result in greater vehicle throughput but only in longer RED times.

The value for BASETIME is normally given, while the choice of DELTATIME must satisfy the MAXREDTIME constraint. From the given BASETIME and an analysis of all possible pairs of SEQUENCES in Fig. 5, you can easily solve for the maximum allowed DELTATIME. Express the resulting RED time for each ROUTE in the form N_1 DELTATIME + N_2 BASETIME. N_1 is the number of DELTATIMES that occur during the RED time, and N_2 is the number of BASETIMES.

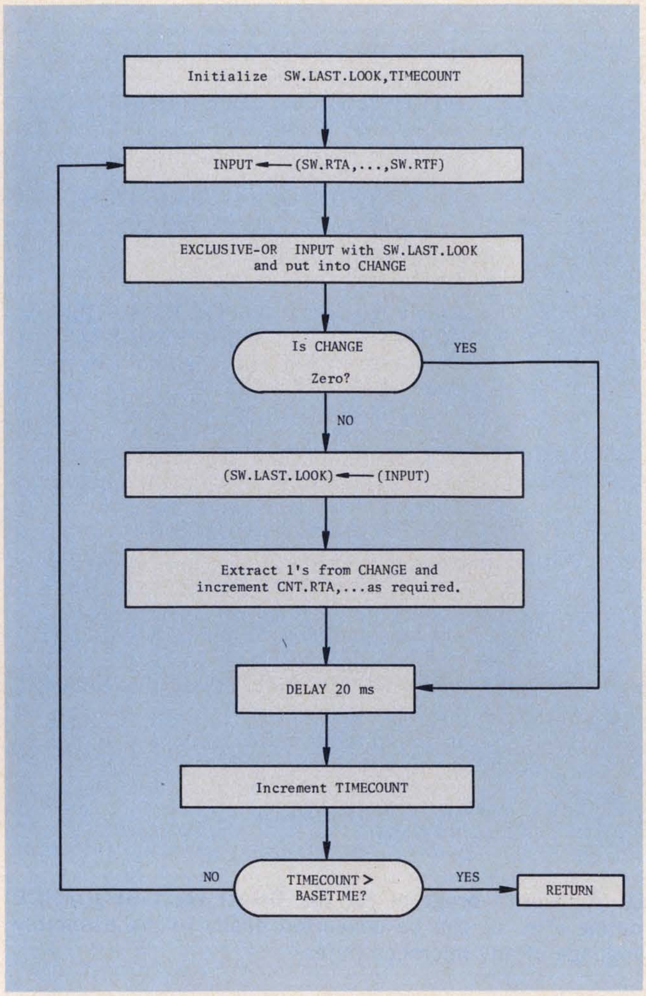
The entire controller algorithm is given by the flow chart in Fig. 7, which incorporates the basic Select Next SEQUENCE algorithm of Fig. 6. If the state of the intersection provides DELTATIME, then you simply create that delay with a program loop. Otherwise scan the toggle switches to count toggles and thus measure the traffic during the BASETIME.

When the current STATE is completed, the STATE must be changed to the next one in the current SEQUENCE. This changes the traffic lights. If the SEQUENCE is completed, a new one must be selected before a return to the start of the major loop.

The working routines

It is now possible to identify the routines to make the controller algorithm work. There are six principal ones:

1. Initialize:
   - Select a starting SEQUENCE, SEQ1.
   - Set all traffic counts to zero.
   - Set other pointers and counters to zero.
2. Time Out:
   - Do a loop of NOPS (do nothing but count) for a DELTATIME period.
3. Scan and Time Out (see Fig. 8):
   - Scan toggle switches every 20 ms, and count the 20-ms intervals until the BASETIME has been spent.
   - Update toggle counts for each ROUTE



8. **Scan and Time Out routine,** one of the working routines, is outlined in this flow chart.

```
S.TABLE.POINTER          X
     /An address in the S.TABLE whose content
     is the current STATE in the current
     SEQUENCE/
CNT.RTA                  X
CNT.RTB                  X
CNT.RTC                  X
CNT.RTD                  X
CNT.RTE                  X
CNT.RTF                  X
     /Counts of number of toggles (of switch in
     that ROUTE) since last initialization/
SW.LAST.LOOK             X
     /Last toggle positions read for all toggle
     switches/
TIMECOUNT                X
     /Location incremented once every 20 ms
     until BASETIME exceeded. More than 8 bits
     required/
LASTSTATE                X
THISSTATE                X
MAXTRAFFIC.RT            X
NEXT.TO.MAX.RT           X
     /X = 1,2,4,8,16,32 for RTA , . . . , RTF/
NEXTSEQUENCE             X
     /X = 1,2,3,4 or 5/
```

9. **Some common memory locations** and content description. Data format for each memory location X must be specified throughout.

```
S.TABLE1     2  /2 means use STATE2/
             4
             5
END1         0
S.TABLE2     2
           203  /Use STATE3 as a DELTATIME
                state/
             4
             5
END2         0
    |
    |
    |
    /The SEQUENCE TABLE contains octal num-
    bers defining the sequences of STATES in
    each SEQUENCE. A "1" in the left-most bit
    flags that STATE as the DELTATIME STATE
    for that SEQUENCE/
STATES      12
             3
             5
            14
            60
    /Five octal data words for STATES 1 through
    5 defining pairs of ROUTES which can be
    GREEN together.
    FORMAT of 8-bit word:
    0 0 RTF RTE RTD RTC RTB RTA/
```

10. **Two required constant-data tables.** These can be stored conveniently in read-only memory.

as required.

4. Process Scan Information:
   - Use toggle counts for the just completed SEQUENCE to determine the busiest ROUTES, MAX.TRAFFIC.RT and NEXT.TO.MAX.RT, as required in Fig. 6.
   - Initialize route counts CNT.RTA,...and CNT.RTF to zero.
5. Select Next SEQUENCE (Fig. 6).
6. Change Traffic Lights:
   - Use LASTSTATE and THISSTATE to determine the required traffic-light control signals. Create the required GREEN-to-YELLOW-to-RED and RED-to-GREEN transitions.

Note that routines 2 and 3 create real time delays with instruction loops. The much shorter execution times outside these major delay loops—which vary from one pass to another—can be neglected in comparison.

Plan memory and register use

Some of the common storage locations are labeled and described in Fig. 9. These may be memory locations or registers, depending on the number of registers available in the microcomputer. Each of these locations is used by more than one working routine.

Two fixed-data tables, shown with labels and memory contents in Fig. 10, could appear in

```
START      ■ Get MAXTRAFFIC.RT and shift word
             until a 1 is found.
             Bit1=1→RTA ,..., Bit6=1→RFT.
             Let RTX be found.
           ■ Compare (CNT.RTX) against the con-
             stant (LIGHTTRAFFIC).
               If (CNT.RTX) is less, go to LIGHT.
                  Otherwise, go to SELECT.
LIGHT      ■ (NEXTSEQUENCE)←1
           ■ RETURN
SELECT     ■ Compute (MAXTRAFFIC.RT)U(NEXT.
             TO.MAX.RT) and store in MAXPAIR.
           ■ Compare MAXPAIR against every
             data word in STATES table (Fig. 10).
               If match found, go to DO.PAIR.
               If no match, go to DO.MAX
  /NOTE:     If a match occurs, let I be the line
             in STATES table at which it occurs.
             Then STATEI will give the DELTA-
             TIME to the two ROUTES./
DO.PAIR    ■ Search S.TABLE2, . . . until a byte is
             found with bit8=1 and low order
             7 bits match line I of STATES table.
             Let this byte be found in S.TABLEJ.
           ■ (NEXTSEQUENCE)←J
           ■ RETURN
DO.MAX     ■ Search S.TABLE2, . . . until a byte
             is found with bit8=1 and a 1 in the
             same position as in MAXTRAFFIC.RT.
             Let this byte be found in S.TABLEK.
           ■ (NEXTSEQUENCE)←K
           ■ RETURN
```

11. A "word" program for the Select Next SEQUENCE routine (Fig. 6) can be converted easily to the assembly language of any microcomputer.

ROM. S.TABLE defines the SEQUENCES chosen in Fig. 5. STATES represents the information in Fig. 3 used by the Select Next SEQUENCE routine. If the S.TABLE.POINTER is an 8-bit storage location, the S.TABLE of Fig. 10 should be positioned to fall on a single 256-word page. In this way only the 8-bit pointer has to be incremented to sequence through the STATES. This approach is usually efficient with 8-bit microcomputers.

Instead of a detailed instruction sequence for a particular microcomputer, Fig. 11 shows a general "word" program for the Select Next SEQUENCE routine. The flow chart for the routine is in Fig. 6, which also contains the program labels. The word program can be converted easily to the assembly language of any microcomputer. ■■

Reference:

1. McCluskey, E. J., "Introduction to the Theory of Switching Circuits," McGraw-Hill, New York, 1965. (see Prime Implicant Tables)

The first article in the series discussed instruction sets and appeared in the April 1 issue. The second article, in the April 12, issue, dealt with microcomputer coding.

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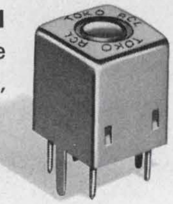

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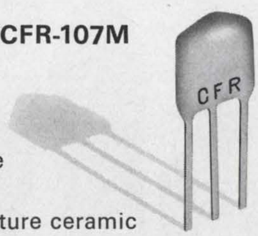

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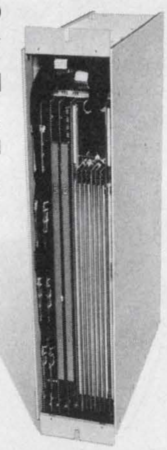

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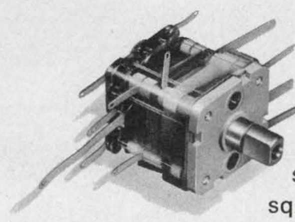
Polyethylene Capacitor



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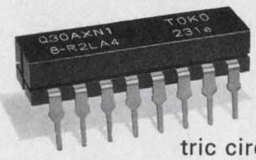
Pulse Transformer Dual In-Line



IC circuits are currently replacing all other electric circuits. There is also an increasing demand to combine active as well as activated elements into identical IC packages. In particular, the Dual In-Line Package (DIP) is gradually becoming the standard for IC packages. Used in electronic computers and other electronic machinery.

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INFORMATION RETRIEVAL NUMBER 67

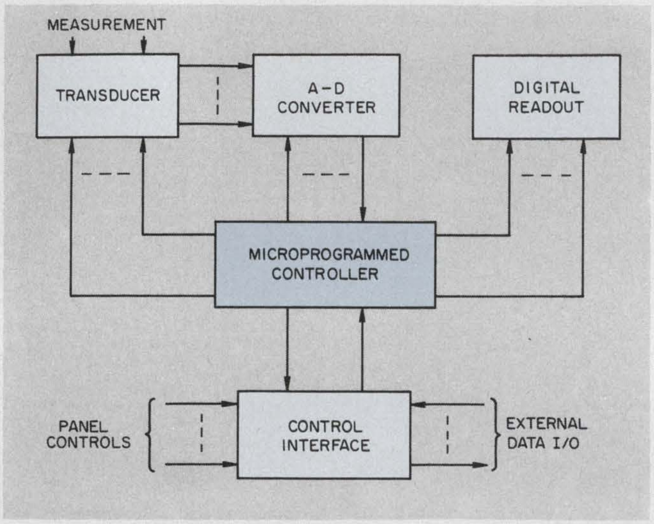
Microprocessor ICs improve instruments.

With the newer designs, an increasing variety of test functions can be provided by software and additional memory.

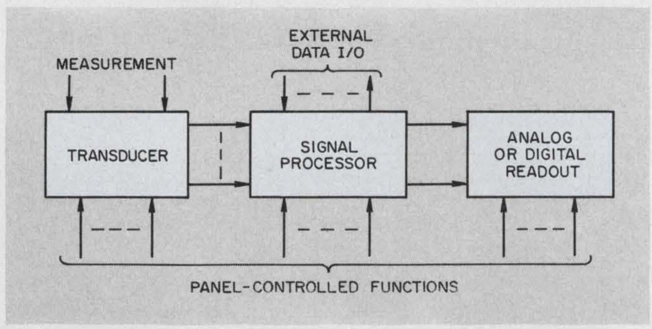
It's a whole new—and better—ball game for instrument designers, now that microprocessors are available. Their application makes practical a different organization of instrument circuitry (Fig. 1). Here the microprocessor has a central and dominant role in data-transfer operations. As a result, the digital processor performs any required signal averaging, shaping or other linear or nonlinear operations to deliver the desired type of information.

In fact, use of microprocessors allows virtually any digital transformation, and at fairly low incremental cost for additional memory. And the instrument transducer—or analog "front end"—need not perform any signal processing beyond the minimum of conditioning required for interface with the a/d converter. Without the availability of microprocessors, such digital processing would be too costly.

Heretofore most digital-readout instruments have used analog, rather than digital, signal-processing. The only digital circuits needed for these instruments were code converters and readout drivers (Fig. 2). The reason was simple: Until recently analog operations were less expensive than digital, and few instrument designers were skilled in digital-circuit design beyond counting and summing circuits.



1. **A microprocessor, functioning as a microprogrammed controller,** allows the economical use of digital techniques for the required operations.



2. **Traditional instrument designs use analog signal-processing** techniques to obtain readouts of measured values. Such techniques used to be cheaper.

An end to interface confusion

In a traditional analog instrument, a microprocessor would offer few obvious advantages. Most newer instruments, however, have some, or all, of these characteristics: digital readout of data, external programmability and external data outputs. But these characteristics are interrelated, and they imply the basic functions of digital data transfer—a hitherto neglected area of instrument design.

Primarily because of this neglect, there are a bewildering variety of interfaces in instrumentation today. Older designs have emphasized the transducer functions and minimized data-processing capability. Output and input data formatting have been sacrificed for measurement-function design.

With the microprocessor as the instrument controller, this picture changes. In most applications a standardized interface, based on a character-serial data transfer using ASCII code, re-

Richard Lee, Head of Development Engineering, Boonton Electronics Corp., Route 287 at Smith Road, Parsippany, N. J. 07054.

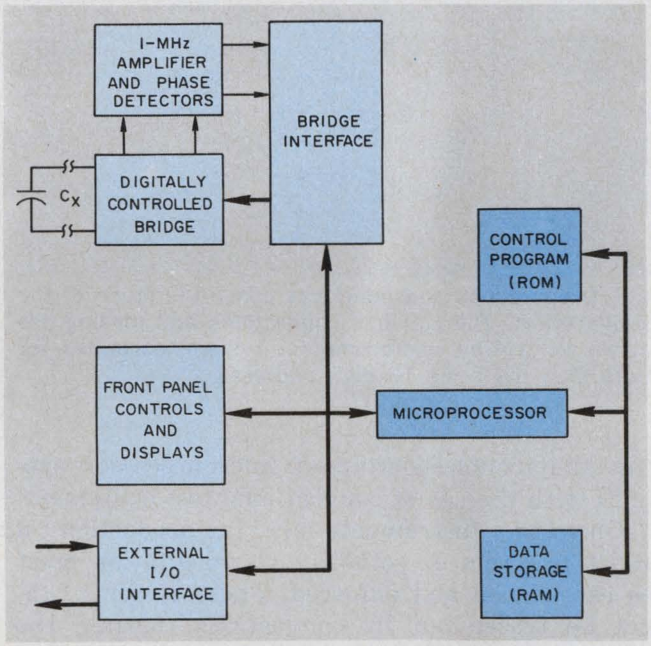
sults in minimum hardware costs. And this standardization of the interface requirements reduces instrument software development costs.

Moreover the data and control interface logic for a diverse range of instruments can use the same basic hardware. Hence the manufacturer can develop new types of instruments at minimum cost and also cut component and assembly costs. Also, because microprocessors substantially reduce the parts count, reliability increases.

Further, the use of more common hardware among various instruments makes maintenance easier; no longer is it necessary to unravel the design of each new instrument before it can be calibrated or repaired.

The programmability of microprocessors allows inclusion within the instrument of diagnostic aids for troubleshooting and self-checking. More generally, programmability simplifies tailoring for the user of instrument function and interface characteristics. As things stand now, the manufacturer has very limited ability to make custom changes unless a quantity order is involved.

Finally microprogrammed instruments, because of adaptability through software, promise to resist obsolescence longer than conventionally designed instruments. Control programs may be changed in the field to update and improve the performance of microprogrammed instruments.



3. **A 1-MHz automatic capacitance bridge** uses a microprocessor to transform measured capacitance and conductance into various quantities useful to the designer.

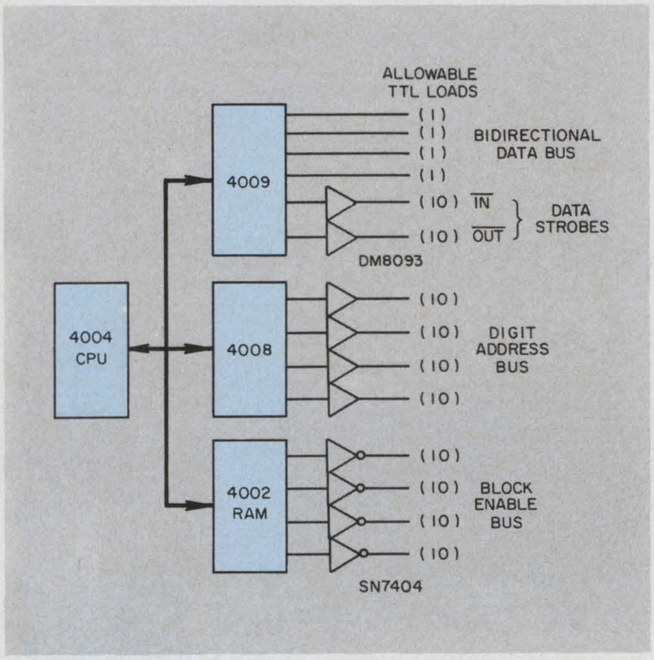
But there are problems, too

Some words of caution, however: The programming of microprocessors differs greatly from the operations encountered in conventional logic design. Few designers are familiar with machine or assembly-language programming; a significant amount of design time can be eaten up during the learning period.

Accordingly, users should note the range of software aids available with a microprocessor in any evaluation of competitive circuits. Need for extensive software development would preclude the use of time-consuming machine-language programming. Hence a minimum requirement consists of an assembly-language program to translate symbolic programs into actual machine language. The availability of a higher-level language would help reduce program costs further. But at present few vendors have such a package available.

Writing programs is only part of the problem. These programs must also be tested and corrected before they are stored in production instruments. A simulator program can test the bulk of the programming, but there is no practical substitute for actual system performance tests. At this stage of the design, the use of programmable ROMs for control memory allows a short turnaround time for the inevitable changes that will be required.

A range of new test equipment must be available to test and repair microprocessor systems effectively. The use of data multiplexing simplifies the design and minimizes interconnections. But at the same time multiplexing makes diffi-



4. **I/O operations and interfaces** constitute much of the design effort. The I/O bus connections and loading are shown for a 4-bit microcomputer system, expanded for more than the basic 16-digit addresses.

cult the troubleshooting of microprocessor systems with the use of conventional test equipment.

Once the instruments are in production, a strict program of software documentation must be established and enforced. These systems cannot be traced out by conventional means; the program listing is just as important as the schematics that describe the hardware. Failure to maintain the software information makes subsequent troubleshooting extremely difficult and can even nullify many of the advantages of using software.

Example: an automatic capacitance bridge

A 1-MHz automatic capacitance bridge—the Model 76A from Boonton Electronics—provides a design example of an instrument using a microprocessor for control functions (Fig. 3). A convenient control organization for the bridge consists of a 4-bit data bus and a 4-bit address bus. The microprocessor system selected—Intel's 4-bit MCS-4 system—can readily handle such an organization.

Any design using microprocessors should begin with a demonstration of a functioning control unit. The demonstration unit involves a complete prototyping PC card containing a working microprocessor system—a SIM4-01 microcomputer card, in this case. The microcomputer card interfaces the prototype bridge with LED-numeric test readouts.

A complete demonstration unit should also include manually operated pROM-programming circuitry. With this the user can load programs for the system. Once a complete demonstration unit has been obtained, the control program can be written directly in machine language to prove the feasibility of the microprocessor control.

Further software development involves additional hardware: A Teletype-based program assembler and pROM-programming system—put together with programs and modules from the vendor—help simplify program development. The system reads paper tape containing assembly-language programs and translates them into machine-language programs, also on paper tape. The latter tape can be reread to program the control pROMs.

I/O considerations are important

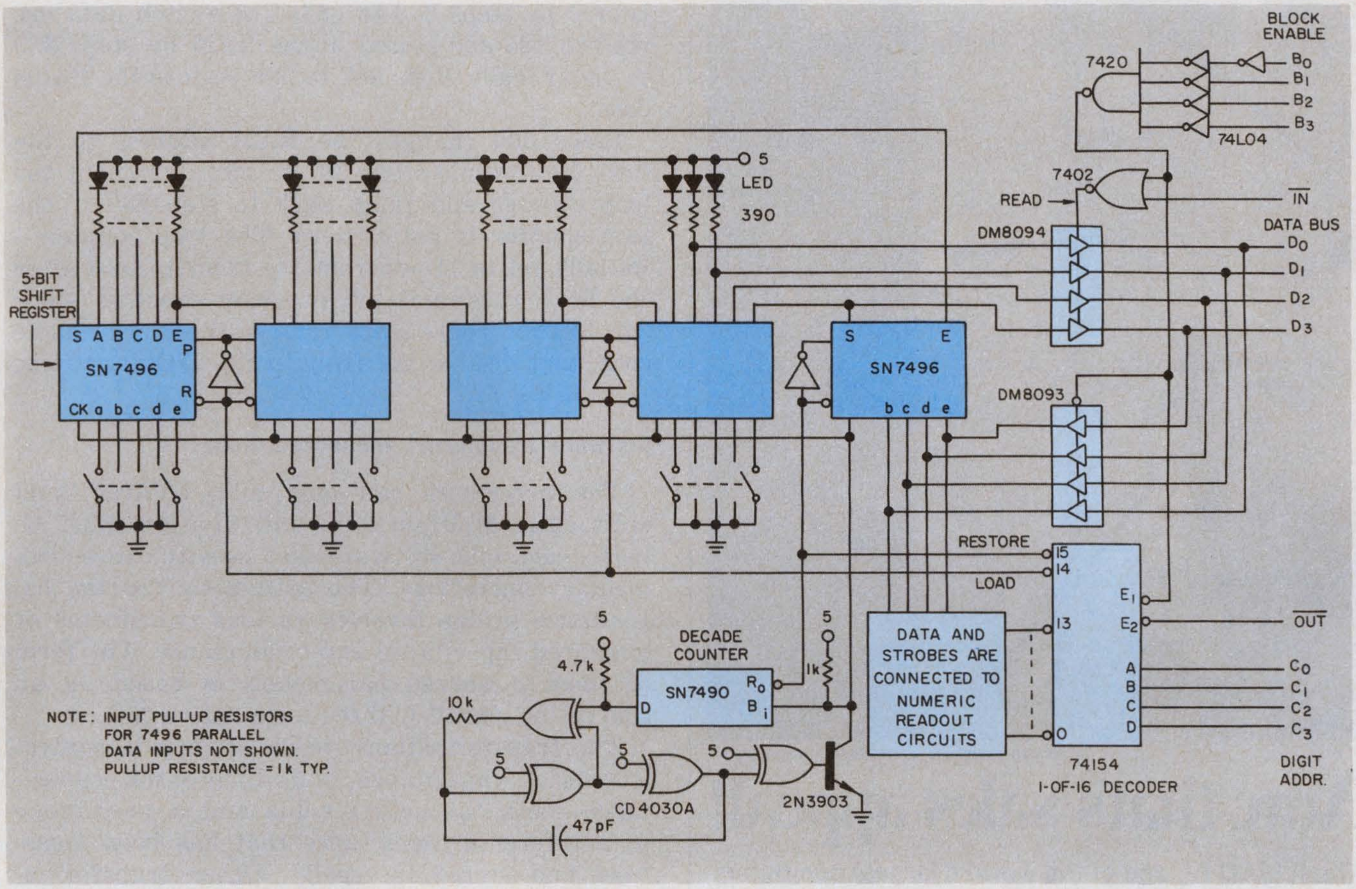
Applications literature tends to emphasize operations internal to the microprocessor itself, with little attention to the problems of getting data into and out of the processor. But the user soon discovers that input/output operations and interfaces constitute the bulk of the circuit design effort, as well as a considerable part of the programming. Design decisions must take into account the programming involved, and the subtle tradeoffs can become fairly involved.

For example, the MCS-4 family includes two devices that provide pROM and input/output interfacing: the 4008 and 4009 ICs. These circuits activate a bidirectional, 4-bit data bus, a 4-bit address bus and read and write strobes in response to RDR (read ROM port) and WRR (write ROM port) commands (Fig. 4). The interface signals are all TTL-compatible and can drive at least one standard load.

When the available 16-digit addresses prove insufficient, a 4-bit block address bus can be generated by use of one of the RAM output ports (RAM-0). But software must be written to make the circuitry work.

Let's examine how the I/O bus interfaces with the front panel-control pushbuttons. The switch circuitry has two functions: First, it logically senses the switch closures. Second, it provides switch-status information by lighting a corresponding LED indicator when a switch closure is read and accepted by the microprocessor. Since 18 status indicators and 20 switches are involved, the design combines the switch-reading and indicator-data storage functions in a shift register. The schematic for this circuit block appears in Fig. 5.

Switch data are transferred in parallel to the



5. **The functions of the switch circuitry** include the sensing of switch closures in an addressable format. Also, the circuitry must provide switch-status information conveyed through a LED indicator.

switch register by pulsing the LOAD line. At this point switch-closure information replaces the status information. The end 4 bits of switch data transfer to the data bus with a pulsing of the READ line. The status information can be replaced by a pulsing of the RESTORE line while the required information is presented on the data bus.

The RESTORE line triggers a gated clock that generates four clock pulses to shift the data along the register. The clock pulses also position the next 4 bits of switch data for reading. The READ and RESTORE operations repeat for a total of five operations each—sufficient to read in 20 data bits.

```
PGM    INST     MNEMONIC
ADDR   CODE     INSTRUCTION                   COMMENTS

0370   209          LDM 1        /LOAD 1 TO ACC; BLOCK ENABLE FOR PANEL
0371   081          JMS BLE      /JUMP TO SR AND WRITE 1 TO RAM PORT 0
       000
0373   046          FIM 14 96    /INIT. REG 14,15 TO ADDRESS DIGIT 0
       096
0375   044          FIM 12 235   /INIT. REG 12 = 14 FOR WRR, REG 13 = 11
       235
0377   045          SRC 12       /PREPARE FOR WRR WITH DIGIT ADDR. = 14
0378   226          WRR          /CREATE SWITCH LOAD PULSE
0379   108          INC 12       /INCREMENT REG 12 FROM 14 TO 15
0380   047     SWL, SRC 14       /PREPARE TO READ DIGIT FROM RAM
0381   233          RDM          /READ DIGIT (STATUS DATA) TO ACC.
0382   244          CMA          /COMPLEMENT; LAMP ON FOR LOGIC ZERO
0383   176          XCH 0        /SAVE TEMPORARILY IN REG 0
0384   234          RDR          /READ SWITCH DATA
0385   244          CMA          /COMPLEMENT; SWITCH CLOSURE = LOGIC 0
0386   224          WRM          /WRITE SWITCH DATA IN PLACE OF STATUS
0387   160          LD 0         /GET STATUS DATA FROM REG 0
0388   045          SRC 12       /PREPARE TO RESTORE STATUS INDICATION
0389   226          WRR          /RESTORE STATUS AND SHIFT 4 PLACES
0390   111          INC 15       /CHANGE RAM ADDRESS TO NEXT DIGIT
0391   125          ISZ 13 SWL   /INCR. REG 13; JUMP TO SWL IF NOT 0
       124
0393   223          LDM 15       /LOAD 15 TO ACCUMULATOR
0394   081          JMS BLE      /JUMP TO SR AND WRITE 15 TO RAM PORT 0
       000


0256   032     BLE, FIM 0 0      /ADDRESS RAM 0
       000
0258   033          SRC 0        /SEND ADDRESS TO RAM
0259   225          WMP          /WRITE BLOCK ENABLE CODE
0260   192          BBL 0        /RETURN TO CALLING POINT
```

6. **Software for I/O operations and interfacing** is provided in this listing.

Program executes I/O operations

A listing of the programs required for these operations appears in Fig. 6. Five digit positions in a RAM register store the existing switch-status information. Program steps 370 to 372 write the proper block access word to enable the panel I/O functions. Steps 373 and 374 initiate two register pairs in the CPU unit for the desired RAM and I/O addresses. They also preset a loop counter (Index Register 13).

Steps 377 and 378 perform the LOAD operation for the switch circuitry when the WRR pulse is decoded out of line 14. Step 379 addresses line 15 for subsequent I/O operations. Steps 380 to 392 perform the READ and RESTORE operations. The first 4 bits of status information are fetched from the RAM and placed in Index Register 0 by steps 380 to 383. The switch data are read in 384 and stored in the RAM by steps 385 to 386. Finally steps 387 to 389 restore the status data.

Steps 390 changes the RAM address to the next digit, while steps 391 to 392 increment the loop counter and jump back to step 380 if the loop counter is not at zero. The loop counter—initially set to 11—increments from 15 to 0 after the fifth pass, and the program executes steps 393 to 395. These steps remove the block enable code, and disable the front panel I/O functions.

Software transforms measured data

The processors can only add, subtract and shift data. Multiplication and division must be performed with software that uses the three elementary operations. The arithmetic for the capacitance bridge involves various transforms of measured capacitance and conductance. The form of these measured parameters is based on an equivalent, parallel, three-terminal circuit.

The transformations provided include equivalent-series capacitance and differential capacitance—both the actual value and a percentage of a reference capacitance that has been measured and stored internally. Other transformations consist of equivalent-parallel resistance, equivalent-series resistance, dissipation and Q.

The value of the reference capacitor is stored internally on command of front-panel controls. The percentage differential capacitance can be used to sort capacitors into tolerance bands or perform temperature coefficient tests.

The selected information appears on two panel displays. Alternate readout modes can be displayed since the instrument retains the original balance data between tests.

Accuracy vs speed: a major tradeoff

Generally a tradeoff of calculation accuracy against calculation time is the major constraint for microprocessor users. Multiplication or division by repeated add or subtract and shift resembles a matrix operation. Hence the time required tends to increase as the square of the number of digits.

This relationship forces designers to define their requirements carefully to optimize performance. A useful technique uses truncated products and quotients when possible, thus avoiding unneeded resolution in calculation results. Software support from vendors—limited at present—can be expected to prove helpful as application libraries stockpile more programs for common arithmetic operations. ■■

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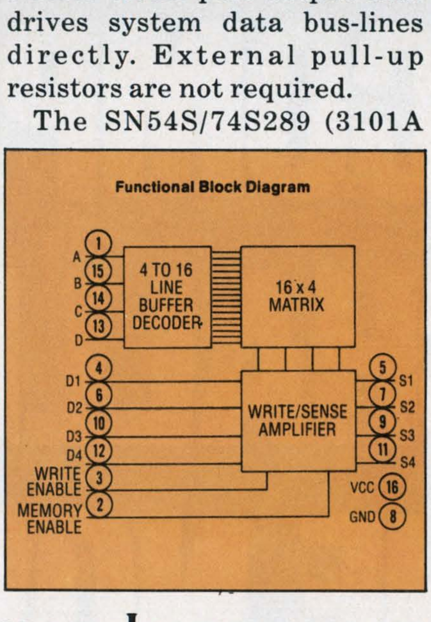
The SN54S/74S189 has a 3-state totem pole output that drives system data bus-lines directly. External pull-up resistors are not required.

The SN54S/74S289 (3101A equivalent) has an open-collector output to use whenever data-bus line impedances are defined by other sources. Both have PNP inputs biased for standard 54S/74S threshold levels.



But the best is price. Both the SN74S189N and SN74S289N are only $4.24 in the 100-piece quantity. At under 7¢/bit, that's less than other 64-bit Schottky RAMs now on the market.

For data sheets, indicate by type number and write: Texas Instruments Incorporated, P. O. Box 5012, M/S 308, Dallas, Texas 75222.

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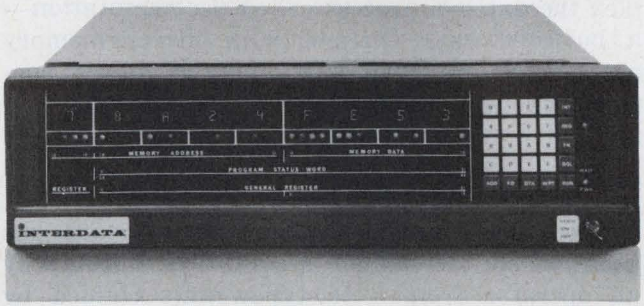

Performance	7/16	Nova 2/4	PDP-11/05
Data word length (bits)	4, 8, 16	16	1, 8, 16
Instruction word length (bits)	16, 32	16	16, 32, 48
General-purpose registers	16	4	8
Hardware index registers	15	2	8
Maximum memory available (K-bytes)	64	64	64
Directly addressable memory (K-bytes)	64	2	64
Automatic interrupt vectoring	Standard	Not available	Standard
Parity	Optional	Not available	Special order
Cycle time (usec.)	1.0 or 0.75	1.0 or 0.8	0.9
Available I/O slots	4	2	2

Price	7/16	Nova 2/4	PDP-11/05
8 KB processor 16 KB processor 32 KB processor	$3,200 3,700 5,300	$3,200 3,700 5,300	$4,795 6,495 10,895
Multiply/Divide option	$950	$1,600	$1,800
Floating Point option	$4,900	$4,000 plus $1,000 for 2/10 configuration	Not available

Source: Data General Price List, Copyright 1973, and addendum dated 5/15/73. Nova 2/4 bulletin 012-000060, 1973. DEC OEM & Product Services Catalog, 1972. Auerbach Minicomputer Characteristic Digest, June, 1973. "How to use Nova Computers", 1973.

Minicomputer myths you can live without:

1. There is no such thing as a high-performance, low-cost minicomputer.

2. You have to choose between two extremes – pay a ton for a machine like the PDP-11 and save on software costs, or buy a cheapie like the Nova 2 and pay the price later.

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It's completely modular in design – plug-in options can be installed in the field to meet your specific application requirements.

Options like multiply/divide, programmers' console with hexidecimal display, power fail/auto restart, memory protect and a high-speed Arithmetic Logic Unit that includes floating point hardware. In fact, you can expand the low-cost 7/16 all the way up to the 32-bit Interdata 7/32.

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Hitch your telemetry system to a mini.

For modest cost, you get high data rates, real-time conversion to engineering units and tape output in standard formats.

Combine a minicomputer and a peripheral to demultiplex data, and you have a reasonably priced integrated system that can handle millions of telemetry data points a day at megabaud rates. Today's test programs call for such capacity.

You could use a large-scale digital computer to do the same job. But the odds are against it. Such a computer requires an expensive interface to format the data, costly software and more time than a minicomputer to do such workhorse tasks as channel identification, data blocking and checks on channel status.

The mini system can handle data in the following ways:

- Raw telemetry data can be buffered into block form and outputted to magnetic tape with appropriate headings and gaps for processing by a data-reduction facility.
- Independent data sources can be correlated and merged before the mini puts out the final tapes.
- The mini can convert raw data collected from sensors to engineering units prior to formatting or make the data available for a quick look.

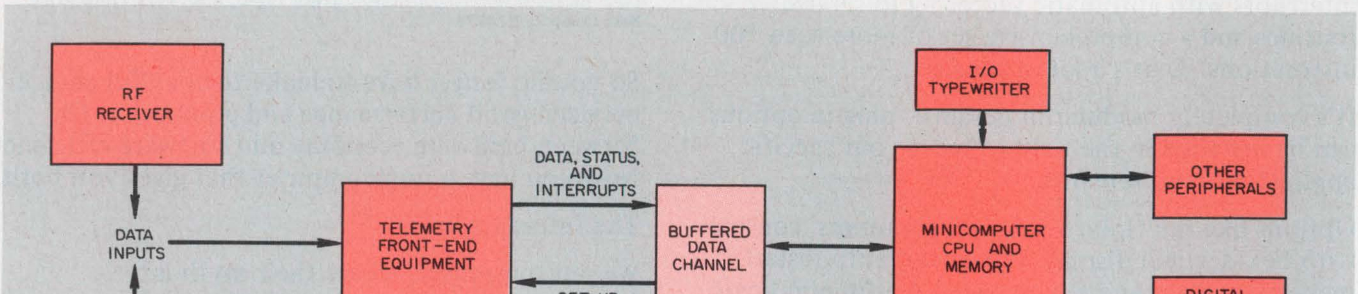
Dave Colin, Senior Engineer, EMR Telemetry, P.O. Box 3041, Sarasota, Fla. 33578.

The basic components of such a system (Fig. 1) include the front-end peripheral to demultiplex the data—a process called decommutation—a buffered data channel with direct memory access, the minicomputer and the mini's conventional peripherals.

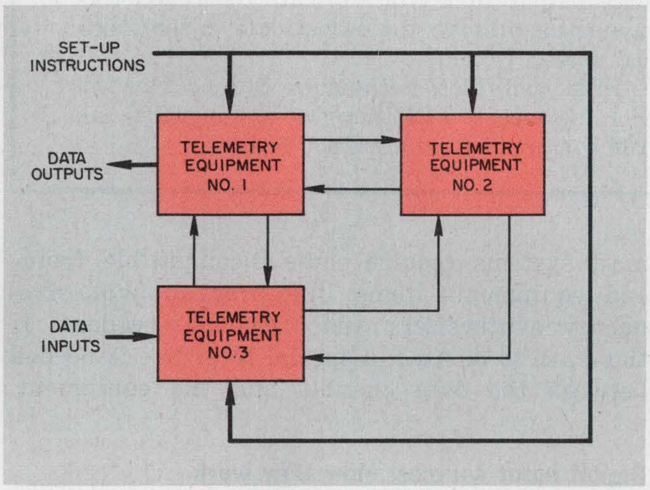
Operator controls startup

For most operations, once the software has been loaded, the system is controlled initially by an operator from a teletypewriter. Guided by the computer, the teletypewriter asks the operator to define the telemetry front-end data links that will be required, and the operator responds with the information. The teletypewriter then asks for equipment setup information. The operator may have the option of typing in each piece of information, as requested, or of directing the system to read this information from a paper tape, disc or card deck.

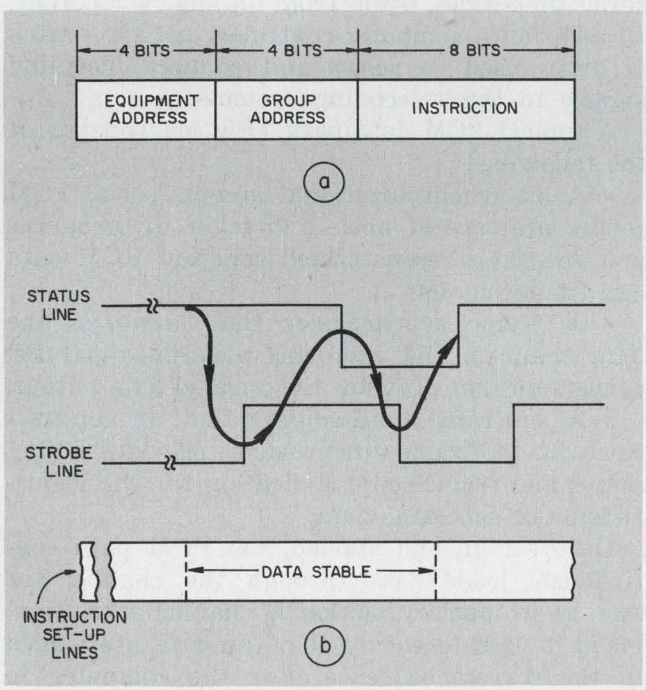
Once the system has been set up and a data run started, the telemetry equipment dumps data continuously into memory blocks. The computer reads these blocks continuously, manipulates the information and outputs the formatted data to the magnetic tape unit or units.



1. **Raw telemetry data are buffered** and converted to block form for processing by the computer. External interrupts force the computer to exchange control between program routines.



2. **Telemetry systems often have** multiple devices that require computer setup. However, a single output channel is typical.



3. **Telemetry control words** (a) specify device address, type of instruction and the value associated with the instruction. For an FM path, the group address could signify center frequency deviation and the last eight bits the value. The status and strobe lines (b) control the transfer of information.

As shown in Fig. 1, there are interrupts along with data and status inputs. The interrupts are signals that force the computer to change from one program or routine to another. Consider the case of formatting the output tapes into spaced blocks of information. When the buffered data channel has completed a block transfer, it sends an interrupt signal to the computer. This signal directs the computer to call up the routine that puts the correct header and gap on the tape before the machine starts to output the next block of information.

Telemetry equipment must accept control information from a computer data channel and respond by transmitting the required data. The computer often must control many pieces of telemetry hardware but receive data from only one. Thus it is convenient to connect the control inputs to the equipment in parallel on a single data-channel output port (Fig. 2).

The control information lines normally contain several lines, or bits, of setup information; a strobe line to load the information, and another line that accepts and acknowledges the data.

Fig. 3a shows typical 16-bit setup information. The first four bits represent the address of the equipment to be controlled. The address is usually defined via jumper wires in the telemetry equipment. The next four bits—the group address—define the type of instruction. In the case of an FM data path, the group address may signify that a particular instruction represents the center frequency, deviation or a similar parameter. The last eight bits are the data associated with any parameter defined by the group address.

A timing diagram (Fig. 3b) shows the loading cycle for the telemetry equipment addressed. The status line indicates to the data channel whether the equipment is ready to accept information. If the data channel has stable information to send, it changes the level of the strobe line. The addressed equipment then responds by forcing the status line low. This acknowledges receipt of the information and also indicates that the strobe pulse is no longer needed. The status line then stays low, inhibiting further strobes until the equipment is ready to receive new data.

Two major telemetry techniques

There are two major telemetry techniques: (1) frequency-division multiplex (FDM), and (2) time-division multiplex (TDM).

In FDM each data channel modulates a separate subcarrier oscillator. The oscillator outputs are mixed or summed to form a composite signal. FDM systems are usually frequency-modulated and structured to be proportional or constant bandwidth. For a proportional system, each oscillator is modulated a fixed percentage for full-scale input. Thus the higher the subcarrier frequency, the larger the bandwidth. For a constant-bandwidth system, all oscillators are modulated the same amount for full-scale input.

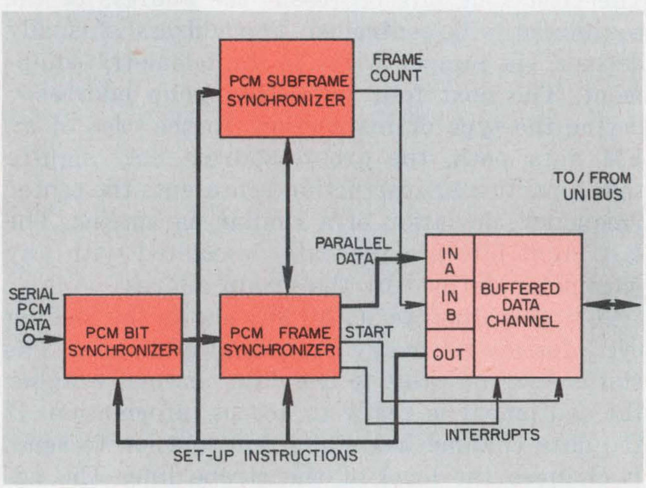
In TDM, channels are separated in time rather than frequency. Each channel is sampled in sequence by a commutator. When all channels have been sampled, the sequence is repeated. TDM systems generally fall into three types: Pulse Amplitude Modulation (PAM), Pulse Duration Modulation (PDM) and Pulse Code Modulation (PCM).

For PAM data, the channel amplitude contains the information. For PDM, the channel duration at some fixed level represents the data. For PCM, the data are represented by binary bits. In general, the recovery equipment for PAM, PDM and PCM presents the synchronized data output in digital format. FDM recovery equipment presents the output data in the original analog form.

FDM and TDM techniques can be blended. For instance, a PCM encoder can modulate an FM carrier to form a PCM/FM link.

Telemetry data output normally is presented as parallel data lines (typically 8 to 16 bits), along with a load strobe. Unlike setup information coming from the computer, the telemetry data output cannot use an acknowledge signal, since the data transfer rates are, in general, fixed by the telemetry rates. Thus the telemetry equipment will continue to update data, irrespective of the data channel's ability to accept and process the data through to the computer. This can become a problem in cases where a system is attempting to operate on many high-speed data streams at the same time. It's up to the user to see to it that he does not overload the system.

It's best if all of the front-end equipment is compatible and from one manufacturer. However, most systems require some incompatible front-end equipment—items like programmable frequency synthesizers and time-code readers. If these are to be used, a special interface is needed between the data channel and the equipment.



4. **A typical PCM data path** uses three pieces of equipment. The bit synchronizer extracts coherent serial PCM data and timing signals. The frame synchronizer identifies the data channels and provides parallel outputs. The subframe unit provides the frame count. Once started, the PCM path continually loads data into the computer via the buffer channel in a DMA mode.

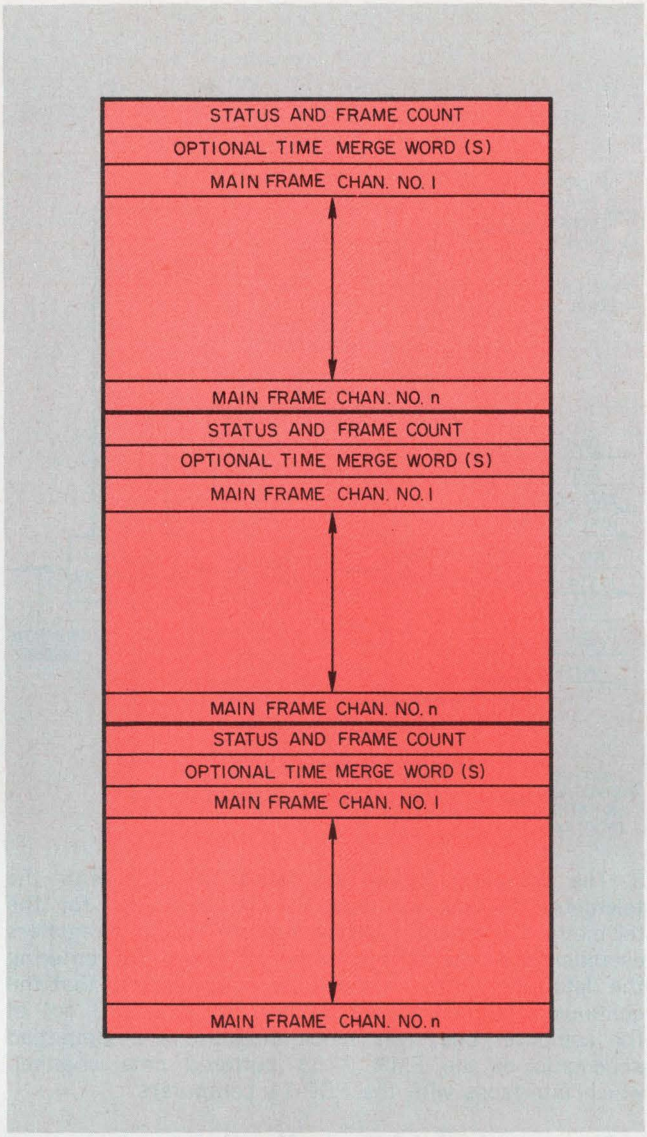
Digital input sources: How they work

Typical of the digital data sources that provide parallel inputs are PCM and FM systems and time tags (see box). These sources accept, respectively, serial PCM, FM multiplex and serial time codes, often from an analog recorder. In addition a computer-controlled matrix switch is often used to select and connect incoming signals to these decoding systems.

A typical PCM data path (Fig. 4) consists of the following:

- A bit synchronizer that accepts serial PCM in the presence of noise and other disturbances and generates reconstructed coherent PCM data and timing signals.
- A frame synchronizer that identifies the data channels and performs a serial-to-parallel conversion that provides the parallel data output.
- A subframe synchronizer that, in conjunction with the frame synchronizer, provides timing pulses and frame count indication for the identification of subframe data.

Once set up and started, the PCM path continuously loads data through the channel for storage in memory blocks. A channel start command is used to ensure that the data are loaded in the correct sequence. For the computer to sort out subframe information, a frame count is included with the data transfers (Fig. 5). The computer can easily identify mainframe data and, using the frame count, also identify subframe data.



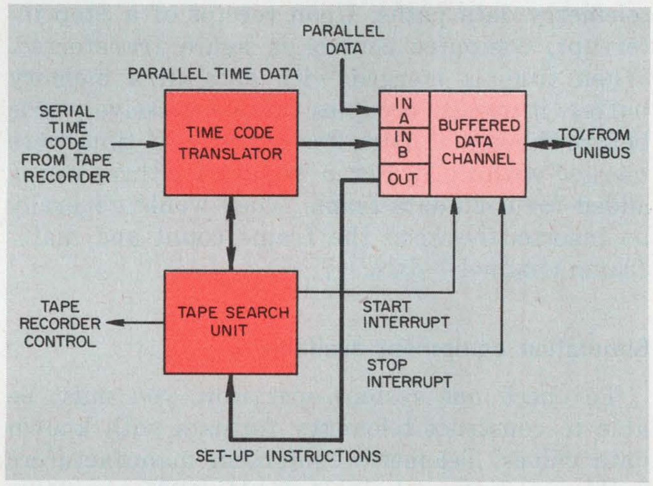
5. **A typical data block** in memory starts at location x and consists of y words. The status block permits the computation of the subframe or channel at which sampling began. The buffer signals the computer via an interrupt when a block is completed and begins a new block in an alternate buffer area.

PAM/PDM data are handled in much the same way that PCM are. Once set up, the path continuously sends data into memory.

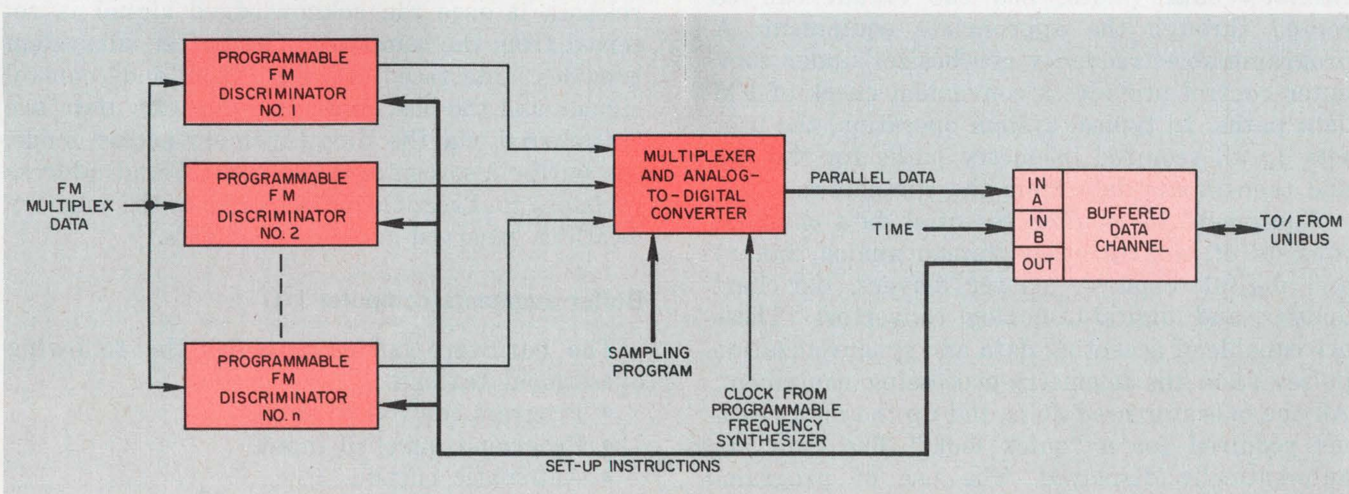
Analog-to-digital conversion needed

A representative FM data path consists of a group of FM discriminators and a multiplexer/analog-to-digital coverter. The analog outputs of the discriminators are thus digitized and sent to the data channel (Fig. 6).

For a data run, the discriminators are set up and then allowed to operate. The multiplexer sampling is under control of the buffered data channel. This allows the sampling plan to be stored in memory and altered to handle different data rates. The multiplexer can also be sampled sequentially, if desired, without use of stored sampling, thereby eliminating computer inter-



7. **Time codes from separate tape channels** permit addressable tape searches. The search unit controls the recorder and furnishes a start interrupt that informs the computer to begin processing the telemetry data.



6. **FM analog data must be digitized** before being inputted to the buffer. The multiplexer controlled by the computer via the channel selects the appropriate sampling plan in accordance with the data rates.

vention during data acquisition.

IRIG or other time codes often accompany recorded telemetry data on separate tracks. These codes allow the data-reduction operation to search out and run a particular segment of the tape as well as to time-correlate the data in different paths, if all were recorded at the same time. The time-tagging path is shown in Fig. 7.

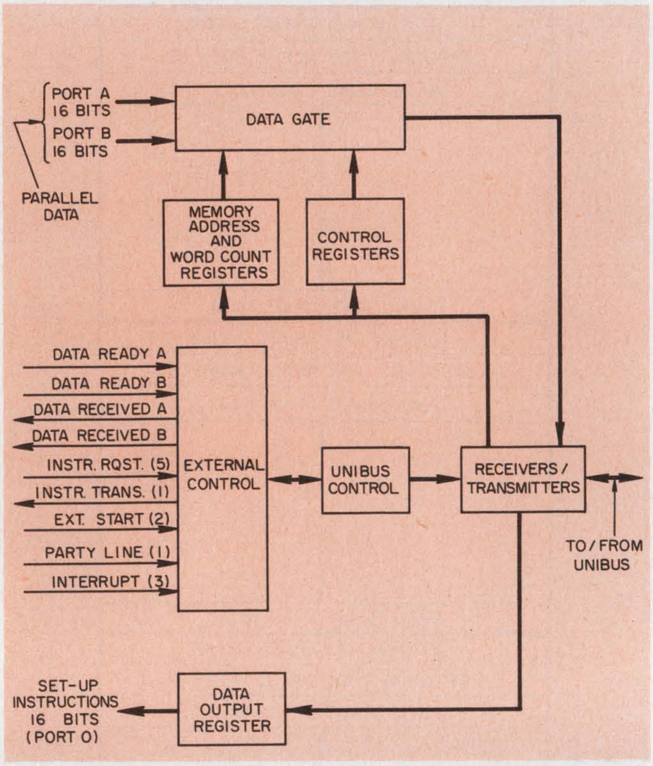
The time equipment is made up of two units: (1) a time-code translator, which reads the incoming serial time code and converts it to parallel format for processing through the data channel and merging with telemetry data, and (2) a tape-search unit, which is set up and started by the data channel. The search unit, which contains two interrupts; then controls the tape recorder.

When the desired starting point on the tape is reached, a Start interrupt is activated. This calls up the correct program for processing the telemetry data paths. Upon receipt of a Stop interrupt, computer control is again transferred. When time is merged with data in a memory buffer, it usually occupies three successive words before the actual data. For example, if time were merged with PCM, Fig. 5 would have three words added for each data frame. They would generally be inserted between the frame count and mainframe channel 1 data.

Simulation equipment available

To check out system operation, you must be able to construct telemetry formats with known data values. Telemetry-equipment manufacturers build simulators. A PCM/PAM/PDM simulator can be obtained in a single unit and programmed through the buffered data channel. Thus, under computer control, the simulator can be programmed for a particular format and the format's data values, and the output can be routed through the appropriate equipment. A programmable frequency synthesizer under computer control provides a convenient check of FM data paths. In typical system operation, the user sets up all required telemetry paths for the run and then inputs data from the simulators.

Equipment to monitor essential data channels consists of, among other things, analog, binary and digital displays, printer drivers, bar-chart drivers and digital-to-analog converters. These are capable of accepting data and synchronization pulses from the telemetry-processing equipment. All the operator need do is dial up the data channel required for a "quick look." The data are automatically displayed. The use of programmable distributors allows computer control of the quick-look function.



8. **The computer buffer interfaces** the bus with the telemetry devices and acts as the controller for the telemetry equipment. The control and memory registers establish the alternating memory buffers for entering the data blocks. Use of the buffer also ensures that the continuous telemetry data do not lock the CPU out of the computer bus. This block diagram is a simplified schematic of the EMR 2763 buffered data channel, which interfaces with the PDP-11 computers.

You can think of the buffered data channel as a gate that allows the computer to talk to the telemetry equipment and vice versa (Fig. 8). The buffer accepts each set of parallel data plus strobe from the telemetry front end, then places the data onto the computer's I/O bus. The buffer seizes the bus when a data word is ready, then releases it once the acknowledged signal is received from the computer. The buffer subsystem provides interface between front-end control signals and the bus. Since the telemetry data are transferred via the direct-memory-access mode, the buffer also contains the control and address registers to direct the data blocks to the memory locations reserved for input buffers.

Buffer augments computer I/O

The hardware buffer provides the following operational features:

- Program-controlled output.
- Program-controlled input.
- Automatic output.
- Automatic input.
- Interrupt provisions.

In the program-controlled mode, all operations are under computer control—that is, the program must specifically call for input or output data transfer. Program-controlled modes are particularly useful for acquiring system-status information. For instance, under certain interrupt conditions, the program might direct the computer to freeze the time-code-translator data register and then direct the input to take this information into the computer.

In the automatic mode, the data channel, which is initially set up by the computer, takes control and transfers block information to or from the computer memory on a cycle-stealing basis. For example, the setup information for a given data path might be located in a block memory of X words in length. Upon gaining control from the computer, the data channel would sequentially output these words to the equipment involved until the block ends were reached, at which time output would stop. The same would be true of inputting a block of data.

In general, the automatic mode has two conditions: cyclic or noncyclic. The operation just described would be noncyclic—upon completion of a block transfer, the data channel is stopped. In the cyclic condition two blocks in memory are used. While the data channel is loading block 1, the computer program is working on block 2, and vice versa.

One other important function of the data channel is the ability to merge input data from two sources. Once the channel is running and taking data on one port, a control signal—either from the computer or external—can switch ports to allow data into the block from another source. A typical example of this is the frame-count information shown merged with data in Fig. 5.

Picking the right mini

The basic mini differs from larger computers in the following ways: It has a smaller memory word (typically 16 bits or less), a smaller amount of memory, no floating-point hardware and no multiply and divide hardware. The mini memory usually is about 8 k for a typical CPU, but this can generally be expanded in increments of 4 or 8 k. Floating-point and multiply-and-divide hardware usually are available at extra cost. They are a must if you plan to have the system do any scaling or other reduction of data, particularly in real time.

Since the main purpose of the computer is to handle large amounts of continuous data, the I/O structure is probably the single most important feature. Direct memory access (DMA) for both data input and output is essential. Most machines have this feature, which allows data to be transferred in and out of memory on a "cycle-stealing" basis. This allows the central processing unit (CPU) to continue execution of a program at essentially the same time that the external data are being loaded.

Good nonpolling hardware interrupt capability is essential. With multidata systems, nesting interrupts (interrupting an interrupt) and the ability to assign independent priorities to a device interrupt and its service routine are also important. These capabilities that input information will not be lost while the CPU attempts to process it. For instance, a system may be handling PCM data at 100 thousand words a second and PAM data at five thousand words a second. The interrupt associated with the PCM must be handled immediately, whereas the PAM interrupt can wait.

Besides extended arithmetic and floating-point hardware, other CPU options are usually available. Some of these include:

- *Interleaved Memory.* This allows the system to read the next consecutive memory address while the previous address is undergoing the restore process (write cycle), thus saving processing time.
- *Real-time programmable clock.* This allows for timed interrupts at program-specified intervals.
- *High-speed solid-state memory.* This increases processing speed, because of a faster cycle rate.
- *Memory parity.* This allows the CPU to check the validity of all memory words read.

Basic computer peripherals used

As a minimum, every CPU must provide manual input. Many machines include an ASR 33 Teletype terminal as standard. It reads and punches paper tape at 10 characters a second and has a hard-copy output. This device is, in general, too slow. Just loading a typical assembler program will take an hour or more, not to mention the time taken for punching out the object tape. If you intend to do any development software at all, a high-speed paper tape system is a must. Such equipment reads, typically, at 300 characters a second and punches at 50 characters. A 30-character-a-second I/O typewriter also is convenient for hard-copy output.

For outputting formatted telemetry information, a digital magnetic tape unit is needed. Even the slowest data rates are far too high for paper tape. Magnetic tape-packing densities up to 1600 bits per inch and speeds to 125 inches per second are available. The choice depends upon the system data rates and your budget.

Various other peripherals should be considered, depending upon system size and use. Some of the more common that are available include:

- *High-speed line printer*—for obtaining reports and software listings. The speeds vary from 60 to 1200 lines per minute.
- *High-speed card reader*—for entering blocks of data and system parameters where changes will be made frequently. Only the cards affected need be changed, whereas with paper tape a new tape must be made. The cards are also very convenient for use with source decks in a disc-operating system. Corrections can be made easily by the addition and removal of source cards, followed by quick reassembly.
- *Disc storage*—for use in larger systems, where numerous programs will be required. In essence, all of the operating system program modules are stored on the disc. Once the disc system executive is in core, these programs can be accessed rapidly. This is extremely useful in a telemetry processing, where numerous users are requesting reduction of different data formats. It is a must if there is going to be considerable software development.

Telemetry software needed

Over and above the software offered by the computer manufacturer to support his machine are various modules written especially for support of the telemetry equipment. EMR Telemetry has developed an extensive library of this type of software, called TELEVENT. Included in TELEVENT are the following:

- *Telemetry executive*. This allows communication and control between operator and software. It lets the operator call up the telemetry software modules to handle his job. In general, the operator need only describe to the executive in conversational mode the functions desired. The executive automatically selects the software modules.
- *Telemetry language translator*. This software, when called up by the executive, decodes the operator commands that define the telemetry equipment and functions to be set up, and it calls up the setup driver for that equipment.
- *Setup drivers*. These modules, when called up by the translator, decode the parameter values —bit rate, frame sync code, etc.—of the operator command and store these in data blocks in the correct form to load the telemetry equipment. The setup driver then returns control to the telemetry executive.
- *Data acquisition software*. When called up by the executive, this software communicates with the telemetry equipment via a data channel I/O driver. It sends the setup data, previously stored by drivers, to the telemetry units, sets up data buffers in memory and commands the data channel to get data. The software also handles the data-acquisition interrupts. This type of software can be considered "standard," in that most systems will require it. In many cases it will be unique to the user, and he will probably want to write most of it himself.

A unique feature of the PDP-11 series computers is that all I/O devices connect to a common bus and appear to the CPU as memory locations. I/O software is simplified. And expansion of the system is allowed by the wiring of additional I/O units, including data channels, to the bus.

Permissible data rates

Estimating the rate at which data can be loaded into the computer can be confusing. The fact that the computer data bus can handle information at memory cycle rates (typically 1 μs) may lead to an erroneous conclusion. When large blocks of data are to be inputted to the computer infrequently, the input channel acquires the bus and transfers its data at a high rate then relinquishes the bus. But telemetry data are continuous, yet the bus cannot be dedicated to inputting this data. To process the data, control must be constantly transferred from the telemetry input to the CPU and back again—a task that is performed by the data channel.

To calculate the data rate that can be handled, the following parameters come into play:

- How long does it take to acquire the bus?
- How much time does the CPU require for formatting the data between inputs?

Both parameters are also affected by the number of data streams being processed. A good rule of thumb for a mini-based system that simply formats and outputs to tape is about 150 k words/sec for a single-stream system. For a multistream system, divide 150 k words/sec by the number of streams.

Since most telemetry data are stored on analog tape prior to processing, the tape recorder can simply be played back at a slower speed to keep the data rate from exceeding the computer system's capability. For example: you want to process a 2-Mbits/sec, 8-bits/word serial PCM data stream. This equals 250 k words/sec. If the analog input tape is played at half the speed it was was recorded at, the rate is reduced to 125 k words/sec and can be formatted to a nine-track digital tape at a rate of 125 k characters/sec. ■■

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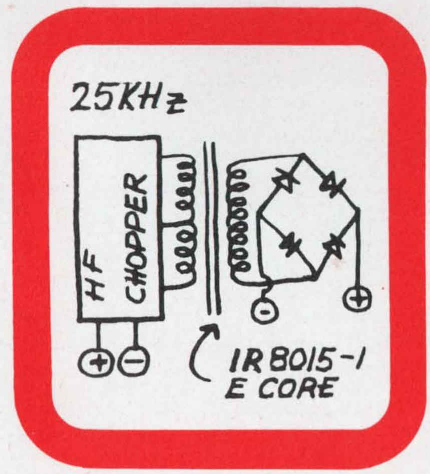

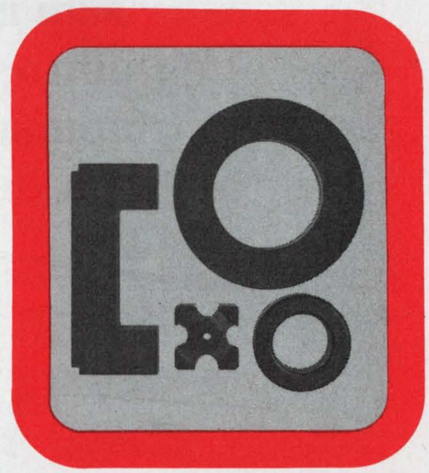

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INFORMATION RETRIEVAL NUMBER 71

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It makes all the
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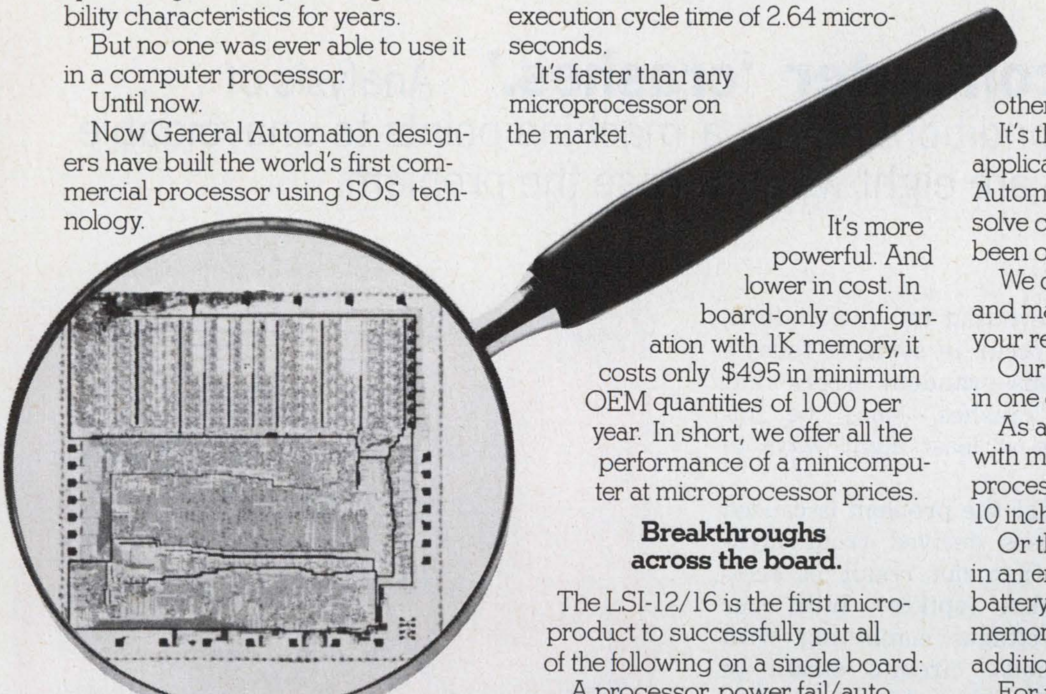

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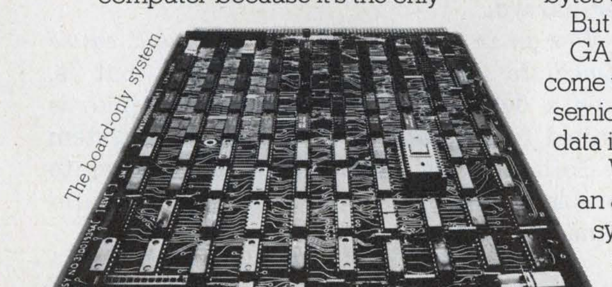

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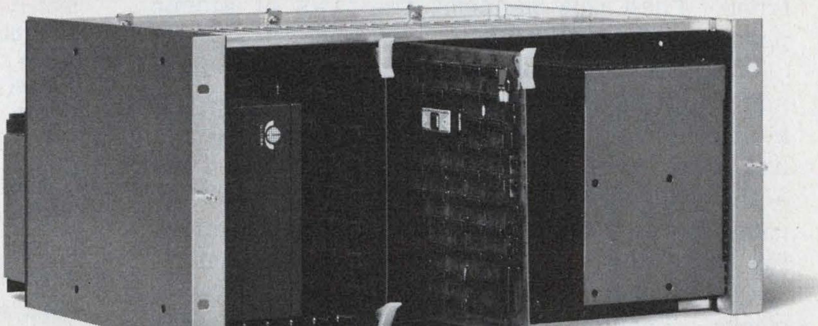

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INFORMATION RETRIEVAL NUMBER 73

Minimize computer 'crashes.' Analysis of asynchronous conditions within a machine points to unavoidable errors, but there are eight ways to ease the problem.

There is reason to believe that the unexplained, intermittent faults that occur in some of today's complex computer systems—random errors that computer people call "crashes"—may be unavoidable. But there are at least eight ways to minimize the problem.

Basically it appears that the problem is caused by "races" between pulses derived from asynchronous clocks—races that can result in arbitrarily narrow signal pulses (spikes). With ever smaller currents and voltages combining with narrowing pulse durations, circuits strain to operate at the limit with mere dozens of electrons. When this happens, the laws of atomic physics come into play.

With the trend toward higher-speed computers and multiplicity (multi-use, multiprocessor, multiprogram)—and also toward massive on-line data bases and many communications lines—the problem of random racing errors will become more frequent. Observance of the following rules, however, can minimize the problem:

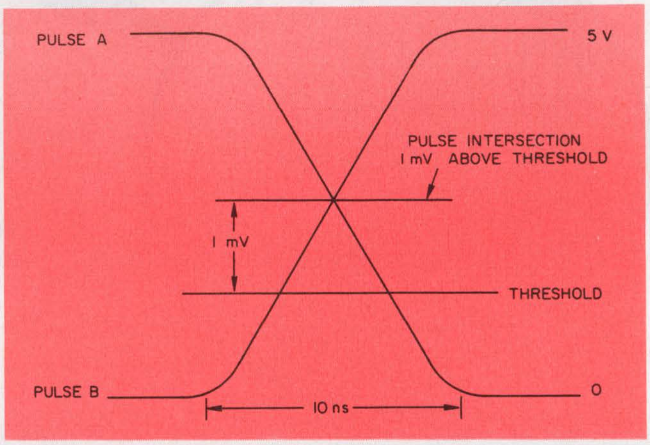
(1) *Minimize the number of asynchronous clocks.* Though running all processors and memory banks from a single clock does create problems in clock design and product factoring, the avoidance of spikes within the mainframe more than pays for the extra cost.

(2) *Move asynchronous boundaries out to the interfaces with the lowest possible speeds.*

(3) *Partition the system according to the regions governed by each asynchronous clock.* Ordinarily this corresponds to a natural partitioning. However, with peripheral controllers, boundaries may go through the controllers.

(4) *Identify all asynchronous boundaries and define the simplest possible asynchronous interfaces*—that is, minimize the number of timing signals that cross these boundaries.

(5) *Adopt a suitable, "handshaking" protocol for each asynchronous interface and minimize the number of elements directly subject to asynchronous signals.*



1. **Problems can arise in a gate** when the leading edge of an incoming pulse intersects the trailing edge of the second incoming pulse at a point near the threshold of the gate.

(6) *Provide specially designed high-speed regenerators for the elements subject to asynchronous signals.*

(7) *Analyze the probability of spikes and the system impact of spikes.* Confine the errors caused by spikes to data rather than control, if possible. System lockups or crashes are a much greater hazard.

(8) *Design in a spike detector that will cause an immediate machine-fault interrupt*—that is, use such a detector if the impact of a spike is not limited to the data but could cause a system crash. Software designers should be alerted to this problem and advised on means of containment and recovery.

Hardware not at fault

Crashes due to spikes differ from the usual errors—such as parity—because they are not caused by hardware malfunctions. Let's take a closer look at them.

Virtually every large digital-computer system incorporates more than one clock. In addition to the main clock, which drives the CPU, some systems have an independent, asynchronous clock

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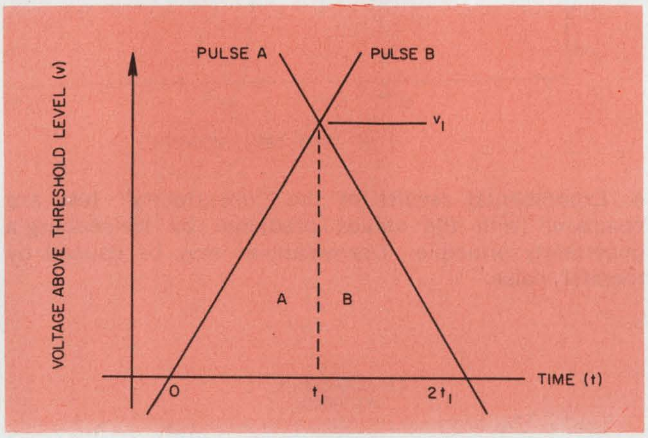
David Mayne, formerly of Pertec Corp., 17112 Armstrong Ave., Santa Ana, Calif. 92705 and **Ralph Moore,** formerly of Xerox Corp., Data Systems Division, Aviation Boulevard, El Segundo, Calif. 90245.



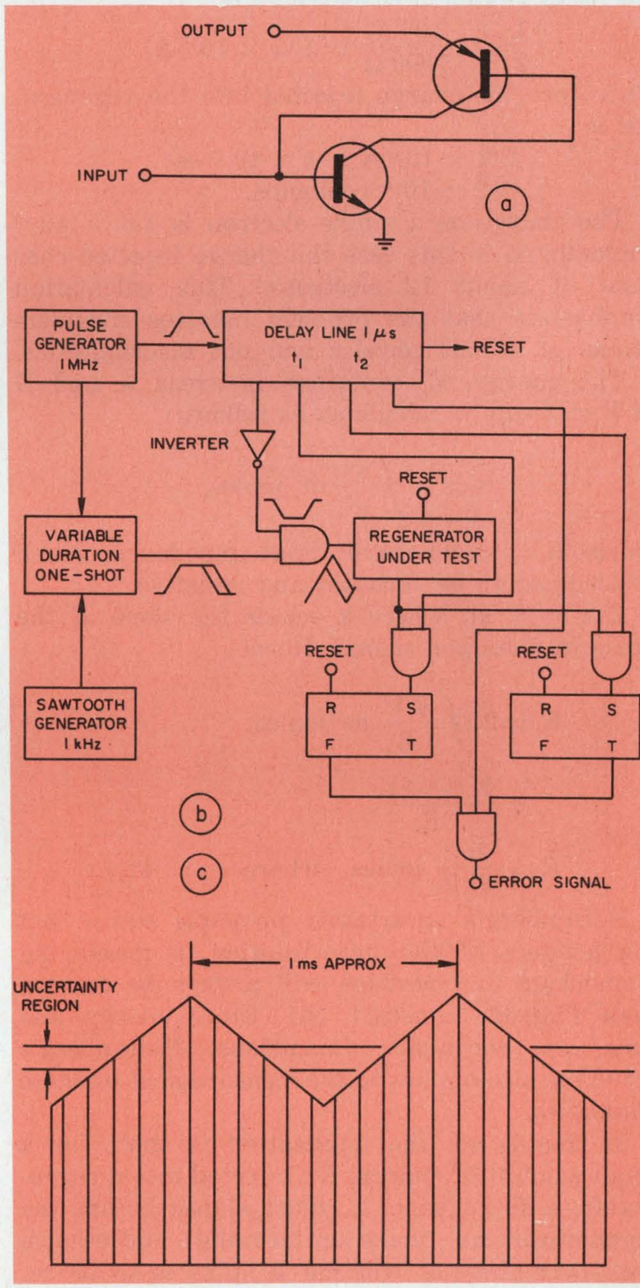
2. **The amount of energy "injected" into a gate** by two overlapping pulses can be determined by calculation of the area under the intersection. The amount injected decreases rapidly as the overlap narrows.

for each memory bank. In systems with more than one processor—input/output processors, multiple CPUs or special processors—each processor has its own independent clock. Also, most moving-media peripherals, such as disc packs, RADs, tapes—incorporate an independent asynchronous clock within the moving medium.

Real-time systems respond to interrupts that are normally asynchronous to the main CPU clock; communications lines ordinarily use their own clocks. At some point within these multiclock systems, a pulse derived from one clock will be ANDed with a pulse derived from another clock. Since the clocks are asynchronous with respect to one another, the pulses will also be asynchronous. Thus the leading edge of one pulse may occur at any time with respect to the training edge of the other pulse.

Consequently the AND result of the two pulses may be an arbitrarily narrow spike, and the peak amplitude of the spike may be arbitrarily close to the threshold of whatever amplifier follows the AND gate.

Normally this amplifier is latched—that is, regenerative. The regenerator decides if the spike should be regarded as a logic ONE or ZERO. With an arbitrarily narrow spike, the energy that is injected into the regenerator can



3. **Typically, a regenerative circuit (a) follows a gate** in a computing chain. When an arbitrarily small spike enters the regenerator, the circuit may delay in resolving the spike into a ONE or ZERO. The "uncertainty" can be measured (b) if an asynchronously modulated spike stream (c) is fed into the gate-regenerator and the error signals are monitored.

drop to an arbitrarily small level.

Consider the case in which the fall of pulse A intersects in a gate with the rise of pulse B and both pulses have rise and fall times of 10 ns (Fig. 1). Assume the intersection of the pulses is 1 mV above the threshold of the regenerator to which the gate output is connected.

The duration for which the spike exceeds the threshold is

$$\frac{2 \times 10^{-3}\ \text{V}}{5\ \text{V}} \times 10^{-8}\ \text{sec} = 4\ \text{ps}.$$

With a regenerator input impedance (R) of 1000 Ω, the average current flow during the time the spike exceeds the threshold is

$$\frac{1}{2} \times \frac{10^{-3}\ \text{V}}{1000\ \Omega} = 1/2 \times 10^{-6}\ \text{A}.$$

Therefore the charge injected into the regenerator is

$$1/2 \times 10^{-6}\ \text{A} \times 4 \times 10^{-12}\ \text{sec}$$
$$= 2 \times 10^{-18}\ \text{coulombs}.$$

The charge on a single electron is 1.6×10^{-19} coulomb, so in this case the charge injected consists of about 12 electrons! This calculation emphasizes that the problem involves considerations of atomic physics and not macrophysics.

The energy, E, contained in areas A and B of Fig. 2 can be calculated as follows:

$$E = 2 \int_0^{t_1} \frac{v^2}{R}\, dt \text{ joules},$$

where R = regenerator input impedance, which is assumed to be constant and resistive.

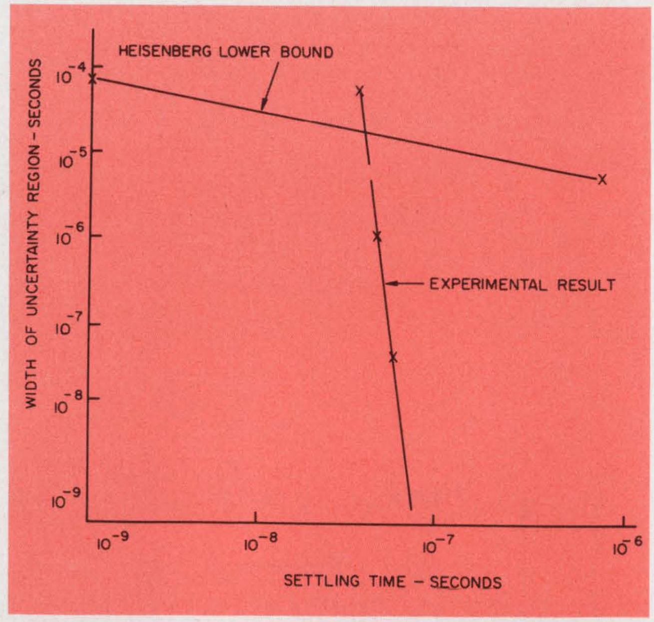
But $v = kt$, where k equals the slope of the pulse in volts per second. Hence

$$E = 2 \int_0^{t_1} \frac{k^2 t^2}{R}\, dt \text{ joules},$$
$$= \frac{2\,(k^2 t_1^3)}{3R}$$
$$E = \frac{2 v_1^3}{3kR} \text{ joules (where } v_1 = kt_1\text{)}.$$

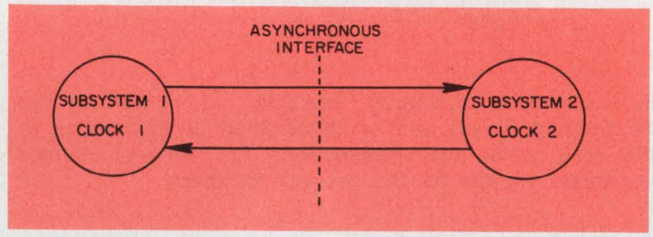
Heisenberg's uncertainty principle states that the product of the uncertainties in measuring momentum and position will always be greater than Planck's constant (h). Since energy and time are conjugate dimensions, Heisenberg's principle also applies to the measurement of these quantities.

If this is so, the implication is that, for a small amount of energy, E_1, injected into a regenerator, a finite time, t_s, must elapse before the regenerator can "make up its mind" and resolve the uncertainty of whether a spike is to be regarded as a ONE or a ZERO.

If the output of the regenerator is sampled before t_s and decisions are later based on the result, then, clearly, the system can malfunction—that is, the regenerator may change state *after* the system has sampled the regenerator's output.



4. **Experimental results of the "uncertainty" test** are compared with the values predicted by Heisenberg's uncertainty principle. Discrepancies may be caused by thermal noise.



5. **In a complex computer system** each subsystem is likely to have its own clock. With this arrangement, problems can occur at the asynchronous interface of the subsystems, and errors can result.

Consider this example:

If a settling time of 50 ns is allowed for the regenerator before its output is sampled, the minimum spike amplitude for satisfactory resolution can be calculated as follows: Planck's constant (h) equals 6.624×10^{-34} joule-seconds. Hence the minimum energy injected must be

$$E_1 = \frac{h}{t_s} = \frac{6.624 \times 10^{-34}}{50 \times 10^{-9}} = 1.3 \times 10^{-26} \text{ joules}.$$

$$\text{But } E_1 = \frac{2\,v_1^3}{3kR}.$$

$$\therefore v_1 = \left(\frac{3kE_1R}{2}\right)^{1/3}.$$

If rise and fall times of 10 ns are assumed for 5-V pulses,

$$k = 5 \times 10^8 \text{ V/s}.$$

$$\therefore v_1 = \left(\frac{3 \times 5 \times 10^8 \times 1.3 \times 10^{-26} \times 10^3}{2}\right)^{1/3}$$
$$= 2.14 \times 10^{-5}\ \text{V}.$$

This result implies that for spikes with an amplitude of less than 21 μV, the uncertainty of resolution is greater than the 50 ns allowed, and a malfunction will probably occur. Although an uncertainty region of 21 μV seems quite small, significant errors may result. Let's see how, using the same example.

Four errors a second possible

With the intersecting pulses, assume a 10-ns gating window in which an interrupt is presented asynchronously at a 1-MHz rate. As a fraction of 5 V, 21 μV is approximately 4×10^{-6}. This is the probability that an interrupt will cause a spike of less than 21 μV, and hence an error.

Since the rate at which decisions are made is 1 MHz, about four errors per second can be expected. Thus the application of Heisenberg's uncertainty principle results in error-rate predictions that are quite significant for present computer systems.

To get a better understanding of the practical effects, consider the physical behavior of the gate-regenerator circuit. All regenerative circuits are characterized by the following:

(a) A region where the loop gain is zero—below threshold, where changes of input do not produce changes of output.

(b) An active region of high loop gain.

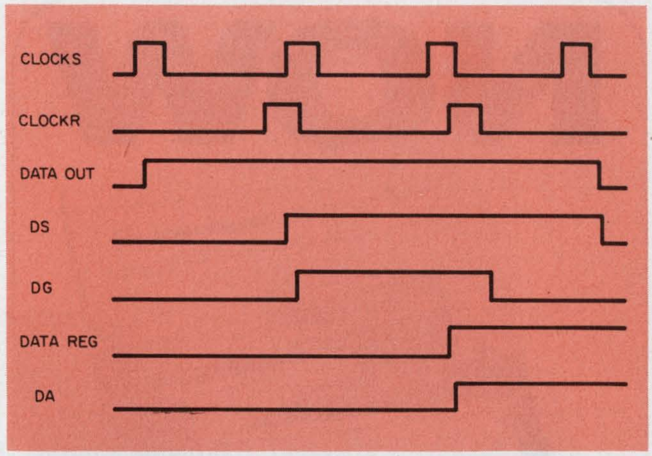
(c) Another region where the loop gain is, again, zero and further changes of input produce no output change.

There is a point between the regions listed in "a" and "b" and also between those in "b" and "c" where the loop gain is unity. One can postulate an input signal or spike that would carry the regenerator to this point and leave it there in a position of unstable equilibrium. The question then is: How long will it remain in this state? The situation is similar to that of a pencil balanced on its point on a table: How long will the pencil take to fall over?

To attempt to measure the width of the uncertainty region, a regenerator with a high gain-bandwidth product can be constructed with pnp and npn transistors in a pseudo pnpn arrangement. Spikes are applied at a 1-MHz rate to a standard logic input, which precedes the regenerator (Fig. 3).

The spike amplitude is asynchronously modulated at approximately 1 kHz (Fig. 3c). The output is sampled twice during the microsecond following the generation of the spike—first at a variable time, t_1, which represents the "settling" time, t_s, and then at a time, t_2, about 500 ns later in the cycle. An error is detected if the regenerator changes state after the first, but before the second, sample.

Note that the errors are counted over a period of several hours for each value of t_1. From this information, along with the pulse rate, modulation rate and amplitude, it is possible to calculate and plot the width of the uncertainty region.



6. **Typical signal interchange** of a send-receive subsystem in which the sender and receiver each have clocks. The key signal here is DG, an internal gating signal upon which subsequent computing depends.

The experimental results are shown in Fig. 4, along with the predictions based on the Heisenberg principle. The gross discrepancy between the Heisenberg "lower bound" and the experimental results may be caused by thermal noise. Observe that the Heisenberg lower bound seems to be valid for settling times close to the propagation time of the regenerative circuit (approximately 10 ns).

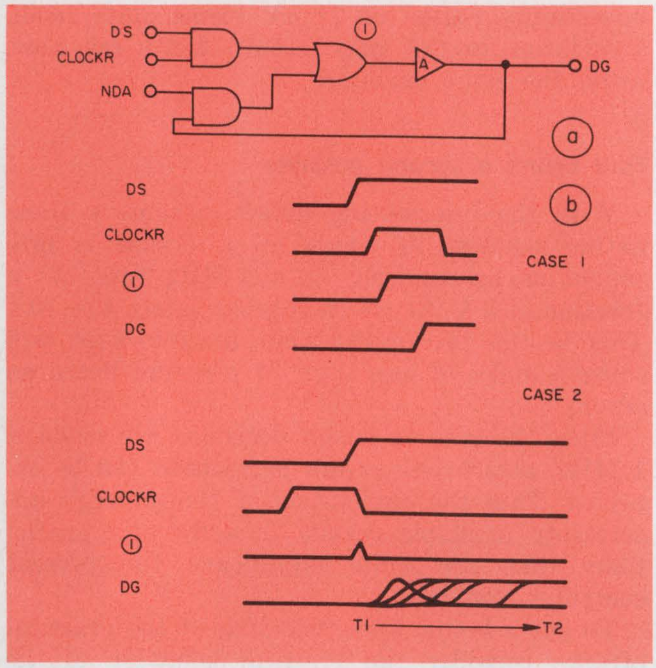
Because of bandwidth limitations, noise should have little effect under these conditions. For settling times that are greater than the propagation time, the circuit's behavior is analogous to that of a pencil balanced on a shaking table. Despite the enormous improvement that noise evidently makes, the basic problem remains.

For analysis, consider a simple, two-clock system (Fig. 5). The system has been partitioned into two subsystems separated by an asynchronous interface. Within each subsystem the corresponding clock controls the timing of all events. Hence a conventional logic-design approach can be used within a subsystem with no problem. However, problems occur at the asynchronous interface.

Isolating the interface error

Generally a well-designed asynchronous interface uses a handshake protocol to exchange data between the subsystems. Under this protocol, the sending subsystem outputs a data-strobe (DS) signal to indicate the presence of data on the sender's output lines. The receiving subsystem senses DS on its next clock and uses its presence to set an internal data-gating signal (DG).

On the next receiver clock, DG causes the data to be clocked into a receiving register. At the



7. **Simplified schematic to generate DG** points to possible source of an error (a). Since DS and CLOCKR are not synchronized, the two signals can be arbitrarily overlapped. In case 1, the pulses fully overlap and no problems occur. But in case 2, DG and CLOCKR don't fully coincide and an uncertainty can result (b).

same time the receiver outputs a data-accepted signal (DA) to the sender to indicate that the data can now be taken off the sender's output lines. When the sender detects this signal, it terminates transmission and resets DS. (Fig. 6).

Now concentrate upon the events within the receiver. From the send-receive scenario, it can be seen that the asynchronous problem in the receiver is reduced to generation of one signal, DG. Once DG has been successfully generated, strobing the actual data into the receiving register becomes a fully synchronized operation.

In a simplified implementation of DG, the receiver clock (CLOCKR) is used as a pulse (Fig. 7). Elsewhere in the receiver the rising edge of CLOCKR is used to set flip-flops. Thus the receiving register, for example, will be set on the next clock after the one that sets DG.

Consider node 1 in Fig. 7. Since DS and CLOCKR are asynchronous, they can overlap to any degree. In the figure, DG and CLOCKR are fully overlapped in case 1. A pulse is generated that is substantially larger than the threshold of the regenerative circuit, and the output DG is immediately set.

However, DG and CLOCKR don't fully coincide in case 2 of Fig. 7, and a spike is applied to the regenerative circuit. Now if the spike is in the uncertainty region, the circuit output DG may take additional time to settle. In this case it is important that subsequent operations of the system do not depend on a sampling of the circuit during its meta-stable state, T_1 to T_2. ■■

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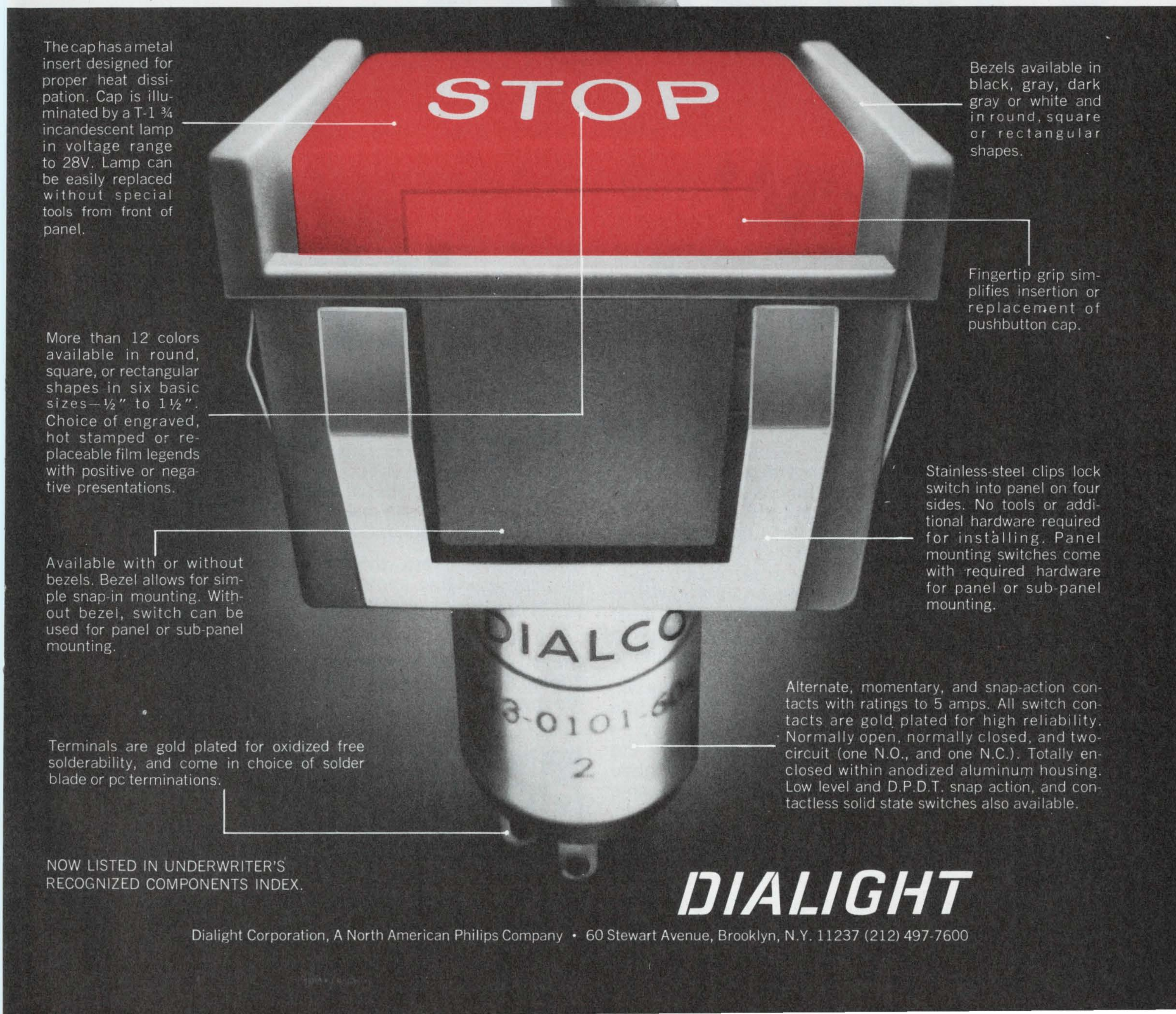

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INFORMATION RETRIEVAL NUMBER 901

Approximate logs easily with a simple combinatorial circuit. A few ICs let you multiply, divide, and calculate any root of any power of two.

The logarithm is a powerful tool in manual computation. It also can be very handy for calculations with digital circuits—if you can generate the logarithms simply. The Mitchell algorithm[1] for finding logarithms to the base 2 is simple to employ, now that complex, single-package MSI digital functions are available. Only two standard MSI chips are needed to convert an 8-bit binary word to its base-2 logarithm. The circuit uses strictly combinational logic without need for clocking.

Once the logarithm of a binary number is obtained, multiplication or division becomes simply addition or subtraction, and taking the square root is merely division by 2. If the logarithm is to the base 2 in binary form, division by 2 is a simple shift of the number, one bit to the right.

But the Mitchell algorithm is an approximate method and when used to find the square root, it can yield a maximum error of about 6%. When multiplying, it can give an error of about −11%, and when dividing, 12.5%. The accuracy can be improved, but even without improvements the algorithm is accurate enough for many applications.

Before we delve into the various circuits, let's take a look at the basic algorithm itself.

The algorithm is simple

To avoid continual writing of the log-base subscript, let's designate

$\log_2 N$ as lg N.

Table 1 lists selected binary logarithms, and the familiar logarithmic curve is plotted in Fig. 1. A line-segment approximation of the binary logarithm results when all integer points of lg N (N = 2, 4, 8, 16 ····) are joined by straight-line segments. The approximations that correspond to the line segments are also listed in Table 1, along with their binary representations.

Note that the characteristic parts of lg N in

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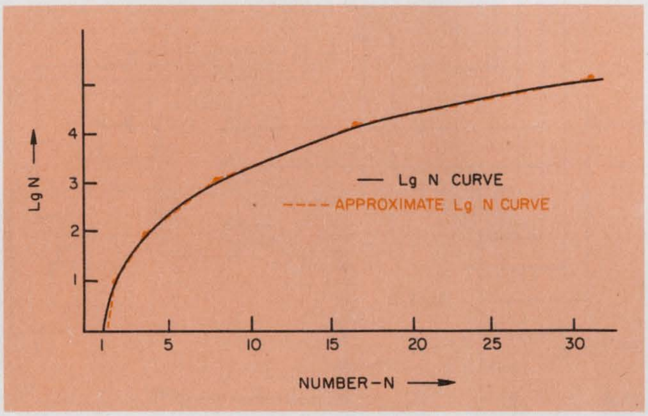
Table 1. Binary logarithms and their straight-line approximation

N	N(binary)	lg N	APPROX. lg N	APPROX. lg N (binary)
1	00001	0.00000	0.000	000.0000
2	00010	1.00000	1.000	001.0000
3	00011	1.58496	1.500	001.1000
4	00100	2.00000	2.000	010.0000
5	00101	2.32193	2.250	010.0100
6	00110	2.58496	2.500	010.1000
7	00111	2.80735	2.750	010.1100
8	01000	3.00000	3.000	011.0000
9	01001	3.16992	3.125	011.0010
10	01010	3.32193	3.250	011.0100
11	01011	3.45942	3.375	011.0110
12	01100	3.58496	3.500	011.1000
13	01101	3.70043	3.625	011.1010
14	01110	3.80735	3.750	011.1100
15	01111	3.90689	3.875	011.1110
16	10000	4.00000	4.000	100.0000
17	10001	4.08747	4.0625	100.0001

decimal form take the value of the exponent of the most-significant ONE bit of N. For instance, if the most-significant ONE is in the 2^2 position, the characteristic is 2; if in the 2^5 position, the characteristic is 5, etc.

The remaining bits of the original binary number become an approximation to the mantissa when they are placed to the right of the logarithm's "decimal," or binary, point. It is easy to see that this mantissa represents a binary fraction within the range 0 to 1 between two adjacent integral logarithms.

Consider the approximate logarithm curve. The coordinates of both ends of each straight-line segment start and end at some whole power of 2 on the N axis. The corresponding lg Ns are the whole-number characteristics. Thus each line segment spans the distance from one characteristic to the next with a unit increase in the characteristic's value at each step, and the bits that



1. A plot of logarithms is closely approximated by straight-line segments between whole powers of 2, which are the $\log_2$ of the binary-number sequence.

Table 2. Truth table of 8243 scaler

Inhibit	Enable 1 & 2	S_0	S_1	S_2	$O_0\,O_1\,O_2\,O_3\,O_4\,O_5\,O_6\,O_7$
0	1	0	0	0	$\bar{I}_0\ \bar{I}_1\ \bar{I}_2\ \bar{I}_3\ \bar{I}_4\ \bar{I}_5\ \bar{I}_6\ \bar{I}_7$
0	1	1	0	0	$\bar{I}_1\ \bar{I}_2\ \bar{I}_3\ \bar{I}_4\ \bar{I}_5\ \bar{I}_6\ \bar{I}_7\ 1$
0	1	0	1	0	$\bar{I}_2\ \bar{I}_3\ \bar{I}_4\ \bar{I}_5\ \bar{I}_6\ \bar{I}_7\ 1\ 1$
0	1	1	1	0	$\bar{I}_3\ \bar{I}_4\ \bar{I}_5\ \bar{I}_6\ \bar{I}_7\ 1\ 1\ 1$
0	1	0	0	1	$\bar{I}_4\ \bar{I}_5\ \bar{I}_6\ \bar{I}_7\ 1\ 1\ 1\ 1$
0	1	1	0	1	$\bar{I}_5\ \bar{I}_6\ \bar{I}_7\ 1\ 1\ 1\ 1\ 1$
0	1	0	1	1	$\bar{I}_6\ \bar{I}_7\ 1\ 1\ 1\ 1\ 1\ 1$
0	1	1	1	1	$\bar{I}_7\ 1\ 1\ 1\ 1\ 1\ 1\ 1$
1	X	X	X	X	1 1 1 1 1 1 1 1
X	0	X	X	X	1 1 1 1 1 1 1 1

X indicates "don't care."

follow the most-significant ONE of N represent a linear proportion along the line segment. These bits, as a binary fraction, are approximations of the true mantissa.

As an example, consider the problem of finding lg 14. The binary representation of 14_{10} is 1110_2 and its most-significant ONE bit is in position 2^3. Thus the characteristic of lg 14 is 3, or 11 in binary. The remaining bits form the approximate mantissa, or fraction 0.110, which is equal to 0.750 in decimal notation. Thus the approximate lg 14 is 3.750 in decimal, or 11.110 in binary notation. From Table 1 note that this is in error by 0.05735. A maximum absolute error of 0.086 occurs when the approximate mantissa is 0.44.

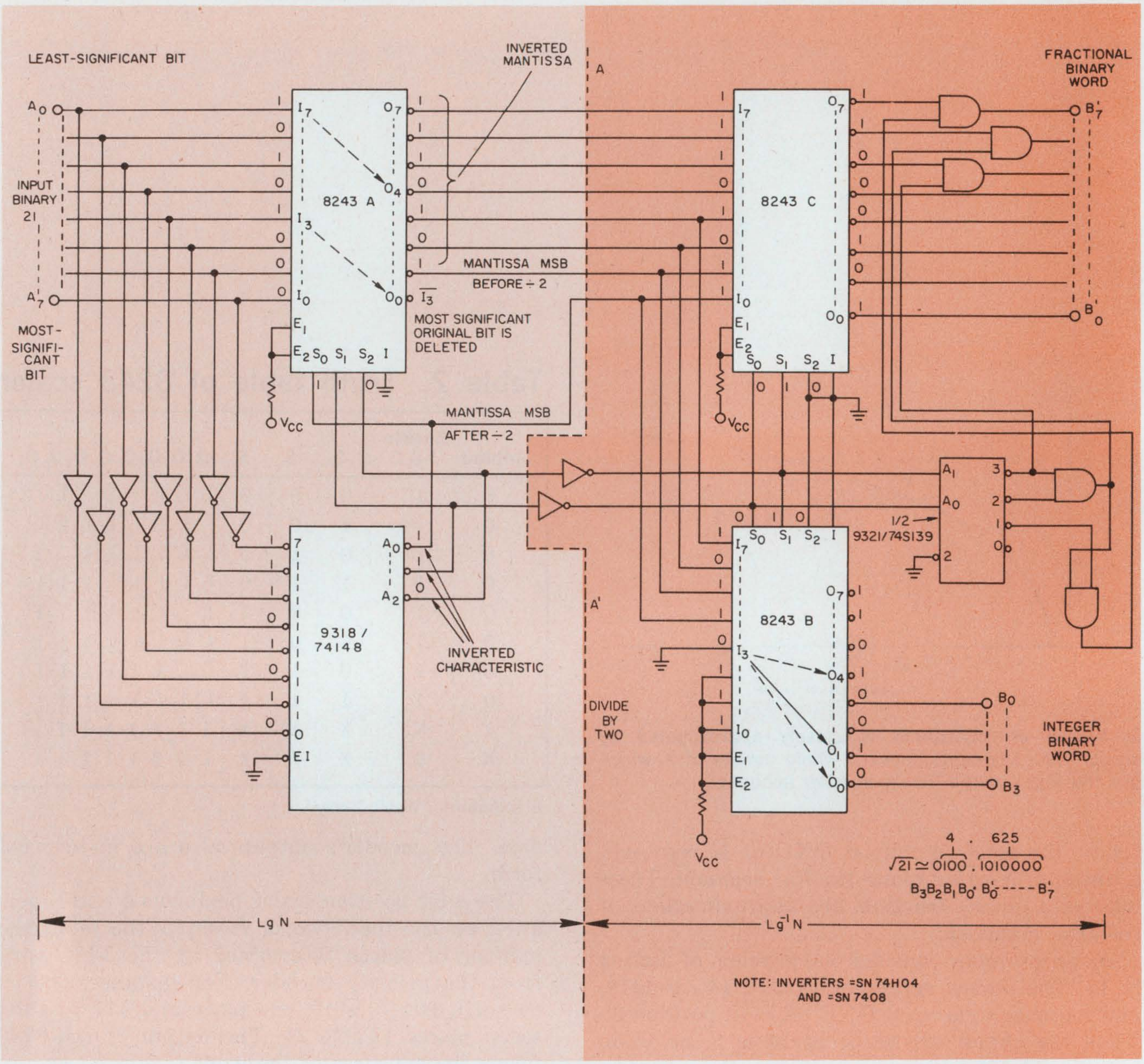
Implementing lg N conversion

Binary-to-logarithm (base-2) conversion can be implemented with a Signetics 8243, 8-bit position scaler and a Fairchild 9318 or Texas Instruments 74148 priority encoder (Fig. 2). The priority encoder chip determines the characteristic of the logarithm by detecting the most-significant ONE bit in the input word and providing a 3-bit output code that corresponds to this bit's position. Inverters are necessary at the inputs to the priority encoder, since it operates on inverted data. The encoder's outputs also are in inverted form.

The 8-bit position scaler performs a shift operation on the input word. It shifts the input the number of places determined by the 3-bit word from the priority encoder. For instance, 000 = no shift, 001 = shift one place and 111 = shift seven places (Table 2). The output of the 8243 forms the mantissa of the word.

Note that output 0_0 of the 8243 is left open, since the most-significant bit of the input, or characteristic-determining bit, must always appear at this output, and the mantissa consists of only those bits to the right of this most-significant ONE. The outputs of the 8243 are also delivered in inverted form, thus the lg N appears in ones complement form at section AA′ in Fig. 1. The lg N is left in complement form, since the subsequent antilog conversion inputs require inverted inputs.

As a more detailed example of the binary-to-log conversion of Fig. 1, let's convert the number $N = 21_{10} = 00010101_2$ to a log-binary form as a preliminary step to obtaining $\sqrt{21}$. Table 4 shows the operation in algorithm form, and the binary numbers in Fig. 1 correspond to all logic inputs and outputs for obtaining $\sqrt{21}$. To calculate lg 21, which corresponds to section AA′ on Fig. 1, the following occurs:



2. **A combinatorial 8-bit square rooter** needs only a $\log_2$ circuit, a wired divide-by-2 and an antilog_2 circuit.

Number N enters the circuit at terminals A_7 (most-significant bit) through A_0 (least-significant). A brief examination of the 8243 truth table (Table 2) shows that the value of the binary number for shift inputs S_2 S_1 S_0 corresponds to the subscripts of the inverted inputs that appear at output 0_0.

Thus if $S_2\ S_1\ S_0 = 101 = 5$, I_5 would appear at 0_0, and so on. Then, in the case of $N = 21 = 0010101$, the most-significant ONE bit enters I_3 and appears at 0_0, because the priority encoder provides output $A_2\ A_1\ A_0 = S_2\ S_1\ S_0 = 011 = 3$ (Table 3). All higher subscript inputs, I_4 to I_7, also shift down by three positions in the output, so that I_7 appears at I_4, etc., and all I_3 and lower subscripted inputs are lost.

In other words, the scaler input subscripts are arranged in reverse order from the customary sequence (I_7 is least-significant and I_0 most-significant). This arrangement can then work properly with the outputs of the priority encoder in complement form.

Dividing by 2 is easy

Most operations with logarithms require the log's conversion back to ordinary numbers at some point. Finding the square root of a number involves, first, obtaining the log, then division-by-2 and then the antilog. With binary numbers, the divide-by-2 is easy to do.

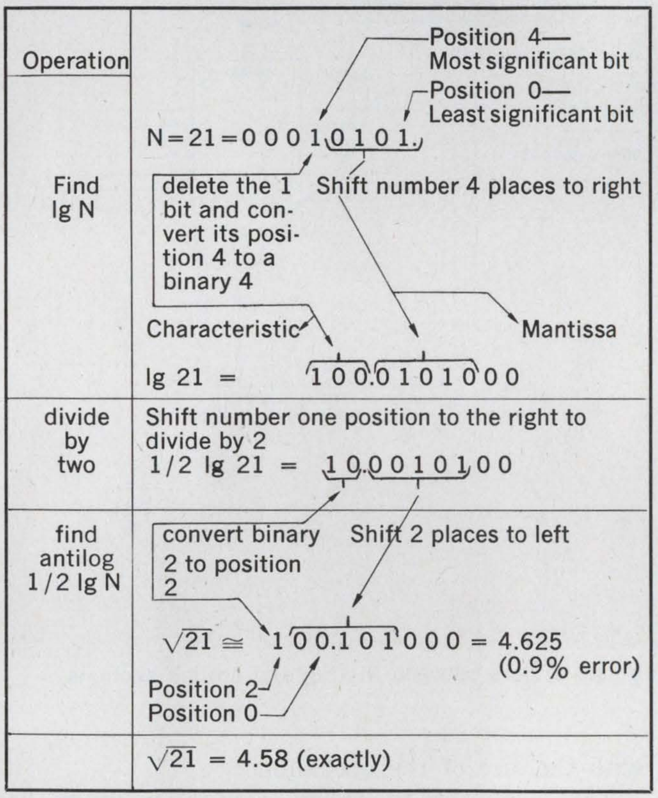
In the circuit of Fig. 1, the divide-by-2 process is hard-wired into the system. Since the required shift entails a shift of the least-significant from

Table 3. Truth table of 9318/74148 priority encoder

Enable EI	Outputs A_0	A_1	A_2	Inputs 0	1	2	3	4	5	6	7	Output G_S	E_O
1	1	1	1	X	X	X	X	X	X	X	X	1	1
0	1	1	1	1	1	1	1	1	1	1	1	1	0
0	0	0	0	X	X	X	X	X	X	X	0	0	1
0	1	0	0	X	X	X	X	X	X	0	1	0	1
0	0	1	0	X	X	X	X	X	0	1	1	0	1
0	1	1	0	X	X	X	X	0	1	1	1	0	1
0	0	0	1	X	X	X	0	1	1	1	1	0	1
0	1	0	1	X	X	0	1	1	1	1	1	0	1
0	0	1	1	X	0	1	1	1	1	1	1	0	1
0	1	1	1	0	1	1	1	1	1	1	1	0	1

X = don't care condition

Table 4. Finding the approximate $\sqrt{21}$



the characteristic to the mantissa, the least-significant bit of the characteristic, A_0, is wired into the most-significant bit of the mantissa (see Table 4), which becomes I_0 of the 8243-B. Note that A_0 is kept in its inverted form to correspond to the other inverted bits of the logarithm.

The integer part of the square-root result of any 8-bit binary number can have only 4 bits. And except for the integer's most-significant bit, the three other bits are formed from the most-significant bits of the mantissa of 1/2 lg N. Note that these four bits, which are the inputs to 8243-C, are also connected to 8243-B of the antilog section. Only two bits, A_2A_1, are sufficient to locate the output's binary point.

To prove that the integer part of a square root in binary form has only half as many bits as the input word, consider our 8-bit case. Its maximum possible characteristic is $7_{10} = 111_2$. After a divide-by-2 operation the maximum characteristic becomes $3_{10} = 11_2$. Thus, when 1/2 lg N is converted back to an ordinary binary number, a ONE must be placed in the 2^3 position. This corresponds to the fourth bit to the left of the binary point. Thus for an 8-bit input, its square root results in a maximum of 4 bits as the integer part of the answer.

Finding the antilog

Now we can concentrate on the antilog circuit. The inputs to 8243-B at I_3 to I_7 become, after proper shifting by the chip's control lines, S_2 S_1 S_0, the integer part of the output word.

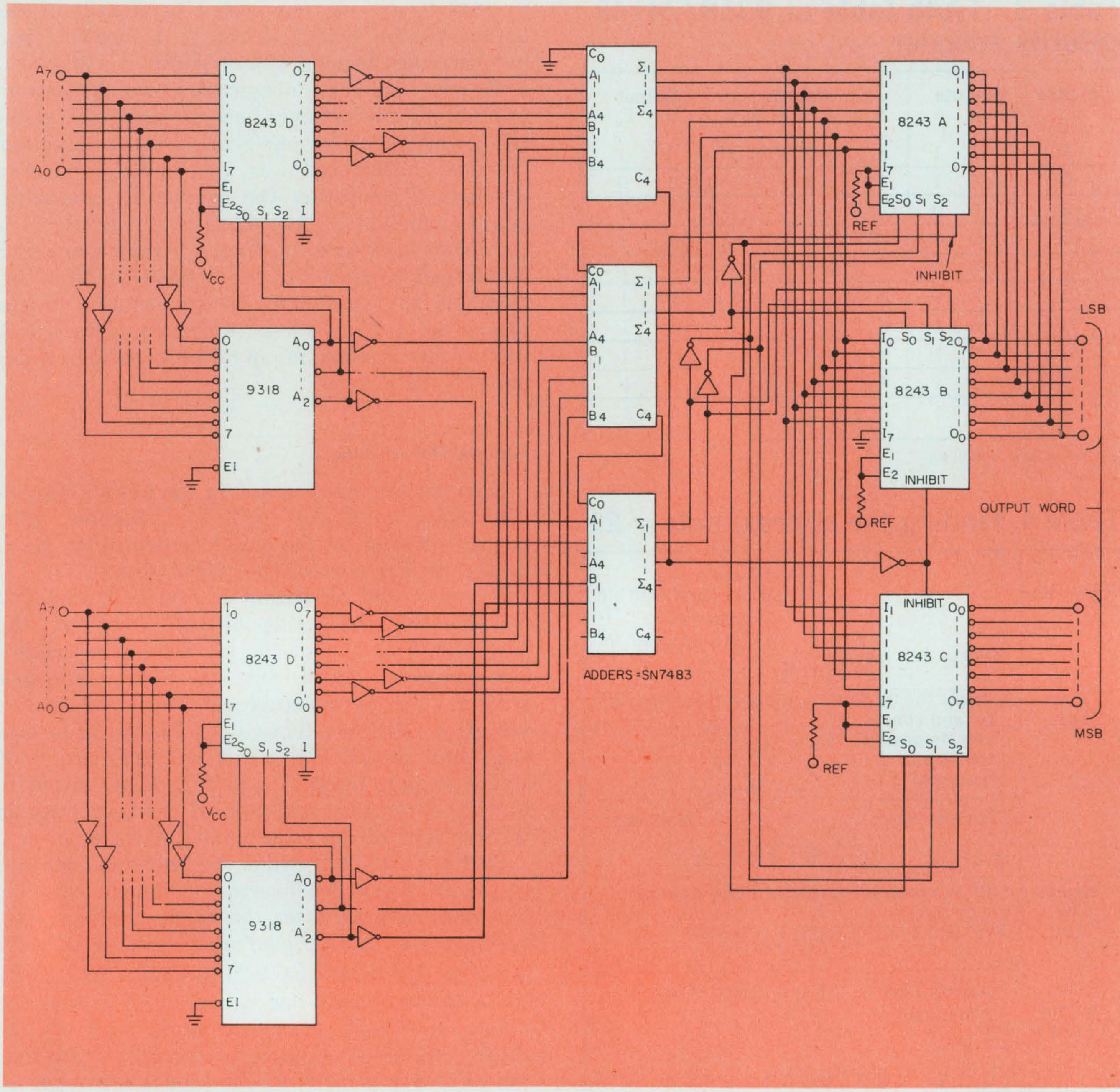
Examine the algorithm in Table 4, and you will find that the antilog operation converts the most-significant bit of the mantissa into the second most-significant bit of the square-root answer. The most significant bit is, of course, always a ONE bit. Thus I_3 of 8243-B is always at ground, or a ZERO, which converts to a ONE at the output. Input I_3 can shift from output 0_3 to 0_0 to cover the maximum of the four possible bit positions of the integer part of the answer.

Shifter 8243-C provides the fractional portion of the output and converts the binary value of the characteristic, after the hard-wired division-by-2 process, into an equivalent number of shift positions. Thus, in the $\sqrt{21}$ example, the (1/2) lg 21 characteristic has a weight of 2, and the inputs of 8243-C therefore must shift in the chip's outputs two places to the left. Note that for 8243-B and C, the S_1S_0 inputs are inverted to their true form. When the log was found, the number was shifted to the right; now, for the antilog, the shift is to the left.

And, finally, for values of S_1S_0 that are greater than ZERO, corresponding trailing bit positions of the answer must be forced to ZERO in the outputs. One-half of a Fairchild decoder 9321, or its T174S139 equivalent, decodes the S_1S_0 values and forces the least-significant bits to ZERO. For the $\sqrt{21}$ example, S_1 $S_0 = 2$; therefore the B'_6 and B'_7 outputs are forced to zero.

Multiply and divide with lg N

The approximate square-root processor is very simple to implement, and multiplication and division are easy, too. Multiplication requires only a single addition process, and division only a subtraction step.



3. **A combinatorial multiplying circuit** for two, 8-bit words uses adders between the log and antilog sections.

To illustrate multiplication with the linear approximation approach, let's multiply 61 by 99:

$N_1 = 61$	=	00111101
$N_2 = 99$	=	01100011
$\lg N_1$	=	101.1110100
$\lg N_2$	=	110.1000110
$P = \lg N_1 + \lg N_2$	=	1100.0111010
$N_1 \times N_2 = \lg^{-1} P$	=	1011101000000.
	=	5952 (−1.4% error)
61×99	=	6039 exactly

Note that although the input numbers are each limited to 8-bits in length, the adder must process 10-bit inputs. And the result may have as many as 16 bits, since the characteristic of P can have 4 bits. Thus the amount of hardware needed for a multiplier circuit increases very rapidly with the size of the operands.

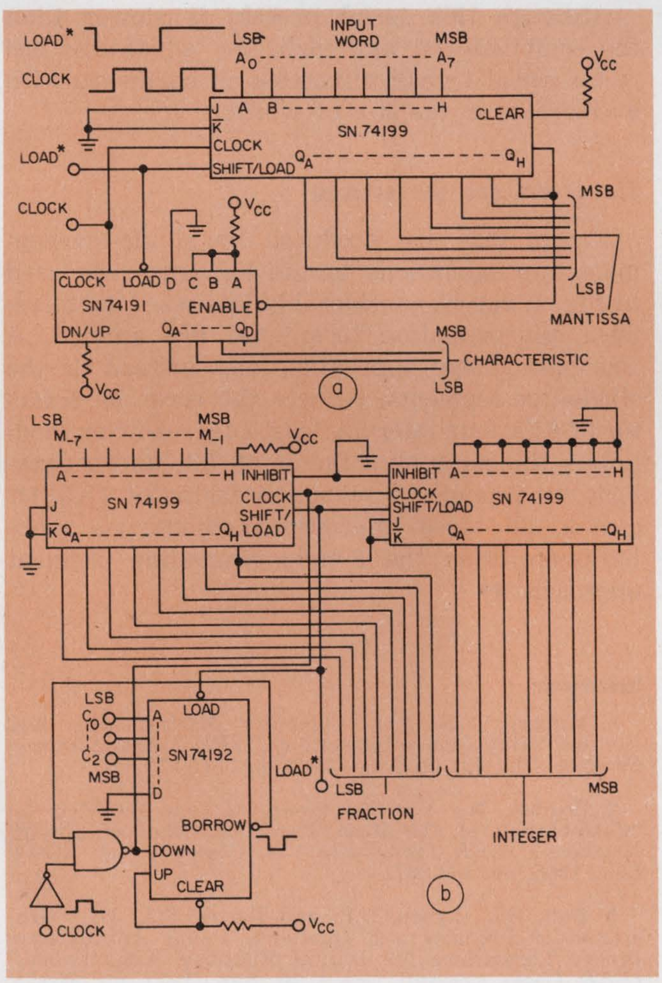
The logarithm-to-binary converter must be capable of shifting 15 places. Fig. 3 shows an 8-bit multiplier that uses the 8243s as converters (see Table 5 for antilog conversion); however, MSI multiplier ICs—such as the AM 2505 and SN 4284, and 9344, which allow high-speed combinatorial implementation of binary multiplication with no approximation error—might be more attractive for multiplication.

Division is a more attractive application for the logarithm method. For example, divide 5839 by 61:

$N_1 = 5839$	=	0001011011001111
$N_2 = \quad 61$	=	0000000000111101
$\lg N_1$	=	1100.011011001111

Table 5. Truth table for multiplier antilog converter

$S_3\,S_2\,S_1\,S_0$	8243 C								8243 B								8243 A							
	O_7	O_6	O_5	O_4	O_3	O_2	O_1	O_0	O_0	O_1	O_2	O_3	O_4	O_5	O_6	O_7	O_7	O_6	O_5	O_4	O_3	O_2	O_1	O_0
0 0 0 0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
0 0 0 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	$\overline{M_6}$
0 0 1 0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	$\overline{M_6}$	$\overline{M_5}$
0 0 1 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	$\overline{M_6}$	$\overline{M_5}$	$\overline{M_4}$
0 1 0 0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	$\overline{M_6}$	$\overline{M_5}$	$\overline{M_4}$	$\overline{M_3}$
0 1 0 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	$\overline{M_6}$	$\overline{M_5}$	$\overline{M_4}$	$\overline{M_3}$	$\overline{M_2}$
0 1 1 0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	$\overline{M_6}$	$\overline{M_5}$	$\overline{M_4}$	$\overline{M_3}$	$\overline{M_2}$	$\overline{M_1}$
0 1 1 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	$\overline{M_6}$	$\overline{M_5}$	$\overline{M_4}$	$\overline{M_3}$	$\overline{M_2}$	$\overline{M_1}$	$\overline{M_0}$
1 0 0 0	1	1	1	1	1	1	1	0	$\overline{M_6}$	$\overline{M_5}$	$\overline{M_4}$	$\overline{M_3}$	$\overline{M_2}$	$\overline{M_1}$	$\overline{M_0}$	1	1	1	1	1	1	1	1	1
1 0 0 1	1	1	1	1	1	1	0	$\overline{M_6}$	$\overline{M_5}$	$\overline{M_4}$	$\overline{M_3}$	$\overline{M_2}$	$\overline{M_1}$	$\overline{M_0}$	1	1	1	1	1	1	1	1	1	1
1 0 1 0	1	1	1	1	1	0	$\overline{M_6}$	$\overline{M_5}$	$\overline{M_4}$	$\overline{M_3}$	$\overline{M_2}$	$\overline{M_1}$	$\overline{M_0}$	1	1	1	1	1	1	1	1	1	1	1
1 0 1 1	1	1	1	1	0	$\overline{M_6}$	$\overline{M_5}$	$\overline{M_4}$	$\overline{M_3}$	$\overline{M_2}$	$\overline{M_1}$	$\overline{M_0}$	1	1	1	1	1	1	1	1	1	1	1	1
1 1 0 0	1	1	1	0	$\overline{M_6}$	$\overline{M_5}$	$\overline{M_4}$	$\overline{M_3}$	$\overline{M_2}$	$\overline{M_1}$	$\overline{M_0}$	1	1	1	1	1	1	1	1	1	1	1	1	1
1 1 0 1	1	1	0	$\overline{M_6}$	$\overline{M_5}$	$\overline{M_4}$	$\overline{M_3}$	$\overline{M_2}$	$\overline{M_1}$	$\overline{M_0}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1 1 1 0	1	0	$\overline{M_6}$	$\overline{M_5}$	$\overline{M_4}$	$\overline{M_3}$	$\overline{M_2}$	$\overline{M_1}$	$\overline{M_0}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1 1 1 1	0	$\overline{M_6}$	$\overline{M_5}$	$\overline{M_4}$	$\overline{M_3}$	$\overline{M_2}$	$\overline{M_1}$	$\overline{M_0}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	MSB															OR-tied								LSB



4. **Sequential converters** for log (a) and antilog (b) circuits require less hardware for handling larger numbers, but they need clocking circuits and they are much slower in operation than combinatorial circuits.

$$\lg N_2 = 0101.111010000000$$
$$\lg N_1 - \lg N_2 = 1100.011011001111$$
$$- \underline{0101.111010000000}$$
$$0110.100001001111$$
$$\lg^{-1} Q' = 1100001.001111$$
$$= 97.234375$$
$$(1.78\% \text{ error})$$
$$= 99 \text{ exactly.}$$

Division differs from multiplication in the use of subtraction instead of addition. This introduces a problem, because the result of the subtraction can produce a result that is larger or smaller than one. This depends upon whether the dividend is larger or smaller than the divisor. When the result is larger than one, as in the example, to find the antilog requires that the difference be shifted to the left. However, a right-shift operation is needed for a result that is less than one. The logic designer may then construct his circuit to handle only one of the two cases, and use scaling methods to properly place the decimal point. Or, he can devise more complex logic to directly handle either case.

A final note of caution: Since this logarithm method operates only on positive numbers, the multiplication and division of negative operands require special preprocessing of the numbers into suitable form before the Mitchell algorithm is used.

Serial converters need less hardware

The increase in hardware for numbers of more than 8 bits can be a serious problem. An alternate approach to generating approximate logs and antilogs is blocked out in Figs. 4a and b. In the binary-to-logarithm converter of Fig. 4a, the number N is loaded into a SN74199 shift register while a counter is reset to the $n-1$ condition ($n =$ number of bits). The number in the register is shifted right, while the counter is decremented. When a ONE is detected on the Q_H output of the SN74199, the operation of the shift register and counter is disabled. At this time the counter contains the characteristic of lg N, and the shift register contains its mantissa. The total length of the shift register should be the length of the full binary input word.

Fig. 4b shows how to convert the logarithm back to binary. The mantissa is loaded into a shift register, and a logic ONE is forced into the MSB + 1 position. The characteristic is loaded into a parallel load counter with the same pulse that loads the mantissa. Clock pulses then decrement the counter and shift the contents of the shift register to the right. When the counter decreases to zero, the borrow inhibits the clock to the antilog converter. The shift register then contains the resultant binary word.

Although this serial process is slower than the combinatorial approach, the advantage lies in the serial's smaller increase in hardware with an increase in the size of words.

The errors can be reduced

Errors that are produced by single-line-segment approximations to the log curve, as used in Fig. 1, can be considerably less when more refined approximation techniques are applied. A four-part linear approximation,[2] instead of the single-line segments, reduces the error by a factor of 6; a four-interval, least-squares-fit method[3] lowers the error by a factor of 7.8; and a parabolic fit[4] provides a reduction factor of 18.5. Of course, all these improved methods use more hardware than the simple single-line segment approach. ■■

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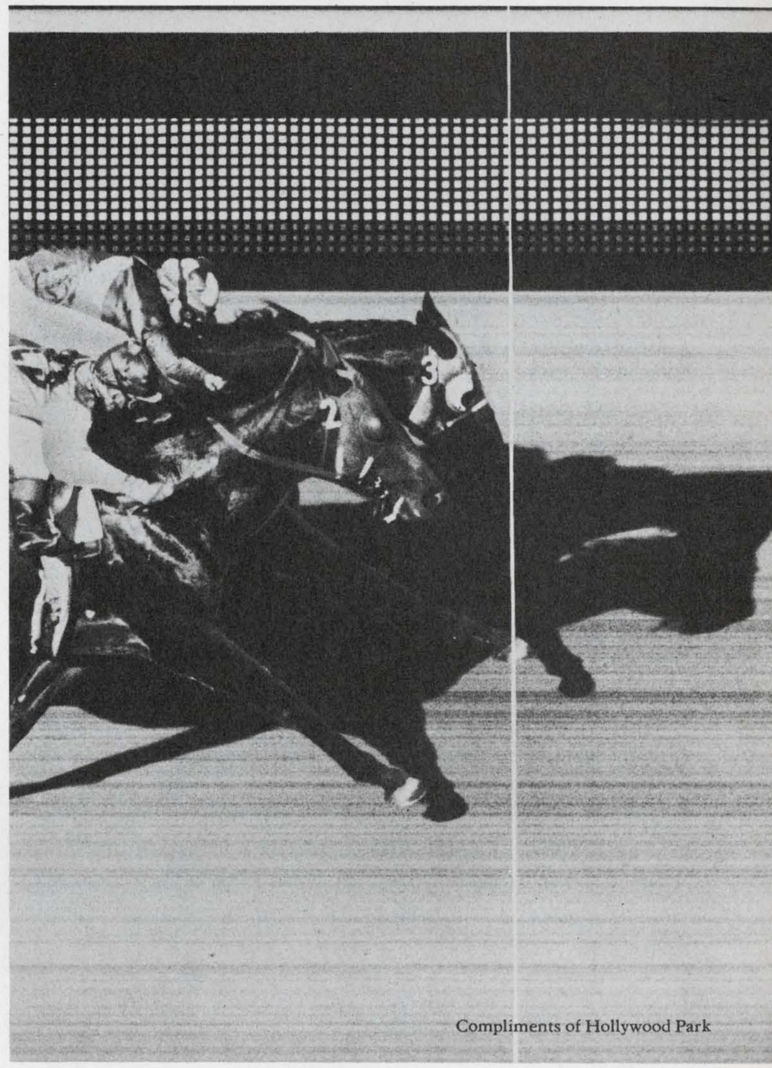
In the stretch it's LUCKY LADY in front...DANCING PRINCESS and MISTER GEORGE. And on the inside, FAST DRIVER. LUCKY LADY, DANCING PRINCESS and MISTER GEORGE. LUCKY LADY and DANCING PRINCESS. LUCKY LADY in front.

Down to the line of finish, it's LUCKY LADY and DANCING PRINCESS. And it's LUCKY LADY, the winner by a nose. DANCING PRINCESS is second by a length and a half in front of MISTER GEORGE.



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INFORMATION RETRIEVAL NUMBER 81

Program cuts logic-design costs

by letting you select with a computer the set of prime implicants that best meets your requirements.

If you want to design logic to have a minimum parts cost, here is a topological computer algorithm to help you select a minimal set of prime implicants. The program finds all irredundant prime-implicant sets to cover the minterms in the original function.

The designer chooses the set that best satisfies his design objective. The sets are irredundant covers because if one term is removed, the set no longer covers all minterms. Even a minicomputer suffices to handle many implicants. And you can use a higher-level language, such as Fortran. The algorithm is also useful for the minimization of the number of states in sequential logic.

The program accepts the problem in the form of a covering closure table, with the horizontal rows representing prime implicants and the vertical columns minterms of the function. To encode a given function, place a one in each column covered by the prime implicant of the row (Fig. 1). Closure tables for prime implicants do not contain zero entries.[1,2,3] However, similar tables are used when the number of states is minimized in sequential machines,[4,5] and these tables can have zero entries. The algorithm minimizes either form of covering closure table, so it's useful for either logic or sequential circuit design.

	PRIME IMPLICANTS	MINTERMS				
		2	6	7	13	15
(a)	x010	1	x	x	x	x
(b)	0x10	1	1	x	x	x
(c)	1x01	x	x	x	1	x
(d)	11x1	x	x	x	1	1
(e)	x111	x	x	1	x	1
(f)	011x	x	1	1	x	x

$F = \sum 2,6,7,13,15 + (\sum 9,10)_{\text{DON'T CARE}}$

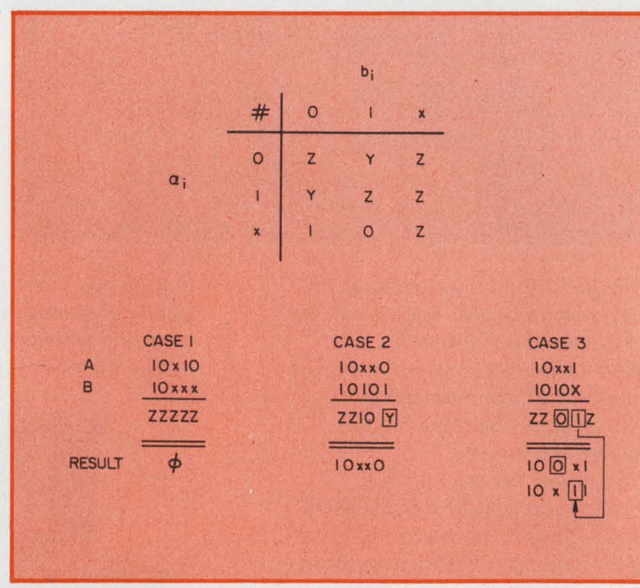
1. **List prime implicants horizontally.** Place a "1" under the minterms covered, otherwise an x. This gives a covering-closure table from which the algorithm extracts sets of irredundant prime implicants.

The extraction operation

The first step is to encode the columns of the table. If we let an x represent blank spaces in the table, the columns of the table in Fig. 1 are encoded as follows:

$$C_1 = 11xxxx$$
$$C_2 = x1xxx1$$
$$C_3 = xxxx11$$
$$C_4 = xx11xx$$
$$C_5 = xxx11x$$

A column encoded in this way is called a Boolean cube. The minimization algorithm uses a single topological operation on these cubes to obtain a minimum cover. That operation is the extraction



2. **Extraction operation deletes common minterms** from A and B. The operation has three outcomes: (1) Vacuous result if all elements are Z; (2) Copy A if one or more Y's occur; (3) Copy A for each occurrence of 1(0), with the 1(0) placed in that column's position. The initial source of A's and B's is the covering-closure table columns; x denotes a blank space in the table.

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operation defined by Miller.[5,6,7]

The extraction operation on Boolean cubes A and B removes from cube A all sub-cubes common to both A and B. Let $[A = (a_1 a_2 \cdots a_m)]$ and $[B = (b_1 b_2 \cdots b_m)]$ represent typical encoded cubes of m elements. Then the extraction operation, denoted #, is formally defined as:

Case 1: $A \leq B$ ($a_i = b_i$ or $b_i = x$ for all i); then $A \# B = \phi$.

Case 2: $A \cap B = \phi$ ($a_i = 0(1)$, $b_i = 1(0)$ for some i); then $A \# B = A$.

Case 3: Neither condition holds; then $A \# B = \bigcup_{i=1}^{m} (a_1 a_2 \cdots q_i \cdots a_m)$ for all $a_i = x$, $b_i \neq x$, and $q_i = 1(0)$ if $b_i = 0(1)$.

The pictorial representative of these rules (Fig. 2) illustrates outcomes for each of the three cases:

$$10x10 \ \# \ 10xxx = \phi$$
$$10xx0 \ \# \ 10101 = 10xx0$$
$$10xx1 \ \# \ 1010x = 100x1 \text{ and } 10x11.$$

The outcome of the operation is also a cube of m elements.

Four-step minimization algorithm

The algorithm uses a four-step loop to generate a series of cubes labeled $L_1, L_2 \ldots L_p$. If $\{C_i\}$

Fortran subroutines for minimization of prime-implicant covers

Main subroutine for cover calculation

```
SUBROUTINE XTRACT                                        CDC 6600 FTN V3.0-P308 OPT=1

      SUBROUTINE XTRACT (CI)
C
C     THIS ROUTINE EXTRACTS CI FROM L AND PUTS THE RESULTS IN LTMP.
C
      COMMON NROW, NCOL, NSOL, NTMP, MASKX, C(100), LTMP(100), L(100)
      INTEGER CI, C, AND, XOR, NOT, OR
      NOT(I) = -I
      XOR(I,J) = OR (AND (I, -J), AND (-I, J))
      NTMP = 0
      DO 40 I=1,NSOL
        J = AND (L(I), NOT (CI))
        IF(J .FQ. 0)GO TO 40
        J1 = XOR (L(I), CI)
        J1 = AND (AND (J1, J1*2), MASKX)
        IF(J1 .NE. 0) GO TO 30
        MASK = 3
        DO 20 K=1,NROW
          J1 = AND (J, MASK)
          IF(J1 .NE. 0)GO TO 10
          NTMP = NTMP+1
          LTMP(NTMP) = XOR (L(I), AND (CI, MASK))
   10     MASK = MASK*4
   20   CONTINUE
        GO TO 40
   30   NTMP = NTMP+1
        LTMP(NTMP) = L(I)
   40 CONTINUE
      RETURN
      END
```

Reduction operation

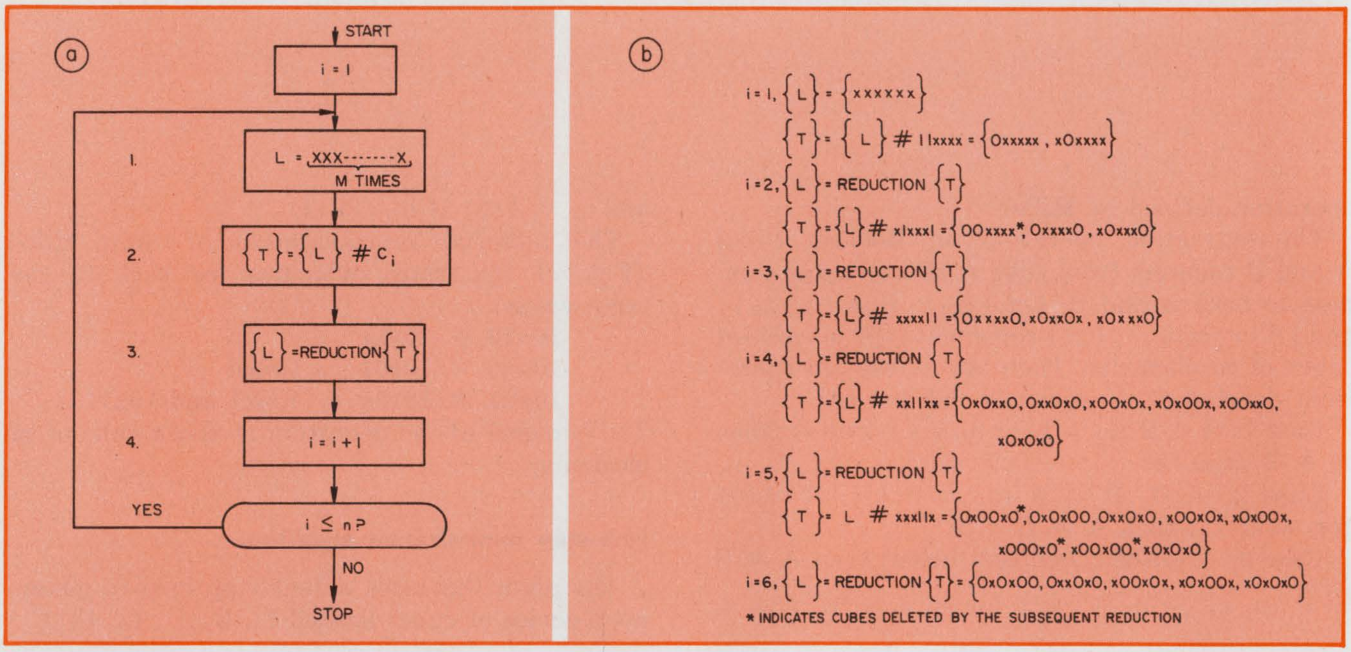
```
SUBROUTINE   REDUCE                                      CDC 6600 FTN V3.0-P308 OPT=1

      SUBROUTINE REDUCE

C
C     THIS ROUTINE SETS L = REDUCTION(LTMP)
C
      COMMON NROW, NCOL, NSOL, NTMP, MASKX, C(100), LTMP(100), L(100)
      INTEGER C,AND,NOT
      NOT(I) = -I
      NSOL = 1
      L(1) = LTMP(1)
      IF(NTMP .EQ. 1) RETURN
      DO 30 I=2,NTMP
        DO 20 J=1,NSOL
          K = AND (L(J), NOT (LTMP(I)))
          IF(K .NE. 0)GO TO 10
          L(J) = LTMP(I)
          GO TO 30
   10     K = AND (LTMP(I), NOT (L(J)))
          IF(K .EQ. 0)GO TO 30
   20   CONTINUE
        NSOL = NSOL+1
        L(NSOL) = LTMP(I)
   30 CONTINUE
      RETURN
      END
```

Extraction operation

```
SUBROUTINE   SOLVE                                       CDC 6600 FTN V3.0-P308 OPT=1
      SUBROUTINE SOLVE
C
C     THIS ROUTINE CALCULATES ALL POSSIBLE IRREDUNDANT COVERS FOR A
C     COVERING-CLOSURE TABLE WHOSE COLUMNS ARE STORED IN
C     C(1) ... C(NCOL).  EACH COLUMN CONTAINS NROW ELEMENTS.  THE
C     POSSIBLE SOLUTIONS ARE STORED IN L(1) ... L(NSOL)
C
      COMMON NROW, NCOL, NSOL, NTMP, MASKX, C(100), LTMP(100), L(100)
      INTEGER C
      NSOL = 1
      L(1) = 4**NROW - 1
      MASKX = 0
      DO 10 I=1,NROW
        MASKX =  MASKX*4 + 2
   10 CONTINUE
      DO 20 I=1,NCOL
C
C     EXTRACT C(I) FROM L, AND PLACE RESULTS IN LTMP
C
      CALL XTRACT (C(I))
C
C     SET L = REDUCTION (LTMP)
C
      CALL REDUCE
   20 CONTINUE
      RETURN
      END
```



3. **Side-by-side comparison** of algorithm and problem shows the types of results expected. The five-column table requires six iterations and has five possible irredundant covers. Zeros indicate the row (prime implicant) used for a given cover. The one used as the solution depends on various cost criteria.

is the set of columns of a covering-closure table with n columns and m rows, then:

1. i = 1
   {L} = x x x ··· x (m times).
2. {T} = L # C_i.
3. {L} = REDUCTION {T}.
4. i = i+1.
   If i ≦ n, go to Step 2.

Elimination of redundant cubes in T occurs in Step 3. Start with {L} = {T_1}. Compare each remaining T_i with every element of {L}. If an all-Z result is obtained at any point (Case 1), discard that T_i since it is a subset of some other member of {L}. If no comparison produces an all-Z result, add that T_i to {L}.

On completion of Step 4, set L will contain P cubes, each with m elements. Each L_j is a unique solution to the covering-closure table. The rows (prime implicants) are indicated by a "0" in L_i. If {L} is empty at any point in the calculation, then no cover exists for the table.

A side-by-side comparison between the algorithm and computational results (Fig. 3) for the five-column table shows five possible covers of the minterms.

1. 0x0x00 = a,c,e,f.
2. 0xx0x0 = a,d,f.
3. x00x0x = b,c,e.
4. x0x00x = b,d,e.
5. x0x0x0 = b,d,f.

The optimal solution depends on the cost criteria. If both the inputs and the complements of inputs are available, all prime implicants require one three-input AND gate and solutions 2, 3, 4 and 5 would yield equal costs.

When the complements are not available and must be generated by an inverter, the prime implicants can be assigned costs based upon the number of gates required for implementation. These costs are:

(a) 3
(b) 3
(c) 2
(d) 1
(e) 1
(f) 2

In this case, solution 4 is one gate less expensive than 2, 3 and 5. A number of algorithms exist for cost criteria where each row is assigned a fixed cost.

Some cost criteria, however, cannot be handled by existing techniques—say, when you assign costs based on the number of gates needed for implementation but allow sharing of the outputs from the inverters. In this case, if a complement is required by two different prime implicants (for example, b,f), the same inverter will be used for each. Therefore solutions 4 and 5 have equal cost.

Computer implementation

Primitive bit-by-bit operations—usually available as simple assembly-language commands—can perform the extraction operation and the data manipulation. These operations—bit-by-bit, OR, XOR and NOT—are also available in most Fortran implementations so higher-level languages are applicable.

Each cube or column is condensed to one or more computer words. The possible values 1,0,x become:

$$0 = 01$$
$$1 = 10$$
$$x = 11$$

A MASK word that consists of n repetitions of a bit pattern—in this instance, 10—is frequently used.

With these definitions, the three cases are determined by the following operations:

Case 1: AND (A, NOT (B)) = 0.
Case 2: AND(T, T*2, MASK) $\neq$ 0
T = XOR (A,B).
Case 3: Neither Case 1 nor Case 2.

The AND operation for Case 2 ANDs the three entities T, T*2 and MASK. The extraction operation consists of the copying of A into the storage location that has been designated to receive the result.

Additional processing is required for Case 3. And multiple results can occur. Assign S to be a set of words with member S_j. Then do the following:

Step 1. i=1; j=0; T = AND(A, NOT(B));
MASK=3.
Step 2. Y = AND(T,MASK);
if Y$\neq$0 then j = j + 1;
S_j = XOR(A,AND(B,MASK)).
Step 3. MASK = MASK *4;
i = i+1; if i $\leq$ m, go to Step 2.

Three Fortran subroutines can perform the four-step algorithm. The major subroutine SOLVE performs Step 1, then calls XTRACT and REDUCE to do Steps 2 and 3, respectively. A DO loop in SOLVE corresponds to Step 4. The program stores column data and answers in integer words, so the word length of the particular computer determines the number of rows that can be handled (one-half the word length). For example, the 60-bit CDC-6600 word permits entry of a 30-row table. Larger numbers of rows or smaller word lengths require storage of data in multiple words or possibly in separate arrays. Repeated multiplication by four, along with integer addition, suffices to map the input data to the desired binary pattern. ■■

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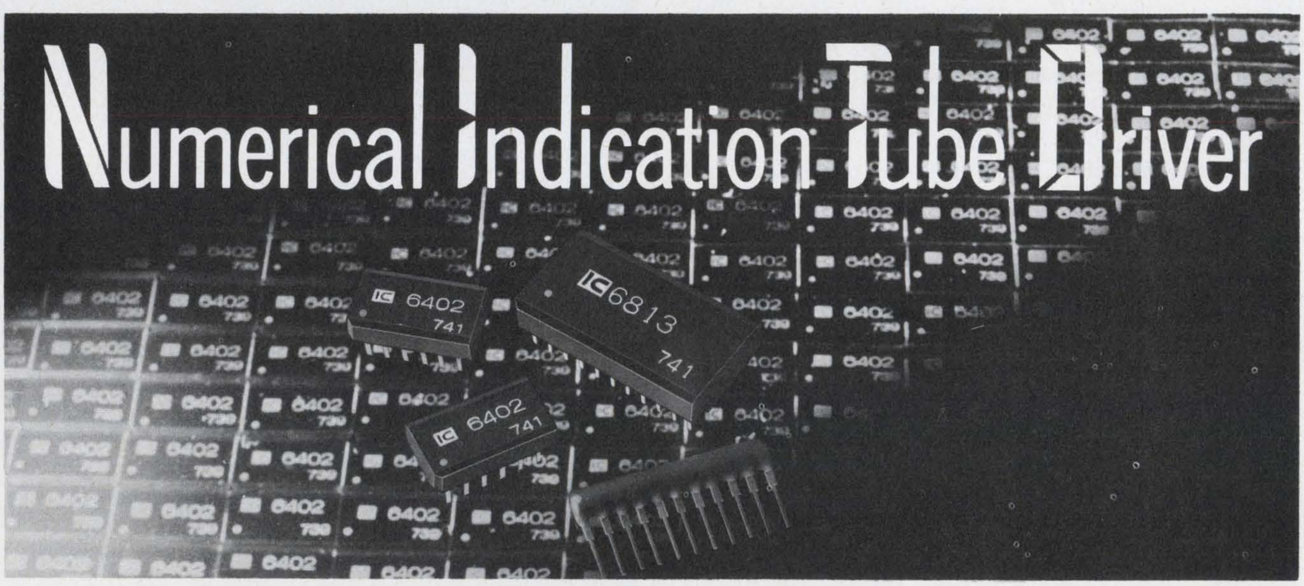

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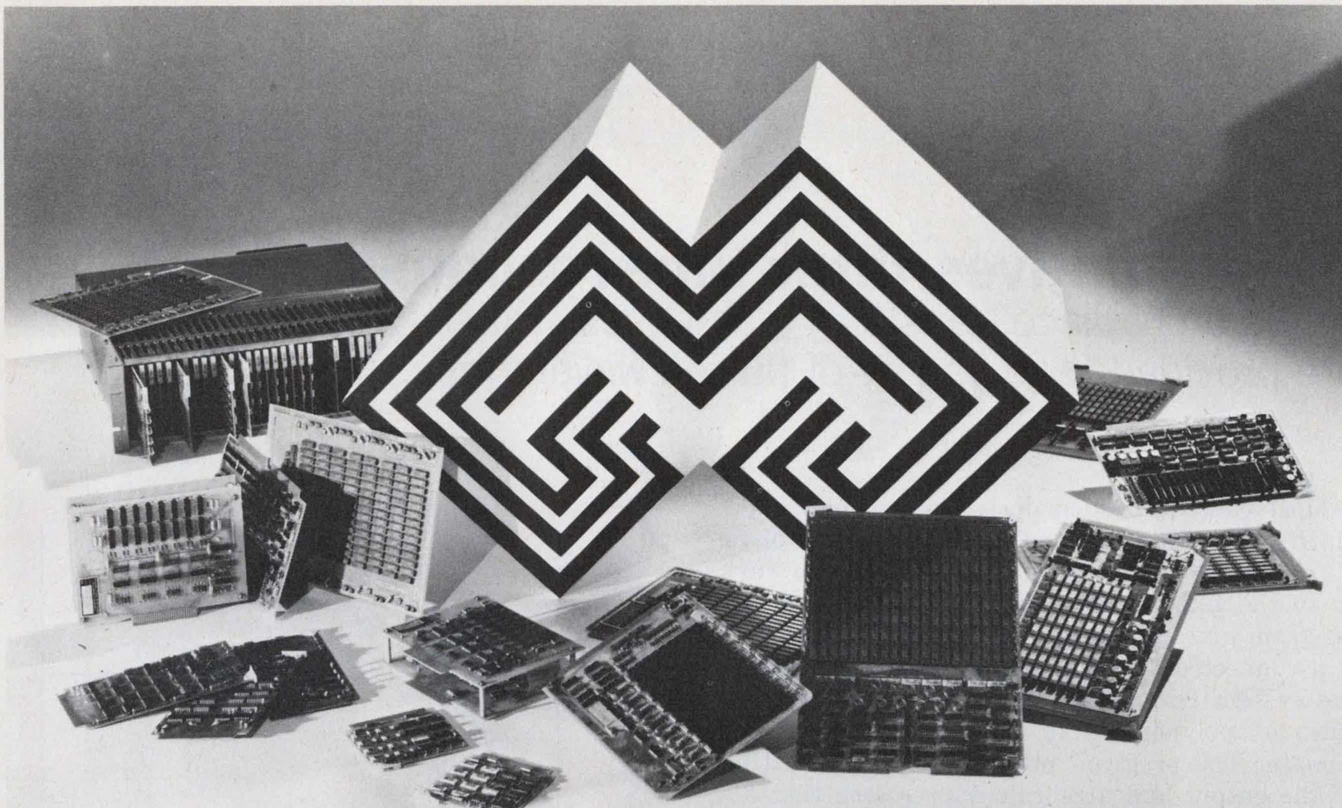

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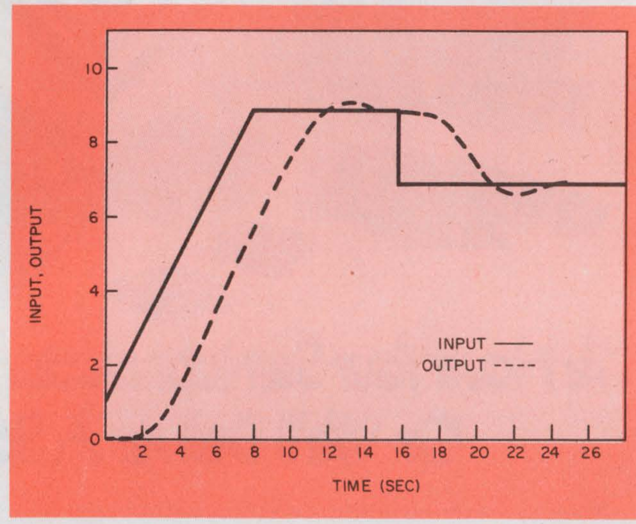
INFORMATION RETRIEVAL NUMBER 85

Program gives filter time response

based on Laplace transform techniques. Exact solutions are provided for a variety of pulsed waveforms.

Most computer-aided design procedures make much ado of filter frequency response and s-plane singularities but leave the designer in the dark as to the filter's time-domain response. A short program gives the time response when the input is a connected series of waveform segments and the system transfer function is described by a ratio of polynomials in the complex frequency domain. The program provides a tabular listing of the output and algebraic expressions that describe the response of the network to each segment of the input.

The type of output furnished is particularly useful for work with pulsed data systems, in which the network's time response is often as important as group-delay and frequency-attenuation characteristics.



1. **Exact responses of linear systems** to commonly used waveforms are computed in segments and combined. The forcing function, in this example, is inputted as a sequence of unit-step, positive-ramp, negative-ramp and negative-step waveforms.

Program uses partial fractions

The response of the network to each input segment can be written in the form of a ratio of polynomials in s. Once the response to each segment is calculated, the over-all response, by superposition, equals the sum of the individual responses.

The program input includes the system transfer-function coefficients, the number of forcing-function segments, the start time for each segment and the time between output data points.

The driving function (Fig. 1) consists of four Laplace transformable functions:

1. A unit step $u(t)$, $t > 0^+$.
2. A ramp $f(t) = t$, $t > 0^+$.
3. A ramp $f(t) = -(t-7.854)$, $t \geqq 7.854$.
4. A negative step $f(t) = -2$, $t \geqq 15.708$.

The program requests numerator and denominator coefficients for each input segment as well as the transfer function, which in this case is the fifth-order, unity-gain Butterworth filter

$$F(s) = 1/(s^5 + 3.2631\, s^4 + 5.2361\, s^3 + 5.2361\, s^2 + 3.2361\, s + 1).$$

Thomas H. Lecklider, Design Engineer, Gould, Inc., Instrument Systems Div., 3631 Perkins Ave., Cleveland, Ohio 44114.

All entries, system-transfer functions and input segments must be represented as a ratio of polynomials, with the coefficient of the highest-order denominator term normalized to unity (Fig. 2). The product of the input-function polynomial and transfer function must give a ratio of polynomials, in which the numerator polynomial is at least one order less than the order of the denominator. The program handles denominators of 10th order or less and up to fourth-order poles. Since poles of an order greater than four are seldom used, the only important restriction is on the order of the combined forcing and system functions.

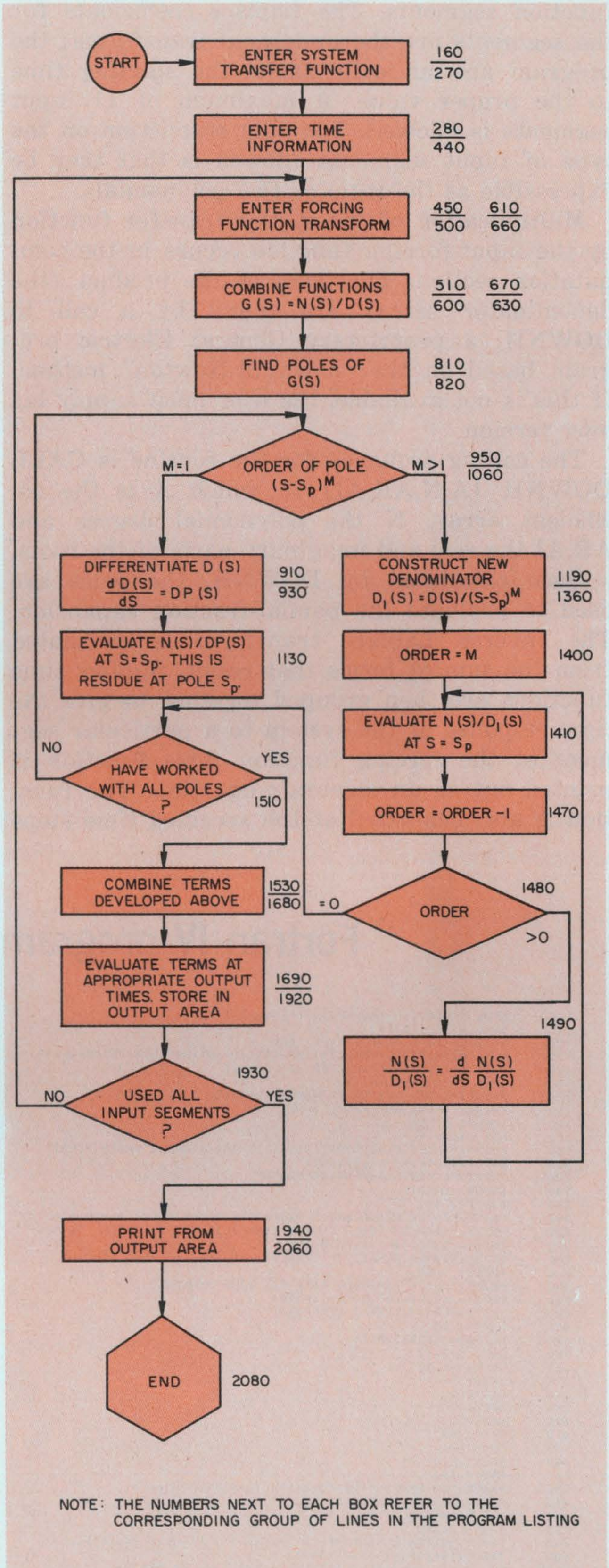
Program has three parts

The Fortran IV computer program, named LAPTR, is organized into three parts: input, computation and output.

The input section accepts transfer-function coefficients as well as the time interval between data output points. The transfer function is

```
LPTR        11:04EST    12/10/73

ENTER SYSTEM TRANSFER FUNCTIØN
ENTER NUMERATØR ØRDER?0

ENTER NUMERATØR CØEFFICIENTS; HIGHEST ØRDER FIRST?1.

ENTER DENØMINATØR ØRDER?5

ENTER DENØMINATØR CØEFFICIENTS; HIGHEST ØRDER FIRST.
HIGHEST ØRDER CØEFFICIENT MUST BE NØRMALIZED TØ 1.0.?1.,3.2361
?5.2361,5.2361,3.2361,1.

ENTER NUMBER ØF SEGMENTS IN FØRCING FUNCTIØN?4

ENTER STARTING TIME FØR EACH SEGMENT?0.,0.,7.854,15.708

ENTER ØUTPUT TIME STEP?.5

ENTER FØRCING FUNCTIØN TRANSFØRM          1
ENTER NUMERATØR ØRDER?0

ENTER NUMERATØR CØEFFICIENTS; HIGHEST ØRDER FIRST?1.

ENTER DENØMINATØR ØRDER?1

ENTER DENØMINATØR CØEFFICIENTS; HIGHEST ØRDER FIRST.
HIGHEST ØRDER CØEFFICIENT MUST BE NØRMALIZED TØ 1.0.?1.,0.


G( 1) =
       1.00000 * EXP**(  0.       *T) *T**( 0 )

      EXP**( -0.80904 *T) *T**( 0 )*(   0.00030 *CØS(   0.58775 *T)
       -2.75292 *SIN(   0.58775 *T)

      EXP**( -0.30901 *T) *T**( 0 )*(   0.89435 *CØS(   0.95106 *T)
       -0.00002 *SIN(   0.95106 *T)

       -1.89466 * EXP**( -1.00000 *T) *T**( 0 )

ENTER FØRCING FUNCTIØN TRANSFØRM          2
ENTER NUMERATØR ØRDER?0

ENTER NUMERATØR CØEFFICIENTS; HIGHEST ØRDER FIRST?1.

ENTER DENØMINATØR ØRDER?2

ENTER DENØMINATØR CØEFFICIENTS; HIGHEST ØRDER FIRST.
HIGHEST ØRDER CØEFFICIENT MUST BE NØRMALIZED TØ 1.0.?1.,0.,0.


G( 2) =
       1.00000 * EXP**(  0.       *T) *T**( 1 )

      -3.23610 * EXP**(  0.       *T) *T**( 0 )

      EXP**( -0.80904 *T) *T**( 0 )*(   1.61778 *CØS(   0.58775 *T)
        2.22741 *SIN(   0.58775 *T)

      EXP**( -0.30901 *T) *T**( 0 )*(  -0.27634 *CØS(   0.95106 *T)
        0.85059 *SIN(   0.95106 *T)

        1.89466 * EXP**( -1.00000 *T) *T**( 0 )

ENTER FØRCING FUNCTIØN TRANSFØRM          3
ENTER NUMERATØR ØRDER?0

ENTER NUMERATØR CØEFFICIENTS; HIGHEST ØRDER FIRST?-1.

ENTER DENØMINATØR ØRDER?2

ENTER DENØMINATØR CØEFFICIENTS; HIGHEST ØRDER FIRST.
HIGHEST ØRDER CØEFFICIENT MUST BE NØRMALIZED TØ 1.0.?1.,0.,0.


G( 3) =
      -1.00000 * EXP**(  0.       *T) *T**( 1 )

       3.23610 * EXP**(  0.       *T) *T**( 0 )

      EXP**( -0.80904 *T) *T**( 0 )*(  -1.61778 *CØS(   0.58775 *T)
       -2.22741 *SIN(   0.58775 *T)

      EXP**( -0.30901 *T) *T**( 0 )*(   0.27634 *CØS(   0.95106 *T)
       -0.85059 *SIN(   0.95106 *T)

       -1.89466 * EXP**( -1.00000 *T) *T**( 0 )

ENTER FØRCING FUNCTIØN TRANSFØRM          4
ENTER NUMERATØR ØRDER?0

ENTER NUMERATØR CØEFFICIENTS; HIGHEST ØRDER FIRST?-2.

ENTER DENØMINATØR ØRDER?1

ENTER DENØMINATØR CØEFFICIENTS; HIGHEST ØRDER FIRST.
HIGHEST ØRDER CØEFFICIENT MUST BE NØRMALIZED TØ 1.0.?1.,0.


G( 4) =
      -2.00000 * EXP**(  0.       *T) *T**( 0 )

      EXP**( -0.80904 *T) *T**( 0 )*(  -0.00061 *CØS(   0.58775 *T)
        5.50584 *SIN(   0.58775 *T)

      EXP**( -0.30901 *T) *T**( 0 )*(  -1.78871 *CØS(   0.95106 *T)
        0.00005 *SIN(   0.95106 *T)

        3.78932 * EXP**( -1.00000 *T) *T**( 0 )
```

2. **Program input is in the complex frequency domain** as a ratio of polynomials. The user inputs the system transfer-function coefficients as well as those of each forcing-function segment. The algebraic expression is the exact response of the system to each input segment, a unique feature of the program. The Laplace transform of each response must be of order 10 or less.



3. **Inversion of the Laplace transform** by partial fractions supplies the time-domain response. The program computes the response to each segment separately, then adds the results to obtain the complete response in accordance with the principle of superposition. Program operation is divided into three parts: input, computation of inverse Laplace transform and output accumulation.

entered first, followed by each of the driving function segments. The Laplace coefficients for the segments are the undelayed transforms; the program automatically shifts the starting time to the proper value. A maximum of 11 input segments is allowed. The only restriction on the type of input segments allowed is that they be expressible as the ratio of two polynomials.

Multiplication of the system-transfer function by the input-forcing function occurs in the computation section. The poles of the product (the denominator zeros) are found by a call to DOWNH, a proprietary General Electric program based on the "downhill-Newton" method. If this is not available, the user must supply his own version.

The calling sequence for the routine is CALL DOWNH (A,N,AR,AI) in which A is the coefficient array, N the polynomial degree and AR,AI the real and imaginary parts of the roots.

Once calculated by DOWNH, the poles are used to evaluate the partial-fraction expansion. The inverse Laplace transform is calculated from the sum of terms that result. Similar time functions are then grouped together to give the time response of the system to a particular segment of the forcing function. This function is printed out as an algebraic equation. The function is also evaluated at the specified time steps and the results stored in an output area.

Output data for each forcing function are calculated separately, then added to the output area. In this way the complete response is built up segment by segment.

The output section provides a tabular listing of the data accumulated in the output area. The program outputs 50 time-output pairs (Fig. 4). The user can add his own plotting routines or use the vendor's if graphical output is desired.■■

```
T   0.500  1.000  1.500  2.000  2.500  3.000  3.500  4.000  4.500  5.000
G   0.000  0.006  0.035  0.116  0.282  0.552  0.932  1.411  1.963  2.559

T   5.500  6.000  6.500  7.000  7.500  8.000  8.500  9.000  9.500 10.000
G   3.167  3.762  4.330  4.864  5.367  5.847  6.315  6.778  7.239  7.686

T  10.500 11.000 11.500 12.000 12.500 13.000 13.500 14.000 14.500 15.000
G   8.098  8.453  8.731  8.920  9.023  9.052  9.028  8.972  8.907  8.849

T  15.500 16.000 16.500 17.000 17.500 18.000 18.500 19.000 19.500 20.000
G   8.809  8.789  8.786  8.775  8.716  8.574  8.338  8.021  7.662  7.307

T  20.500 21.000 21.500 22.000 22.500 23.000 23.500 24.000 24.500 25.000
G   7.000  6.773  6.639  6.593  6.617  6.685  6.769  6.848  6.907  6.937
```

4. **Tabular output contains 50 values** of system output and the corresponding times. The output is taken directly from data accumulated in the output area. The same area can be used for input to user-supplied plotting routines.

Fortran IV program for transient analysis

```
      REAL N(100),IM,IMD,NF(100),IMN,NF(11)
      REAL N3(11),D3(11)
      INTEGER DØRD,DFØRD,D1,DF1,ØRD
      DIMENSIØN D(100),RTR(11),RTJ(11),M(10),DP(100),ANS(2,10,10)
      DIMENSIØN D2(100),GØUT(2,51),ST(11)
      DATA RTR/11*973461.2/
      PRINT,"ENTER SYSTEM TRANSFER FUNCTIØN "
      PRINT,"ENTER NUMERATØR ØRDER"
      INPUT, NØRD1
      N1= NØRD1+1
      PRINT,"ENTER NUMERATØR CØEFFICIENTS; HIGHEST ØRDER FIRST"
      INPUT,(N3(N1+1-I),I=1,N1)
      PRINT,"ENTER DENØMINATØR ØRDER"
      INPUT, DØRD1
      D1= DØRD1+1
      PRINT,"ENTER DENØMINATØR CØEFFICIENTS; HIGHEST ØRDER FIRST."
      PRINT,"HIGHEST ØRDER CØEFFICIENT MUST BE NØRMALIZED TØ 1.0."
      INPUT,(D3(D1+1-I),I=1,D1)
      PRINT,"ENTER NUMBER ØF SEGMENTS IN FØRCING FUNCTIØN"
      INPUT, NSEG
      PRINT,"ENTER STARTING TIME FØR EACH SEGMENT"
      INPUT, (ST(ISEG),ISEG=1,NSEG)
      PRINT,"ENTER ØUTPUT TIME STEP"
      INPUT, DT
      DØ 5000 ISEG=1,NSEG
      DØ 7 I=1,10
      DØ 7 J=1,10
      K=10*(I-1)+J
      N(K)=0.
      NP(K)=0.
      D(K)=0.
      DP(K)=0.
      D2(K)=0.
      ANS(1,I,J)=0.
    7 ANS(2,I,J)=0.
      PRINT,"ENTER FØRCING FUNCTIØN TRANSFØRM", ISEG
      PRINT,"ENTER NUMERATØR ØRDER"
      INPUT, NFØRD
      NF1=NFØRD+1
      PRINT,"ENTER NUMERATØR CØEFFICIENTS; HIGHEST ØRDER FIRST"
      INPUT,(NF(NF1+1-I),I=1,NF1)
C                MULTIPLY TØGETHER NUMERATØRS ØF SYSTEM
C                         AND FØRCING FUNCTIØNS.
      DØ 10 I=1,N1
      DØ 10 J=1,NF1
   10 NP(I+J-1)=NP(I+J-1)+N3(I)*NF(J)
      NØRD= NØRD1+ NFØRD
      N1=NØRD+1
      DØ 11 I=1,N1
      N(I)=NP(I)
   11 NP(I)=0.0
      PRINT,"ENTER DENØMINATØR ØRDER"
      INPUT, DFØRD
      DF1=DFØRD+1
      PRINT,"ENTER DENØMINATØR CØEFFICIENTS; HIGHEST ØRDER FIRST."
      PRINT,"HIGHEST ØRDER CØEFFICIENT MUST BE NØRMALIZED TØ 1.0."
      INPUT,(NF(DF1+1-I),I=1,DF1)
C                MULTIPLY TØGETHER DENØMINATØRS ØF SYSTEM
C                         AND FØRCING FUNCTIØNS.
      DØ 13 I=1,D1
      DØ 13 J=1,DF1
   13 NP(I+J-1)=NP(I+J-1)+D3(I)*NF(J)
      DØRD= DØRD1+ DFØRD
      D1=DØRD+1
      DØ 14 I=1,D1
      D2(I)=NP(I)
      M(I)=0
   14 NP(I)=0.0
      DØ 40 I=1,D1
   40 D(I)=D2(I)
      L1=DØRD
C                FIND PØLES ØF CØMBINED SYSTEM AND FØRCING FUNCTIØN.
      CALL DØWNH(D2,L1,RTR,RTJ)
      DØ 45 J14=1,11
      D2(J14)=0.
      IF(ABS(RTR(J14))-.001) 41,41,42
   41 RTR(J14)=0.0
   42 IF(ABS(RTJ(J14))-.001) 43,43,45
   43 RTJ(J14)=0.0
   45 CØNTINUE
C                SØRT PØLES ACCØRDING TØ THEIR MULTIPLICITY
      DØ 100 II=1,DØRD
      I=DØRD+1-II
      DP(I)=I*D(I+1)
      IF(RTR(I)-973461.2) 50,100,50
   50 M(I)=1
      I1=I-1
      IF(I1)100,100,55
   55 DØ 90 KK=1,I1
      K=I1+1-KK
       IF(ABS(RTR(K)-RTR(I))-.001)60,60,90
   60 IF(ABS(RTJ(K)-RTJ(I))-.001)70,70,90
   70 M(I)=M(I)+1
       RTR(K)=973461.2
       M(K)=0
   90 CØNTINUW
  100 CØNTINUE
C                EVALUATE CØMBINED SYSTEM AND FØRCING FUNCTIØN
C                         AT ALL FIRST ØRDER PØLES.
       DØ 1000 I=1,DØRD
       IF(RTR(I)-973461.2)120,1000,120
  120 IF(M(I)-1) 1000,130,1000
  130 ØRD=M(I)
       CALL PØVAL(RTR,RTJ,N,NP,DP,I,ØRD,DØRD,ANS,D2)
 1000 CØNTINUE
C                EVALUATE CØMBINED SYSTEM AND FØRCING FUNCTIØN
C                         AT ALL HIGHER ØRDER PØLES.
       DØ 2000 I=1,DØRD
```

```
      IF(M(I)-1)2000,2000,210
  210 D(1)=1.
      DO 215 K=1,99
      DF(K)=0.
  215 D(K+1)=0.
      K=1
      DO 250 J=1,DORD
      IF(J-I) 220,250,220
  220 IF(M(J)) 250,250,230
  230 ORD=M(J)
      K=K+ORD
  235 DO 240 LL=1,K
      L=K+1-LL
      D(L+1)=D(L)+D(L+1)
      RL=D(L)
      D(L)=-D(L)*RTR(J)+DF(L)*RTJ(J)
      DF(L+1)=DF(L)+DF(L+1)
      DF(L)=-DF(L)*RTR(J)-RL*RTJ(J)
  240 CONTINUE
      ORD=ORD-1
      IF(ORD) 250,250,235
  250 CONTINUE
      ORD=M(I)
  260 CALL POVAL(RTR,RTJ,N,NF,D,I,ORD,DORD,ANS,DF)
      L1=ORD-1
      IF(L1)2000,2000,262
  262 DO 265 L=1,L1
      ANS(1,I,ORD)=ANS(1,I,ORD)/L
  265 ANS(2,I,ORD)=ANS(2,I,ORD)/L
      ORD=ORD-1
      IF(ORD) 2000,2000,270
  270 CALL PODIF(N,NF,D,DF)
      GO TO 260
 2000 CONTINUE
      PRINT 540, ISEG
      DO 3000 I=1,DORD
      IF(M(I))3000,3000,300
  300 L=I+1
      EANS=RTR(I)
      ORD=M(I)
      IF(L-DORD)305,305,355
C                   FIND PAIRS OF CONJUGATE POLES.
  305 DO 350 J=L,DORD
      IF(ABS(RTR(I)-RTR(J))-.001)310,310,350
  310 IF(ABS(RTJ(I)+RTJ(J))-.001)320,320,350
  320 SARG= ABS(RTJ(I))
      LL=RTJ(I)/ABS(RTJ(I))
      DO 330 K=1,ORD
      L1=ORD-K
      SANS=-2.*LL*ANS(2,I,K)
      CANS=2*ANS(1,I,K)
      DO 325 KJ=1,51
      T=DT*KJ-ST(ISEG)
      IF(T) 325,325,324
C                   EVALUATE OUTPUT, FOR CURRENT SEGMENT,
C                                AT DT TIME STEPS.
  324 GOUT(1,KJ)=GOUT(1,KJ)+EXP(EANS*T)*T**(L1)*(CANS*
     &COS(SARG*T)+SANS*SIN(SARG*T))
  325 CONTINUE
  330 PRINT 510, EANS,L1,CANS,SARG,SANS,SARG
      M(I)=0
      M(J)=0
      GO TO 3000
  350 CONTINUE
  355 DO 370 J=1,ORD
      L1=ORD-J
      LL=L1+1
      CANS=ANS(1,I,LL)
      DO 360 KJ=1,51
      T=DT*KJ-ST(ISEG)
      IF(T) 360,360,359
  359 GOUT(1,KJ)=GOUT(1,KJ)+CANS*EXP(EANS*T)*T**(L1)
  360 CONTINUE
  370 PRINT 520,CANS,EANS,L1
 3000 CONTINUE
 5000 CONTINUE
      DO 380 J=1,51
  380 GOUT(2,J)= DT*J
      DO 4000 I=1,5
      J=10*(I-1)+1
      K=J+9
 4000 PRINT 530,(GOUT(2,L),L=J,K),(GOUT(1,L),L=J,K)
  510 FORMAT(1H ,7X,6HEXP**(,F9.5,10H *T) *T**(,I2,5H )*( ,
     &F9.5,7H *COS( ,F9.5,4H *T)/1H ,7X,F9.5,7H *SIN( ,F9.5,
     &4H *T)//)
  520 FORMAT(1H ,7X,F9.5,9H * EXP**(,F9.5,10H *T) *T**(,I2
     &,2H )//)
  530 FORMAT(1H0//1H ,3HT  ,9(F6.3,1X),F6.3/1H ,2HG ,10(F7.3))
  540 FORMAT(1H0,2HG(,I2,3H) =)
      STOP
      END
      SUBROUTINE PODIF(N,NF,D,DF)
C               DIFFERENTIATES QUOTIENT OF TWO POLYNOMIALS, N/D,
C               WITH COMPLEX COEFFICIENTS, AND RETURNS RESULTS
C               IN NF AND DF.
      REAL N(100),NF(100),N2(100),N2F(100)
      INTEGER ORD
      DIMENSION D(100),DF(100),D2(100),D2F(100)
      DO 100 L=1,50
      DO 100 J=1,50
      N2(L+J-1)= D(L)*N(J+1)*J-N(L)*D(J+1)*J-DF(L)*NF(J+1)*J
     &+NF(L)*DF(J+1)*J+N2(L+J-1)
      N2F(L+J-1)=D(L)*NF(J+1)*J-N(L)*DF(J+1)*J+DF(L)*N(J+1)*J
     &-NF(L)*D(J+1)*J+N2F(L+J-1)
      D2(L+J-1)=D(L)*D(J)-DF(L)*DF(J)+D2(L+J-1)
  100 D2F(L+J-1)=D(L)*DF(J)+DF(L)*D(J)+D2F(L+J-1)
      DO 200 L=1,100
      D(L)=D2(L)
      D2(L)=0.
      DF(L)=D2F(L)
      D2F(L)=0.
      N(L)=N2(L)
      N2(L)=0.
      NF(L)=N2F(L)
  200 N2F(L)=0.
      RETURN
      END
      SUBROUTINE POVAL(RTR,RTJ,N,NF,DF,I,ORD,DORD,ANS,D2)
C                   EVALUATES QUOTIENT OF TWO POLYNOMIALS WITH
C                            COMPLEX COEFFICIENTS.
      INTEGER DORD,ORD
      REAL N(100),IM,IMN,IMD,NF(100)
      DIMENSION RTR(11),RTJ(11),DF(100),ANS(2,10,10),D2(100)
      RL=RTR(I)
      IM=RTJ(I)
      IMD=D2(1)
      IMN=NF(1)
      RLD=DF(1)
      RLN=N(1)
      DO 140 J=1,99
      IMN=N(J+1)*IM+IMN+NF(J+1)*RL
      RLN=N(J+1)*RL+RLN-NF(J+1)*IM
      IMD=DF(J+1)*IM+IMD+D2(J+1)*RL
      RLD=DF(J+1)*RL+RLD-D2(J+1)*IM
      RL1=RL
      RL=RTR(I)*RL-RTJ(I)*IM
  140 IM=RTJ(I)*RL1+RTR(I)*IM
      DIV=RLD*RLD+IMD*IMD
      RL=RLN
      RLN=(RLN*RLD+IMN*IMD)/DIV
      IMN=(RLD*IMN-RL*IMD)/DIV
      ANS(1,I,ORD)=RLN
      ANS(2,I,ORD)=IMN
      RETURN
      END
```

IM6523

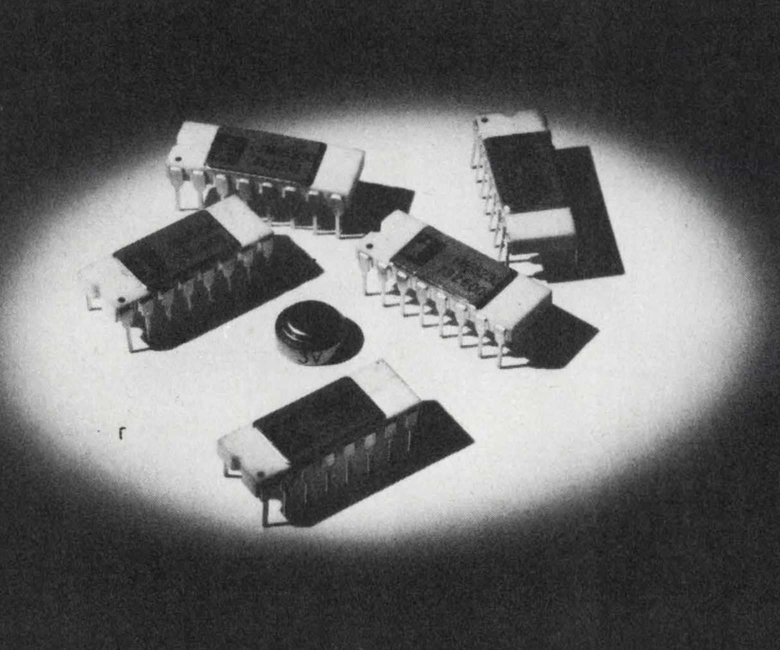
New 256 bit CMOS RAM.

Less than 0.002μW/bit standby.

And it's so easy to use.

It's the Intersil IM6523 256 bit CMOS silicon gate RAM, a low, low power memory any designer will love working with.

It typically uses less than 2 nanowatts per bit standby and 20 microwatts per bit active power, and works from a single power supply. Supply voltage may be anything from 3 to 7 volts.



New rules for faster design. Shortages of components, market changes, diminishing lead times—all call for a shrewder, more informed engineer.

It used to take as long to design a product as it does to have a baby, but faster and faster evolving markets and technology have changed that. Now designers must create a product in six months instead of nine, and tomorrow they'll probably have to do it even faster.

To meet the challenge, the engineers in our company, Data Precision, have had to alter their working habits. They had been following the trend of making the product less expensive and more convenient by using the latest technologies. But the ground rules for design have changed in the last few years in the following ways:

- Because of component shortages, today's designer must be more concerned about their price and availability than ever before.
- Unlimited design changes and improvements are a thing of the past; unlike the old aerospace market, in the commercial area it's still a question of price and field service.
- Customers don't want versatility any more. They are looking for small, inexpensive dedicated instruments, and here complex ICs are fulfilling the need.
- Engineers must learn to interface with all departments to be better informed about customer problems.
- Engineers must keep up with current events, particularly as they relate to overseas technology and competition.

New points of view needed

The older engineers tend to be conservative people; they resist change. The newer designers don't resist as much because they think that computer technology is a panacea, and that's not realistic either. To beat those attitudes, I had to make believers out of those fellows. I didn't tell them what to do; I told them what's happening.

For background, I told them that during the days of the big aerospace market, the engineer was insulated from problems other than those of design. He was separated from management, purchasing, sales and manufacturing because that's the way the system seemed to work best.

But what seems to work best now is for the engineer to interface with all departments, and especially with his customers. He should find out, for example, how shortages are affecting his

Harold Goldberg, President, Data Precision, Wakefield, Mass. 01880.

Harold Goldberg

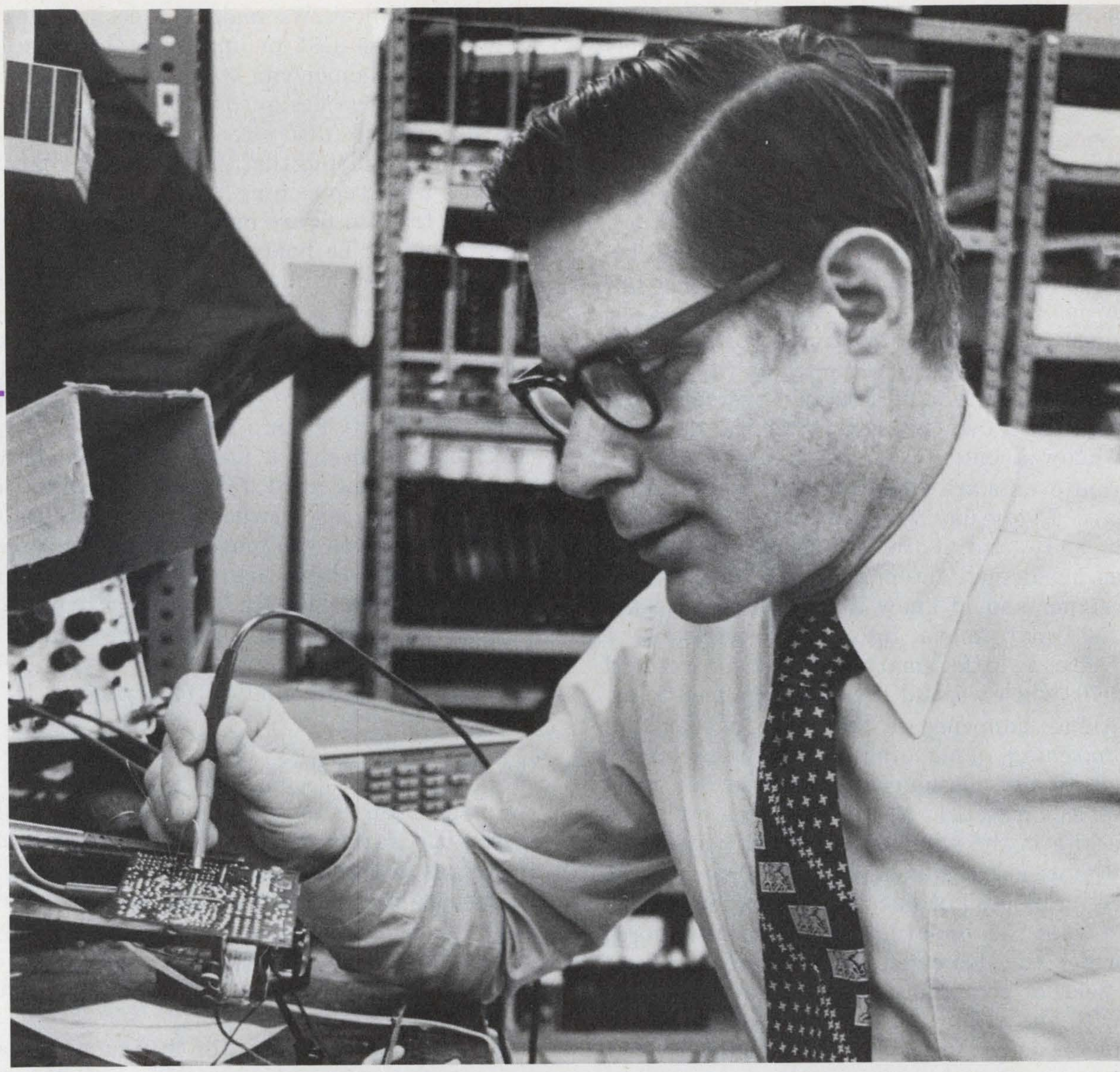
As a company president, Harold Goldberg has made good use of the courses in engineering economics he learned at Cooper Union in New York City where he graduated in 1944. But then he has found a knowledge of finances very helpful throughout his career in a large variety of jobs with many companies.

He started designing at Press Wireless, Radio Receptor, and Northern Radio, after a stint in the army. He earned an MEE at Brooklyn Polytech in 1950 and immediately got a job at the Allen B. Dumont Labs in New Jersey where he worked his way up to assistant production manager responsible for test facilities. He designed conveyorized test systems for radar and military receiver/transmitters, and TV receivers.

Later he joined Emerson Radio as head of engineering fabrication where he set up short-run manufacturing facilities. He left to become chief development engineer of Consolidated Avionics Corp., and, some years later, he became engineering manager of EPSCO, Systems Div. There he helped develop advanced data handling systems, multipoint analog inputs to computer formatted digital tape, PCM telemetry, manual, automatic and computerized automatic test equipment.

In 1962 he helped form Lexington Instrument Corp., a maker of medical instrumentation, as vice-president for R&D. He developed patient monitoring systems, coronary care units and measuring instrumentation, ectopic beat monitors, and multichannel EKG monitors.

When the company turned out to be more



of a technical success than a financial one, he left in 1966 to join Avco Research Labs at Everett, Mass., as part of Dr. Arthur Kantrowitz medical heart register research team. There for only 18 months, Mr. Goldberg designed the instrumentation and control to run the balloon counterpulsation research still in progress.

After joining ORION research in 1968 as operations manager and chief engineer of manufacturing electro-chemical instrumentation, he helped to develop the selective chemical measurement techniques that are changing the classical field of chemical analysis. In 1971 he helped start Data Precision Corporation, developing primarily digital multimeters. In the past three years the company has grown and prospered.

Mr. Goldberg is a member of the IEEE Board of Directors, and vice chairman of the Institute's technical activities board. When he finds time, he skis. When he doesn't find time to ski, he plants trees. He has turned a perfectly good pasture into a forest around his Lexington, Mass., home where he lives with his family.

customers and perhaps find a way to compensate.

The designer should accompany the salesman on his field trips. So often the salesman doesn't know what the engineer's design options are, and the engineer can be of valuable assistance if he's exposed to the problem personally. The designer must listen to his marketing people more than he ever did. The day of telling the sales people, "Look I'll design it, you go out and sell it," is gone, because the sales people know where the market is.

It's helpful, too, if the designer thinks the way the user of his equipment does—as a medical technician, for example, if it's medical equipment he's designing. It's not easy for an engineer to think this way, because seldom has he been trained in that direction. You might gently remind him that the ground rules have probably changed since he graduated from engineering school.

Current events influence designs

I also told our engineers that they must know more about current events and economics, because these affect their designs. The designer has to know more about foreign trade, because the government has put restrictions on items that are manufactured overseas. A lot of the designer's suppliers are manufacturing overseas, and they have their own problems that the designer should know about.

Current events are affecting us more than they ever have. Every day we read that electronics is moving more and more into other industries, such as medicine, automobiles and recreation. The designer should know that a couple of these industries may move into quasi-recessions. I hope we're a little smarter than we were in 1969-1970, when we said it couldn't happen to us.

What has happened is that for 30 years we were marching along singing our song totally oblivious to the outside word because our markets weren't affected. All of a sudden we're as much a kite in the wind as any other industry.

But the winds of change are prevalent even in our own industry. For one thing, very few people seem to want the versatile instrument any more; they prefer the dedicated instrument. The idea, in my field, of combining the capacitor measurement with the digital voltage or a counter with a voltmeter is very easy to do technically, but there's no market for it now. If the customer wants a voltmeter, that's what he wants. One large electronics company has found this out and changed its product structure to reflect this.

The usual engineering trick is to say that I can give the guy more because technically I can add this additional feature to it and it'll only cost me X number of bucks, and I steal a march on my competitors. But that doesn't work now.

Another thing I tell our engineers is to design smart without making the customer pay more. This doesn't mean the company absorbs the difference but rather the wise use of today's technology. No one has a monopoly on brains. The other guy is just as smart as I am, maybe smarter. Fortunately, for me, there can be more than one winner.

Flexibility to counter shortages

Shortages have taught our engineers a little humility. They can't afford to ignore the parts salesman as they used to. And they can no longer rely on one vendor or one technology to see them through a project. We make the designs flexible, so we can use LSI or multiple chips, in case some of the components we've ordered don't arrive. Also, we've designed a PC board that can use ICs and/or discretes. In good times we'd never think of doing that, but who can guarantee that ICs will keep coming in.

We've tried to figure out what might be stolen or what might be hoarded as a result of shortages. We make a miniaturized product that could be carried off by a thief easily. We're now designing it with a benchstand so it's not so easy to steal; the benchstand itself is very difficult to take apart. And we're coming out with a larger model that won't fit into a lunch pail.

We used to design a piece of equipment with a removable line cord for the customers' convenience. If it isn't removable, it dangles and gets in the way as you move it. Line cords today, if you can get them, are delivered in 26 to 52 weeks. You don't design a product with a removable line cord today because they walk. You have no way of knowing that unless you go into the customer's plant and he tells you.

The need to think ahead

Finally I think the designer has to do a little crystal-ball gazing to get a feel for the direction of designs in the future.

The computer industry, at the moment, is relatively unaffected by design changes, because we're still in the throes of moving computerized systems into new areas, such as inventory control and accounting systems.

The new design area for instruments is to move digital output instruments into the field formally served by analog instruments. With the advent of molded plastics, we've been able to move into the analog domain with the $200 multimeters. The LSI chip has enabled us to move in size and complexity into the analog world and compete effectively. Obviously the market is looking for instruments that are both portable and inexpensive.

In components, more and more people want complex ICs, because there's a major space saving, a major power-dissipation savings and, in many cases, a major cost savings. The ticket of admission is very high. What the IC manufacturer tries to do is develop his own proprietary product, which he can then sell to the instrument or device manufacturer. He's second-guessing the guy who's making the instrument.

We have to find a way to control the situation, because, for one thing, the maker is forced to design around what the IC maker has to offer, and I don't believe anyone thinks that's healthy —to have an IC maker dictate what we're going to design. ■■

10-MHz differential video line receiver built with monolithic IC transistor array

Use the well-matched properties of the CA3046 monolithic npn IC transistor array to build a differential video line receiver. The circuit amplifies signals between a coaxial cable's center conductor and shield, but rejects common-mode voltages to ground. Video-signal levels can be 2 V pk-pk, with a ±5-V common-mode range.

The circuit shown exploits the matching of the five transistors in the array. Transistors Q_3 and Q_4 form a degenerated (controlled gain) differential pair with Q_1 and Q_2 used as an emitter-current source. With no signal coupling between the Q_3 and Q_4 emitters, the common-mode amplification is very low, due to the low output conductance of Q_1 and Q_2. The low conductance produces a common-mode rejection of 60 dB, while the differential signal transfer through R_6 and R_7 results in nominal unity gain for differential signals. The actual gain is very close to the ratio of R_{11} to $R_6 + R_7$.

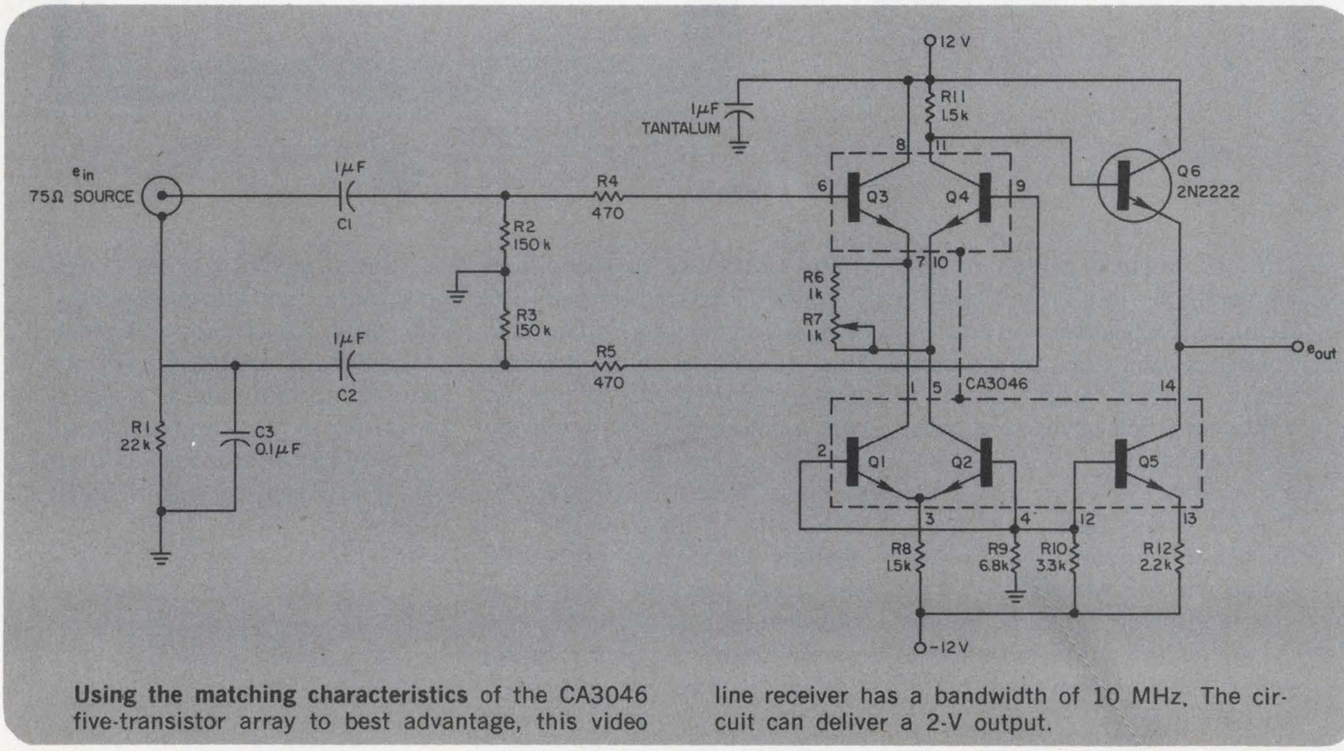
A common-mode swing of 10 V pk-pk is provided by Q_1 and Q_2. The transistors are biased to feed 1 mA into each side of the differential pair, Q_3 and Q_4. Parasitic suppression resistors are used in the Q_3 and Q_4 input base leads to prevent vhf oscillations. The remaining array transistor is used as an emitter feed for the discrete output buffer, Q_6.

The high f_t of the transistors, low circuit time constants and the common-collector/common-base drive of Q_3 and Q_4 give the circuit a video bandwidth greater than 10 MHz.

The input impedance is high enough to bridge a 75 Ω coaxial line without excessive loading, and does not reflect Miller capacitance to the input line. Loads should be 2 kΩ or greater, and Q_6 will deliver a 2-V pk-pk linear output.

Walter Jung, 1946 Pleasantville Rd., Forest Hill, Md. 21050.

CIRCLE NO. 311



Using the matching characteristics of the CA3046 five-transistor array to best advantage, this video line receiver has a bandwidth of 10 MHz. The circuit can deliver a 2-V output.

Transistor reduces output variation in three-terminal regulator circuit

The addition of a transistor buffer improves regulation by a factor of β when a three-terminal regulator is used in conjunction with a resistive divider. The divider circuit is often used to obtain adjustable or nonstandard output voltages.

The voltage divider (Fig. 1a) biases the ground lead so that the output voltage V_o equals

$$V_O = V_{XX}\,(1 + R_2/R_1) + R_2 I_Q. \qquad (1)$$

Output regulation is degraded by changes in I_Q in accordance with

$$\frac{d\,V_O}{d\,I_Q} = R_2. \qquad (2)$$

For the LM340 series, I_Q can vary by 1.5 mA with line and load changes, so that the output change varies by as much as 150 mV for $R_2 = 100\ \Omega$.

Use of the transistor (Fig. 1b) improves voltage regulation by a factor of β, as shown by the equation for the output voltage:

$$V_O = V_{XX}(1 + R_2/R_1) + (R_2\, I_Q)/\beta + V_{BE}.$$

For example, if Q_1 has a β of 100, the output change is 1.5 mV instead of 150 mV. Use of diode CR_1 minimizes the effect of V_{BE} drift on V_O.

A similar scheme improves regulation of a current source built from a three-terminal current regulator. Without the transistor (Fig. 2a):

$$I_O = \frac{V_{XX}}{R} + I_Q. \qquad (3)$$

Use of the transistor (Fig. 2b) gives

$$I_O = \frac{V_{XX}}{R} + \frac{I_Q}{\beta}, \qquad (4)$$

so that the effects of variation in I_Q on the output is reduced by a factor of β.

Eqs. 1 to 4 apply to positive regulators, such as National's LM109 and LM340 series, Fairchild's A7800 series and Beckman's 805 series. The method also works with negative regulators, such as National's LM120 series and Beckman's 855 series. However, an npn transistor is required, and the diode polarity must be reversed.

J. C. Anderson and R. E. Shipp, Beckman Instruments, Inc., Helipot Div., 2500 Harbor Blvd., Fullerton, Calif. 92634.

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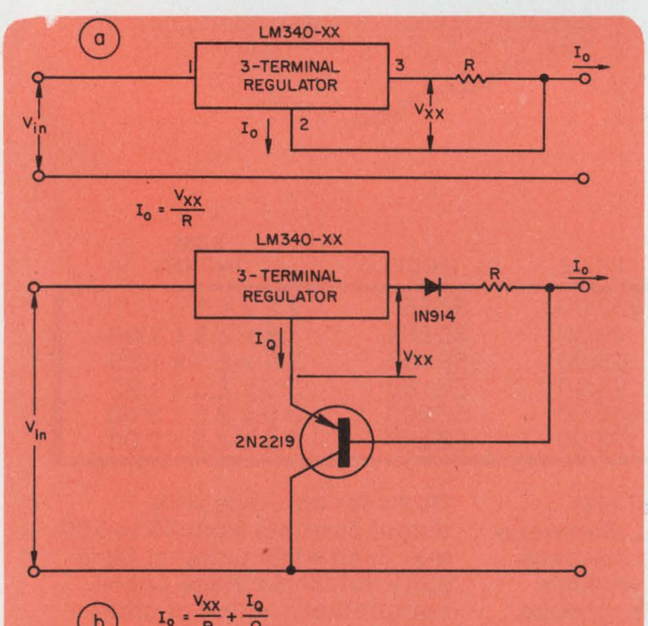
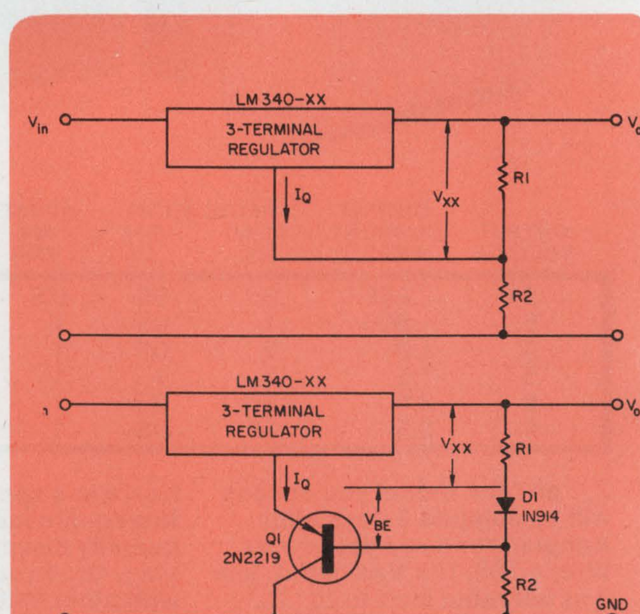


1. **Resistive output divider allows adjustment** of three-terminal regulator output (a) at the expense of variations due to changes in I_Q. Addition of the transistor (b) reduces this sensitivity by a factor of β.



2. **Current regulator sensitivity to I_Q** (a) can also be reduced with addition of the transistor-diode circuit (b).

A few extra components 741 op amps for high-voltage-swing applications

Have a special application where large output swings and high voltages are required? With the circuit shown, you can boost the voltage capability of the 741 op amp to handle ±45-V supply voltages, deliver output swings of 70 V pk-pk and even have adjustable gain.

Resistors R_1, R_2, R_3 and R_4 form a voltage divider that splits the ±45-V supply down to ±22.5 V. Transistors Q_1 and Q_2 drop the ±22.5 V still further, by 0.7 V. Thus the op-amp supply terminals never see more than a 43.6-V differential.

Transistors Q_1 and Q_2 always conduct, and thus maintain the 43.6 V across the op-amp supply terminals under all signal conditions. You can prove this with the following three equations:

$$+V = +\left(45 - \frac{45 - V_o}{2} - 0.7\right) = 21.8 + \frac{V_o}{2} \qquad (1)$$

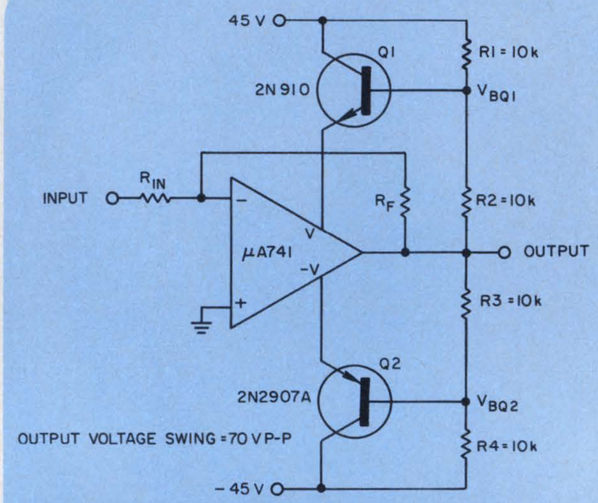
$$-V = -\left(45 - \frac{45 + V_o}{2} - 0.7\right) = -\left(21.8 - \frac{V_o}{2}\right) \qquad (2)$$

$$(+V) - (-V) = \left(21.8 + \frac{V_o}{2}\right) + \left(21.8 - \frac{V_o}{2}\right) = 43.6 \qquad (3).$$

Resistors R_F and R_{IN} adjust the gain as usual. The table shows that a 72-V pk-pk output signal is possible without the op-amp specs being exceeded and by use of a 2-kΩ load.

Surjan Dogra, Gull Airborne Instruments Inc., 55 Engineers Rd., Smithtown, N.Y. 11787.

CIRCLE NO. 313



V_O	V_{BQ1}	V_{BQ2}	V	−V	(V) (-V)
0	22.5	−22.5	21.8	−21.8	43.6
36	40.5	−4.5	39.8	−3.8	43.6
−36	4.5	−40.5	3.8	−39.8	43.6

Two transistors and a few resistors help the 741 op amp handle 72-V pk-pk output-voltage swings and ±45-V supply voltages.

IFD Winner of December 20, 1973

Robert W. Wedwick, Senior Engineer, Honeywell Information Systems, Inc., 13430 N. Black Canyon Highway, Phoenix, Ariz. 85029. His idea "Detector Gives Computer Warning of ac Power-Line Failure in 150 μs" has been voted the Most Valuable of Issue Award.

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DPM forms the basis for inexpensive laboratory temperature measurements

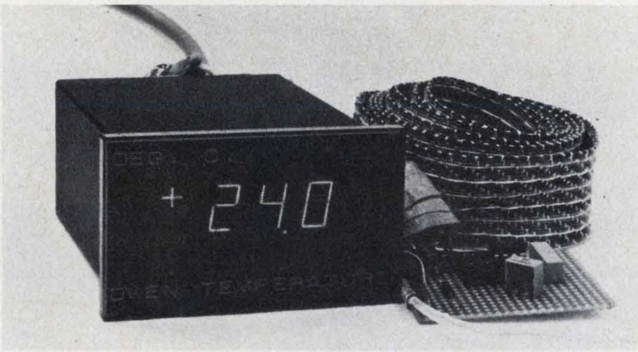
If you've got a DPM that can measure ratios, you can follow the lead of Analog Devices and use the meter to build an inexpensive instrument to measure temperature. And if the DPM outputs dc power, then you'll need only a few additional components to complete the unit.

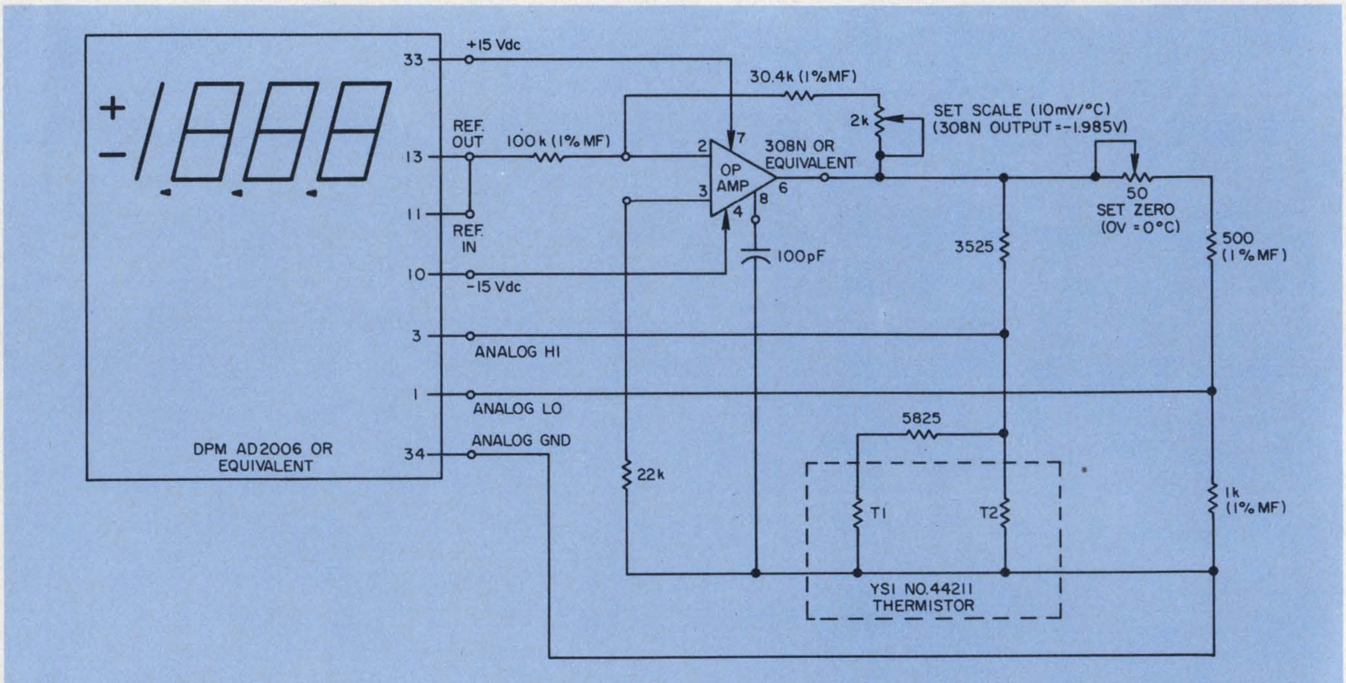
With the DPM and components shown in the diagram, the instrument has a range of −55 to +125 C, can resolve 0.1 C and has an accuracy of 1 C.

The thermistor is a YSI-44211, available from Yellow Springs Instrument Co., Yellow Springs, Ohio. The 2-V excitation needed by the thermistor was derived from the DPM's internal reference via the op amp, used as a buffer and scaler.

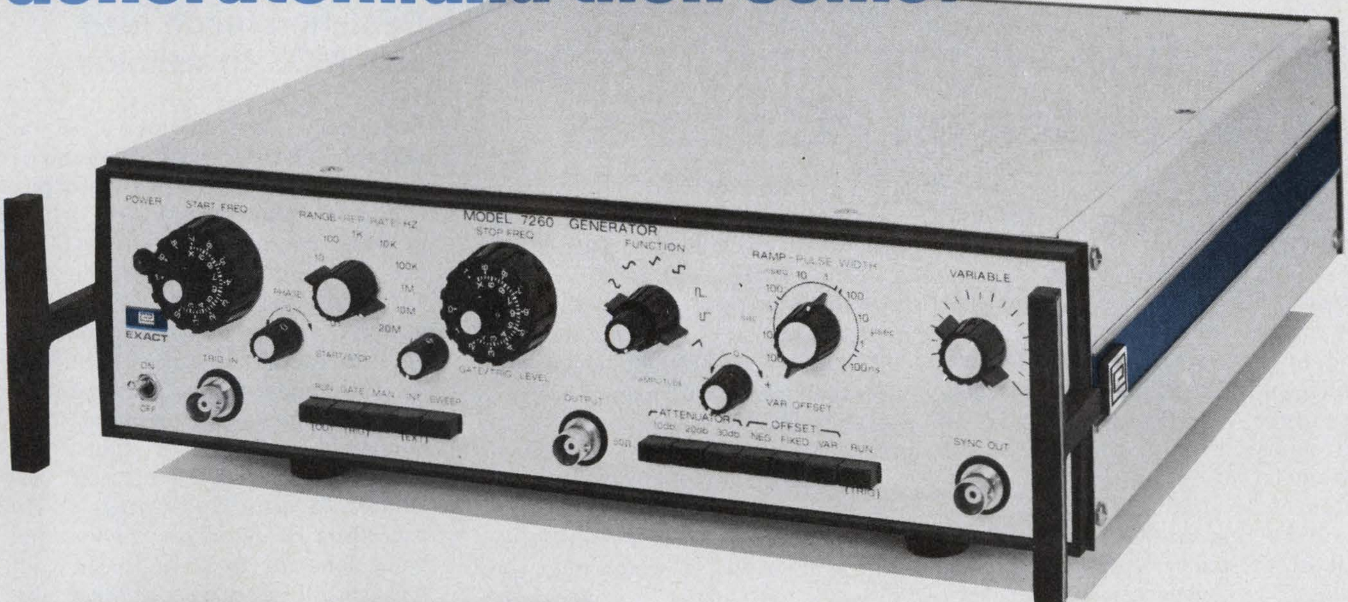
Trimming pots are used to calibrate the zero and the scale factor. Thus the 50-Ω pot is adjusted so that 0 C gives a reading of zero volts, and the 2-kΩ pot sets the scale factor to read 10 mV/°C. Calibration can also be set for Fahrenheit readings.

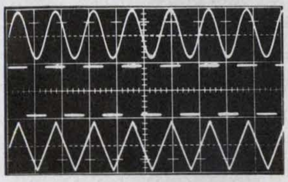
The result: an accurate measuring tool that is in continuous use at Analog Devices' engineering laboratories to check the temperature rise of new products.



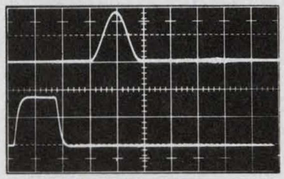


VCF/Sweep/Start-Stop/Pulse/Ramp/Sync/Trigger/Search/2-in-1 Function Generator...and then some!

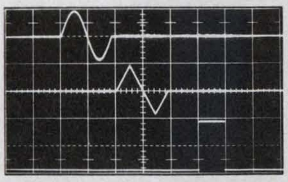




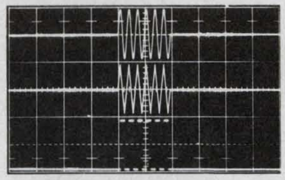
Sine, square and triangle waveforms.



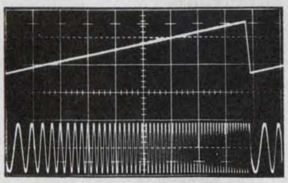
Sine² pulse (top waveform) and 100 ns pulse (bottom waveform).



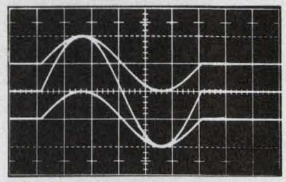
Single shot waveforms.



Burst mode.



Sweeping with internal ramp.



Fixed D.C. offset halves amplitude and offsets waveform positive or negative in relation to ground.

The Exact Model 7260 VCF/Sweep Generator is one in a series of higher performance instruments designed to be more useful in more test applications.

Its frequency range, from 0.0001 Hz to 20 MHz, expands the versatility of function generators into new areas. For instance, the Model 7260's ability to produce sine^2 waveforms to 20 MHz now provides a signal source for transmission line testing. Frequency response is flat all the way out to 20 MHz, with high quality waveforms even at the highest frequencies.

For sweep applications, the Model 7260 offers "start" and "stop" frequency controls that let you precisely set starting and stopping frequencies. Accurate Kelvin-Varley dividers tell you exact frequencies without using a counter.

As a pulse generator, the Model 7260 produces pulses with widths variable from 100 ns to 1000 seconds, and repetition rates from 0.0001 Hz to a full 20 MHz. Ramp waveforms with ramp times from 100 ns to 1000 seconds are another plus in this instrument.

The Model 7260 sets the pace in D.C. offset, too, with the ability to select either fixed positive or negative or variable ±15V offset. Offset also can be externally programmed with an analog voltage.

Two complete generators in one, the Model 7260 generates sine, square, triangle, ramp, pulse and sync waveforms, sweeps over a 1000:1 range and has push-button control of the operating modes of both generators. The main generator can operate in internal and external trigger modes. In the internal trigger mode, the ramp/pulse generator triggers the main generator. Other features include 80 db step attenuation, V:f (voltage proportional to frequency) output, search mode, floating output, sync input for locking to an external frequency or clock and 30V P-P open circuit (15V P-P into 50 ohms) output.

20 MHz Models:

Model 7260 VCF/Sweep Generator . . . . $ 895.00
Model 7271, same as Model 7260 with the addition of lin or logarithmic sweep plus gated sweep $1,145.00

11 MHz Models:

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INFORMATION RETRIEVAL NUMBER 92

international technology

Ultra-fine wiring for IC chips saves space on PC boards

A system that uses ultra-fine, insulated copper wires to interconnect IC chips requires one-tenth the area of comparable multilayer circuit boards. Developed by researchers at the Laboratoire d'Electronique et de Technologie de l'Informatique in Grenoble, France, the wire has a diameter of 30 μm and an insulation of 10 μm.

With this system, the wires can lie a few micrometers apart, compared with separation of at least 1000 μm for regular PC board connectors. The heat resulting from the ultra-compact wiring is dispersed when the circuits are mounted on a copper plate.

The developers estimate that production runs of less than 500 could pay for the setting-up costs. By contrast, production runs of several thousand are needed to justify the preparation costs for conventional multilayer circuits.

The wired-up circuits can be combined with PC boards where required. The French researchers are working on a system that uses 15-μm wire suitable for welded connections. Commercial production of the system is expected this year.

Common Market studies linear-motor TRANSIT

A proposed 186-mph rapid-transit system powered by linear motors is being studied by the Commission of the European Communities (Common Market).

A group of European manufacturers of linear-propulsion equipment presented the initial outline to the Commission in Brussels. The system would link major cities in Europe.

No details of the mode of suspension have been made public so far. However, the linear motor has been mentioned often in conjunction with the tracked air-cushion vehicle which travels in the 150-to-200-mph range. Air-cushion work in Europe centers on Ste. de l'Aerotrain of France, in which Rohr Corp. holds a majority interest.

A flight simulaior for the Concorde due

A supersonic flight simulator for the Concorde SST will be built by Redifon Flight Simulation, in Crawley, England, in collaboration with the British branch of Link-Miles (Singer Co.). A contract, awarded by the British Aircraft Corp. calls for use of a Link six-axis motion system, a Redifon Duoview color closed-circuit display, and Redifon R200A computers and interface equipment.

Depletion-mode load sets MOS thresholds

Advances in p-channel MOS integrated circuits have been made in West Germany by use of depletion-mode load transistors, which provide currents proportional to the square of their threshold voltage. With ion implantation, limits are set on the maximum obtainable threshold voltage, depending on the implantation parameters.

Researchers at Dortmund University have reported that optimum parameters have been calculated for threshold voltage shifts exceeding 6 V. The calculations were done for 10-Ω cm silicon bulk material. The oxide thickness was assumed to be 1200 Å. The results were in good agreement with experimental data at 35 keV.

Cordless headphone receives ultrasonics

A cordless headphone system developed by Philips Research Laboratories in Hamburg, West Germany, modulates an ultrasonic carrier with the same audio used for wired headphone listening. The phones contain an ultrasonic receiving transducer/demodulator, eliminating the need for a cord.

Auto-ignition timed by digital unit

A digital electronics unit for auto-ignition timing control has been announced by Robert Bosch GmbH of Stuttgart, West Germany. The company compares the complexity of the unit with that of a desk-top calculator. Timing is determined from engine, air and catalyst temperatures. The company also has a magnetic ignition timer.


Cermet Trimming Potentiometers
Short Form Technical Bulletin
November 1973
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6440 Hillcroft Ave.
Houston, Tex.
(713) 774-2568

Norvell Electronics
3340 S. Memorial Dr.
Tulsa, Okla.
(918) 663-1247

Sheridan Sales Co.
Box 37826
Cincinnati, Ohio
(513) 761-5432

Sheridan Sales Co.
Box 4457
Cleveland, Ohio
(216) 524-8120

Sheridan Sales Co.
Box 423
Dayton, Ohio
(513) 277-8911

Sheridan Sales Co.
33708 Grand River Ave.
Farmington, Mich.
(313) 477-3800

Sheridan Sales Co.
P.O. Box 677
Florissant, Mo.
(314) 837-5200

Sheridan Sales Co.
Suite 5009
1717 Penn Ave.
Wilkinsburg, Penn.
(412) 244-1640

WESTERN REGION

Almac/Stroum Electronics
8888 S.W. Canyon Rd.
Portland, Ore.
(503) 292-3534

Almac/Stroum Electronics
5811 Sixth Ave. South
Seattle, Wash.
(206) 763-2300

Marshall Industries
G. S. Marshall Products Group
5633 Kendall Court
Arvada, Colo. 80002
(303) 423-9670

Marshall Industries
G. S. Marshall Products Group
835 W. 22nd Street
Tempe, Ariz. 85282
(602) 968-6181

Marshall Industries
G. S. Marshall Products Group
9674 Telstar Ave.
El Monte, Ca.
(213) 686-0141

Marshall Industries
G. S. Marshall Products Group
17975 Sky Park Blvd.
Irvine, Ca. 92707
(714) 556-6400

Marshall Industries
G. S. Marshall Products Group
8057 Raytheon Rd.
San Diego, Ca.
(714) 278-6350

Marshall Industries
G. S. Marshall Products Group
788 Palomar Ave.
Sunnyvale, Ca.
(408) 732-1100

Wyle Distribution Group:

Elmar Electronics
6777 East 50th Avenue
Commerce City, Colo.
(303) 287-9611

Elmar Electronics
2288 Charleston Road
Mt. View, Ca.
(415) 961-3611

Liberty Electronics
124 Maryland Street
El Segundo, Ca.
(213) 322-8100

Liberty Electronics
3130 North 27th Avenue
Phoenix, Ariz.
(602) 257-1272

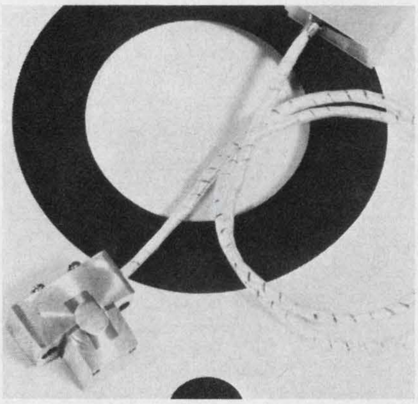
Liberty Electronics
8248 Mercury Court
San Diego, Ca.
(714) 565-9171

Liberty Electronics
5305 Second Avenue South
Seattle, Wash.
(206) 763-8200

Beckman®
HELIPOT DIVISION

INFORMATION RETRIEVAL NUMBER 94

IBM-compatible disc and tape heads offered



Nortronics Co., Inc., 8101 Tenth Ave. N., Minneapolis, Minn. 55427. (612) 545-0401.

Among the magnetic heads introduced will be a floppy-disc head and a 6250 bit/in tape head—both IBM-compatible. The Model FD-TE4 head is designed for disc speeds of 360 to 375 rpm. It provides a density of 3200 bit/in, 48-tracks/in and a transfer rate of 250-k bit/s. The LTC tape head reads and records data at speeds to 200 in/s with 6250 bit/in density. Maximum crossfeed, write-to-read, is six percent. Other products include heads for 3M cartridge systems, cassette read-after-write heads and heads for credit-card readers.

Booth No. 849 *Circle No. 258*

Four new peripherals to be shown

Okidata Corp., 111 Gaither Dr., Moorestown, N.J. 08057. (215) 546-6537.

Four new computer peripheral products: a 500 lpm printer, for heavy-duty applications; a low-cost, 110-cps printer; a line of double-density, head-per-track disc drives, with capacities to 38-million bits; and alphanumeric plasma display panels in 64 and 128-character configurations for use where the CRT is impractical are part of Okidata's display. In addition, a new optical mark reader for punched and marked cards in 300, 450, and 600-card reading speeds, available with an optional RS 232 interface will be shown.

Booth No. 250-252 *Circle No. 259*

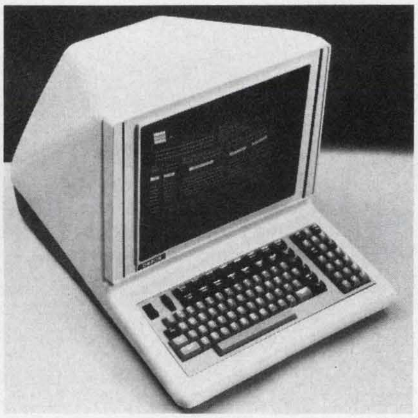
Strip printer handles two ASCII channels

Electro-Tec Corp., 1600 N. Main St., Blacksburg, Va. 24060. (703) 552-2111. $750; 30 days.

A dual channel unit, the Model W strip printer, delivers up to 120 char/s for each line printed. The unit can print all 64 upper-case ASCII characters on each of two independent lines. The 5 × 7 dot-matrix characters are spaced eight-to-the-inch on 0.5-in. electro marking tape. Data input to each channel are serial by character. All logic and data lines are TTL compatible.

Booth No. 375 *Circle No. 260*

Mix cassette and printer peripherals with CRT



Omron R&D, 432 Toyama Dr., Sunnyvale, Calif. 94086. (408) 734-8400. $2450 (terminal).

Two peripherals, Model 1020 cassette storage and the Model 2306 printer, can interface with the 8025 CRT terminal. The 8025 terminal is an intelligent unit with modular hardware and modular software design. RAM and ROM memories and interfaces are accommodated by use of printed circuit boards. The designer may select the precise amount of terminal memory and I/O he needs. If he needs to change, the terminal may be expanded in the field, on site. For example, if a system requires a printer, merely plug in an interface PC board and run cable to the printer. If additional RAM (working memory) is desired, add a PC board in 2 k or 4 k increments.

Booth No. 821 *Circle No. 261*

Data format controllers work with 4 tape drives

Ampex, 401 Broadway, Redwood City, Calif. 94063. (415) 367-4151. From $1100; 60 to 90 day.

The DE-800 family of data format controllers includes NRZI only, PE only, or PE/NRI data electronics and operates at tape speeds up to 125 ips. The units operate with up to four tape drives. Model DE-810 is a basic data electronics unit designed to be mounted within a TMA or TMB drive. Either NRZI, PE or both are provided with a digital input/output interface compatible with the current industry standards. Model DE-830 is a data electronics unit providing either NRZI, PE, or both with single-bit on-the-fly error correction capability. Model DE-840 is a format control unit with all of the features of the DE-830 with Pertec, Wangco, or Datum compatible format control features and interface. The DE-850 is a data electronics unit providing either NRZI, PE or both with error correction capabilities that correct unlimited single-bit errors in a record, or up to six consecutive errors in a track. Model DE-860 is a format control unit with all the features of the DE-850 and Pertec, Wangco, or Datum compatible format control features and interface. All DE-800 series units are provided in a standard 19 in. rack mounting chassis requiring 5.25 in. of rack height and 16.3 in. in depth.

Booth No. 645 *Circle No. 262*

Magnetic tape drive speeds off-line plotting

Houston Instrument, One Houston Square, 8500 Cameron Rd., Austin, Tex. 78753. (512) 837-2820. 45 days.

The MTR-3 magnetic tape reader is designed specifically for use with the company's COMPLOT Plotter series. It is available as either a seven or nine-track reader with 200, 556 or 800 bit/in density. The buffered unit for off-line plotting use features forward and reverse block advance and a hardware vector generator to reduce computer preparation time.

Booth Nos. 1011, 1110 *Circle No. 263*

Centralab perspectives

FOR USERS OF ELECTRONIC COMPONENTS

CENTRALAB
Electronics Division
GLOBE-UNION INC.
5757 NORTH GREEN BAY AVENUE
MILWAUKEE, WISCONSIN 53201

Ceramic capacitors are now available with lead times as short as 6 weeks.

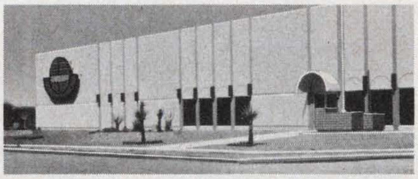
In the last year, Centralab increased production and established a new distribution center. That means they have larger inventories of quality ceramic disc capacitors to meet today's requirements.

Inventories of Centralab capacitors from its Distributor Products stock in Menomonee Falls, Wisconsin are in addition to those in the 40,000 square foot Distribution Center at El Paso to assure customers of off-the-shelf delivery.

In January 1973, when industry-wide lead times on capacitor deliveries were at an unprecedented high, Centralab took positive action. As a result, today they are able to assure the electronics buyer of 12 to 16 week delivery on any of their broad line of reliable disc capacitors. And some types in 6 weeks!

The first step in Centralab's Capacitor Service Program was a drastic one. In January 1973 they began refusing orders rather than accepting them for extended delivery. They then moved to bring to full production a new capacitor assembly plant in Juarez, Mexico. To provide dual sources for raw fired ceramic discs, they increased capacity at their plants in Milwaukee and Mexico City. At the same time, a new Service and Distribution Center was established in El Paso, Texas. Its 40,000 square feet provided for broadening capacitor inventories received from Centralab's five manufacturing locations.

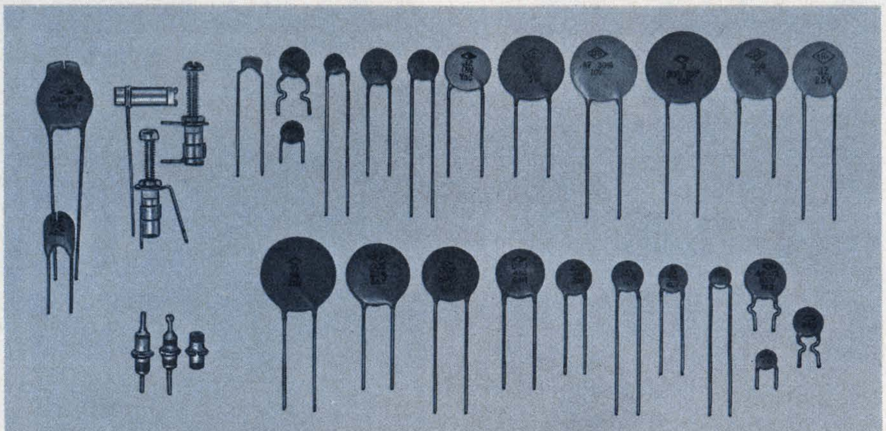
Within six months most large OEM orders were on schedule, the backlog reduced and, with inventories of selected types available, orders were again accepted. Today, with inventories of all types and production facilities running at full capacity, Centralab offers capacitor buyers the only reasonable answer to meet their requirements. A buyer placing an order at the beginning of his 13 or 20 week planning cycle, for example, can be certain of on-time delivery of the types he needs.



Located just across the border from Centralab's Distribution Center in El Paso, this Juarez, Mexico plant has helped shorten lead times on capacitor delivery.

Centralab's Distribution Center in El Paso is a key reason why today they can provide better service on capacitor orders. Its 10 man customer service staff is equipped to handle any capacitor delivery problem from order entry through special shipments. An application engineering staff is also on call to help with design problems. After reviewing a customer's specifications, for example, they may even be able to recommend stock types which eliminate the need for special requirements. That could be important when delivery is critical.

Customer service is important — to the buyer and to Centralab. It requires more than fancy promises. It takes positive action. Centralab has done just that to help you meet your capacitor needs. For further information or assistance, call Bob Michaels at 915/779-3966 or write Centralab, Milwaukee.



The extensive line of Centralab capacitors includes both disc and tubular types, with sizes and ratings designed for a variety of functions.

INFORMATION RETRIEVAL NUMBER 201

Centralab perspective:

WHEN THE CHIPS ARE DOWN WE DELIVER!

CAPACITORS THAT IS

We said it and we meant it. We're USCC/Centralab and we said we were preparing to meet the capacitor delivery crisis by substantial commitment to automated production machinery and facilities expansion.

We did it, and we've got the chips to prove it — ELEVEN MILLION in stock, most in the following popular sizes:

- BC - .080±.010x.050±.010
- BF - .100±.010x.050±.010
- BI - .150±.010x.050±.010
- DJ - .180±.010x.080±.010
- FH - .125±.010x.095±.010

We'll also deliver non stock and custom chips in not more than 8 to 12 weeks A.R.O.

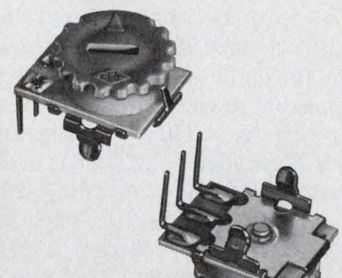
Whether it's an immediate or future requirement, contact our applications engineering department now at (213) 843-4222.

USCC/Centralab
2151 N. Lincoln Street
Burbank, California 91504

INFORMATION RETRIEVAL NUMBER 202

Centralab perspective:

Trimmer resistors.



Now, with new Snap-Tite® rigid PC mounts.

When you specify the new Snap-Tite rigid mount you can simplify both installation and assembly. Available on both Centralab Series S carbon and cermet trimmer resistors, it lets you snap them into a PC board. Easy. The mount locks the trimmer securely into the board prior to soldering.

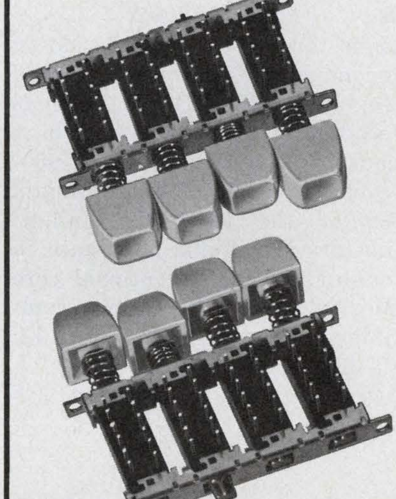
Centralab gives you more of the things you want in trimmers. Ceramic bases for higher wattage in a smaller space. Smooth positive adjustment. A variety of choices in mountings, terminations and knobs. And multiple sections too.

Send for Bulletin 1549T so you'll have all the specs.

INFORMATION RETRIEVAL NUMBER 203

Centralab perspective:

Pushbutton switches.* With 4 lockout options.



Centralab offers four lockout options for its momentary, push-push and interlocking action pushbutton switch modules. Lockout prevents actuating more than one switch at the same time — even if they're *not* adjacent. Another example of design flexibility. Other features include:

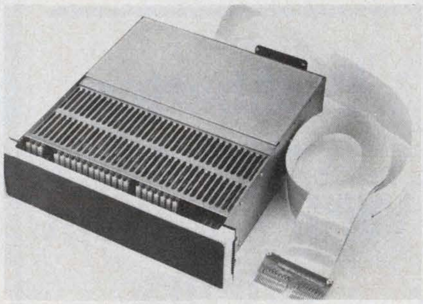
- 10, 12.5, 15, 17.5 and 20 mm spacing options.
- Epoxy sealed terminals.
- Modular LINE SWITCH — mounts in any station.
- 25 button styles and 18 colors.

Write Centralab for Bulletin 1550.

*Isostat licensed

INFORMATION RETRIEVAL NUMBER 204

Semicon memory matches PDP-11 speeds

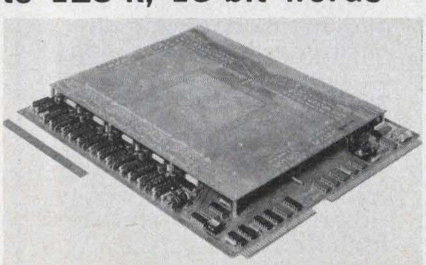


Monolithic Systems Corp., 2700 S. Shoshone, Englewood, Colo. 80110. (303) 761-2275. See text.

Monostore III, a new add-on semiconductor memory designed especially for the PDP-11, expands the system by up to 32-k × 16 bits. Because its 450-ns access and 650-ns cycle times match the optimum speed of the PDP-11's Unibus, Monostore III offer a 20% gain in throughput over conventional core memories. It's fully Unibus compatible and priced at just 1.2 cents/bit.

Booth No. 127 Circle No. 264

Fast memory expands to 128-k, 18-bit words

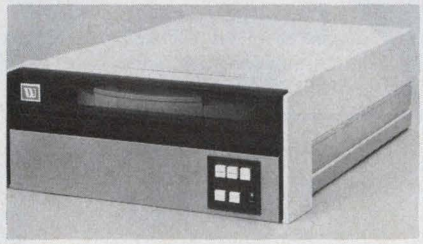


Dataproducts Corp., 6219 De Soto Ave., Woodland Hills, Calif. 91364. (213) 887-8465. $2000 (quan); 120 days.

A planar core-memory system designated the Store/1618 provides a capacity of 16,384, 18-bit words. The 3-D, 3-wire, planar memory system features 700-ns cycle time and 275-ns access time. Up to eight, 16-k modules can be daisy-chained to form a system with a capacity up to 128-k words. Core arrays and all electonics are housed in a module that measures 12 by 14 by 0.85 in. and contains two circuit boards.

Booth No. 309 Circle No. 265

Disc drives feature 200 tracks per inch



Wango Inc., 5404 Jandy Pl., Los Angeles, Calif. 90066. (213) 390-8081. Start at $3200; 60 days.

This new series of magnetic disc drives features 200 track per inch capability and is said to provide twice the data storage capacity of comparable devices in only 7 in. of rack height. The front-loading Series-F, Model F-2222, has a capacity of 100 Mb, recording 2200 bpi on 200 tracks/in. The top-loading Series-T, Model T-2422, has a capacity of 200 Mb, recording at a density of 4400 bpi. The Model T-2222, recording 2200 bpi, has a capacity of 100 Mb.

Booth Nos. 843, 845, 847
Circle No. 266

Intelligent terminal uses microprocessor

Digi-Log Systems, Babylon Rd., Horsham, Pa. 19044. (215) 672-0800. From $1600; 30 days.

The Series 3300 CRT terminals are microprocessor controlled and can be tailored to the users' needs. User selectable features include page formats of up to 80 char. × 24 lines, protected fields, and addressable cursor. Editing capabilities include line insert, character insert and line delete. The wide variety of communication disciplines includes transmission by character, page, line or message; self-generated or remote polls, and programmable speed switching (75—9600 bit/s).

Booth No. 478, 480 Circle No. 267

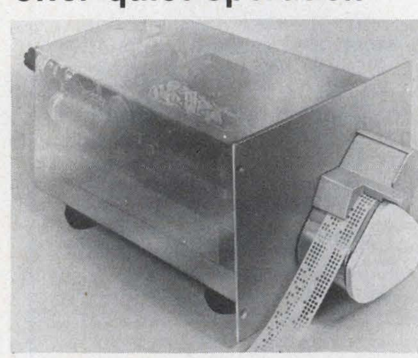
Minicomputer systems offer wide versatility

Microdata, 17481 Red Hill Ave., Irvine, Calif. 92704. (714) 540-6730.

The 1600 series of minicomputers is microprogrammed and microprogrammable. The 3200 series computer has a 32-bit micro-instruction word length, 16 bit data path, MOS main memory and push-down stack processor architecture. One of these computers (32/S) is programmed by using a high-level language called MPL which is patterned after the popular PL/I language. The series 6000 tape drive is IBM compatible, runs at speeds between 12.5 and 45 ips and uses 10.5 in. reels. The series 6800 is identical to the series 6000 except for size—it uses 8.5 in. reels. The series 9000 disc drive has a 200 tpi density and a 2400 rpm rotational speed.

Booth No. 751 Circle No. 268

Clutchless tape readers offer quiet operation



Electro-Tec Corp., 1600 N. Main St., Blacksburg, Va. 24060. (703) 552-2111.

The AR Series of paper tape readers offers speeds up to 500 char/s with asynchronous operation. The units feature LED light sources and TTL signal levels. The absence of clutches and brakes assures quiet operation.

Booth No. 375 Circle No. 269

Time-share terminal shows 1920 characters

Westinghouse Canada Ltd., P.O. Box 510, Hamilton, Ontario, L8N 3K2, Canada. (416) 528-8811. $1100.

1620 CRT Terminal meets the needs of time-share and minicomputer users for an unbuffered, interactive terminal. The unit displays up to 1920 characters, transmits and receives at various data rates to 9600 BPS (960 characters per second) and can operate with a tape cassette and/or printer either on or off line. Standard features include a keyboard with numeric pad and 80 characters × 24 lines presentation.

Booth No. 941-3 Circle No. 270

Reader handles punched or marked cards

Documation, P.O. Box 1240, Melbourne, Fla. 32901. (305) 724-1111. 60 days.

One head of the "T" series card reader handles conventional punched data. The second head reads in two optical-mark modes: cards with registration marks and cards without registration marks. The three-in-one readers are available in speeds of 150, 285, 300, 600, 1000 and 1200 cards/min. The system is expected to save users 40% of the cost of two readers.

Booth No. 867-869 Circle No. 271

Interactive terminal gives 16 functions

Lear Siegler Inc., 714 N. Brookhurst St., Anaheim, Calif. 92803. (714) 774-1010. Under $3000; 3 mos.

ADM-2 interactive display terminal provides the user with flexibility of format, editing, interface and transmission. Sixteen function keys permit the operator a wide choice of commands. The basic keyboard is a standard 53-key TTY and, in addition to the 16 function keys, also contains a numeric 10-key pad. The CRT measures 12 in. diagonally, with a P4 phosphor, and can display 960 or 1920 characters, upper or lower case, on a 12 or 24-line format.

Booth No. 216-217 Circle No. 272

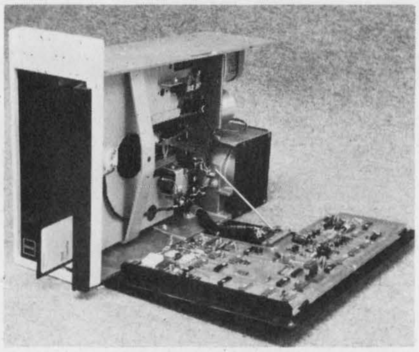
Semiconductor memory delivers 1.28 G bit/s

Intel Corp., Memory Systems Div., 365 Middlefield Rd., Mountain View, Calif. 94040. (408) 246-7501.

First developed as a custom memory for a large systems manufacturer, the unit consists of two independent bipolar memories each containing 8-k, 16-bit words. The system has an effective data rate of 1.28 gigabit/s. One memory can be read while the other is loaded (and vice versa.) Or, both memories can operate in parallel to form a 16-k × 16-bit system. The IN-50 PC cards are used in this ECL memory. Each card contains 1-k, 8-bit words and offers 100 ns cycle and access times. Other memories to be shown include the in-26 available in increments of 4-k × 9 (1¢ a bit) and the in-60 a semiconductor memory that stores 200-k bits serially on each PC card.

Booth No. 711 Circle No. 273

Floppy disc drive has IBM compatibility



Innovex, 75 Wiggins Ave., Bedford, Mass. 01730. (617) 275-2110. $750; 45 day.

The Model 210 disc drive is compatible to the disc drive used in the IBM 3740 data entry system. A number of operator oriented features have been incorporated into the 210. The drive can be operated in any orientation without modification. In the vertical position, four drives fit in one 19 in. rack, occupying 10.5 in. of rack height including mounting hardware. The 210 has a capacity of 3.1-million bits, a track-to-track seek time of 10 ms, and an average latency of 83 ms. Diskette cartridges written on any of the IBM 3740 line of equipment can be read on the Model 210 drive and vice versa.

Booth No. 348, 350 Circle No. 274

Tape-cassette drive offers 1 × 10^{-8} error rate

Interdyne, 14761 Califa St., Van Nuys, Calif. 91401. (213) 787-6800. $390 (100); 30 days.

The IC-2400 digital tape-cassette drive offers mechanical reliability, low error rate and useful life, equivalent to present IBM compatible reel-to-reel tape handlers. Featured are a servo capstan drive; a rugged die cast frame; an error rate of less than 1 in 10^8 bits recoverable and 1 in 10^9 bits nonrecoverable; full compliance with ANSI/ECMA standards; cassette interchangeability; cassette pressure bypass pad; no mechanical brakes, clutches or belts; and flexibility of bidirectional write/read at any speed between 4 ips and 20 ips. Speeds may be programmed separately.

Booth No. 1124 Circle No. 275

Lighted dpdt pushbutton switches go 100-k cycles

Clare Pendar, P.O. Box 785, Post Falls, Idaho 83854. (708) 773-4541. For 1000 up: $1.62 (momentary), $1.92 (alternate action).

The S190 lighted pushbutton switch series offers dpdt switching in momentary or alternate action. The switches use dual wiping contacts, and can switch 100,000 cycles at 2 A resistive or 250,000 cycles at 100 mA resistive. Widely spaced silver inlay terminals accept either two #22 AWG soldered wires or 0.11-in. quick connect receptacles. All molded parts are thermoplastic material SE-O rating (new U.L. designation is 94VE-O). Neck bushings are provided for sub-panel installations while front panel mounting is accomplished with any of five differently sized mounting adaptors, with or without barriers. Lenses, available in square, rectangular and round configurations, are custom engraved in letter sizes ranging from 0.093 to 0.25 in. high.

Booth No. 934, 936 Circle No. 276

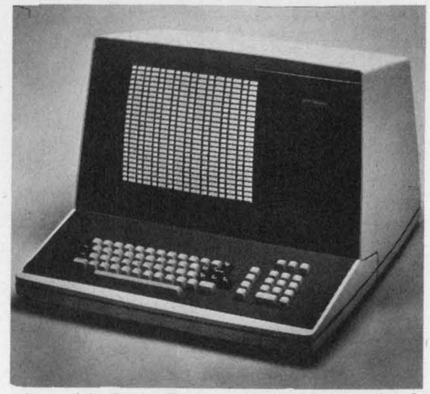
Printer/plotters deliver 500-ft drawings silently

Versatec, 10100 Bubb Rd., Cupertino, Calif. 95014. (408) 257-9900. $12,300 (Model 2030); $14,900 (Model 2030A).

The Model 2030 matrix plotter and 2030A printer/plotter use 20-in. wide paper in lengths up to 500 ft. and print electrostatically. The plotter provides 100 nib/in. resolution for a total of 1856 nibs (18.56-in. plot) and 232 bytes provide one scan of the plotted data. An incremental stepper motor drives the paper at speeds up to 3-in/s. The printer/plotter has the same plotting characteristics as the matrix plotter and, in addition, can print 232, 7 × 9 dot-matrix characters across the page from ASCII input data. The 20-in. paper width permits 80 or 132 column printing on one side and simultaneous raster-scan plotting the remainder of the paper width. Also, print and plot data can be intermixed. The manufacturer offers controllers as well as software for use with many mini and midi-computers.

Booth No. 937, 939 Circle No. 277

CRT terminals come with six formats



Ann Arbor Terminals, 6107 Jackson Rd., Ann Arbor, Mich. 48103. (313) 769-0926. See text.

The Design III series of CRT terminals features contemporary molded-case design. Each terminal includes a 14-in. CRT monitor and modular circuit cards that are interchangeable with the manufacturers series 200 display controllers and keyboards. The series is available in 16 RO, KSR and ASR models. Users are offered six display formats (up to 3200 characters) plus upper and lower-case displays. Prices start at under $1000. For greater economy the user can assemble CRT terminals around the Series 200 controllers which offer a display capability of up to 3200 characters plus a choice of seven display formats.

Booth No. 379 Circle No. 278

Modems use MOS LSI circuits

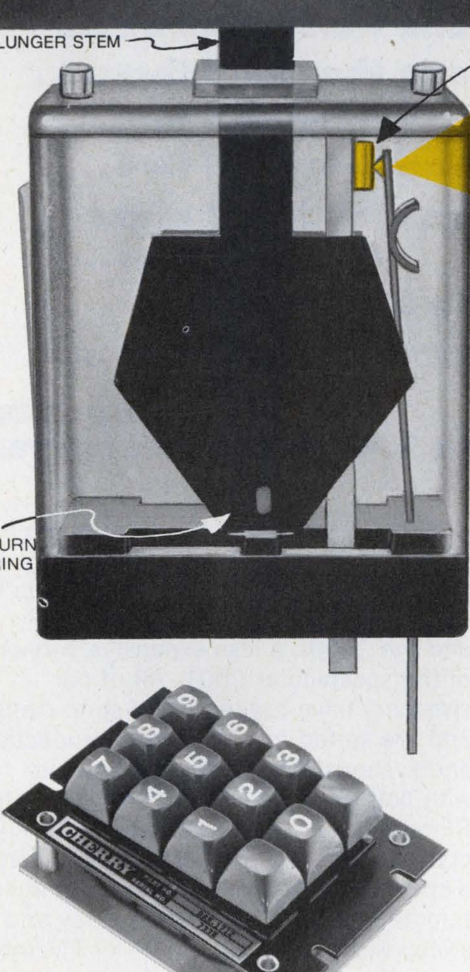
International Communications Corp., 7620 N.W. 36th Ave., Miami, Fla. 33147. (305) 691-1220.

Modem 20-LSI and 24-LSI transmit data at 2000 bps and 2400 bps, respectively. A remote test feature provides error diagnosis in point-to-point or multipoint systems from a single site. A status panel display enables on-line evaluation of the data communication system. The LSI series also features ICC's Fastar, which reduces personnel time and telephone company toll charges by minimizing turn-around delay on dial circuits. The modems operate over the public dial-up network as well as dedicated lines. They are on-line compatible with ICC's Modem 2200 series, as well as Telco's 201 series data sets.

Booth No. 517 Circle No. 279

STRIKE GOLD

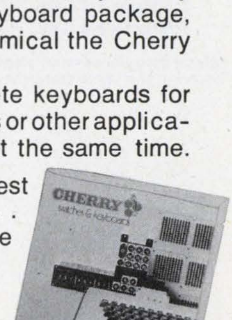
...every time you depress a CHERRY KEYBOARD SWITCH



Cherry's unique gold "crosspoint" contacts plus simplified electronics enhance reliability and provide long life . . . low profile . . . lower power consumption . . . low, low cost. The crossed knife-edge contact configuration has been tested to 50,000,000 operations and beyond. Available from stock with a wide variety of key legends and colors. Or, buy them as part of a keyboard package, ready to slip into your panel. Either way is economical the Cherry way.

When you need keyboard switches or complete keyboards for numerical control, calculators, computer terminals or other applications, strike gold with Cherry—and save silver at the same time.

FOR A FREE TEST SAMPLE and a copy of our latest complete-line catalog just TWX 910-235-1572 . . . or PHONE 312-689-7700 . . . or circle appropriate reader service number.



CHERRY®

CHERRY ELECTRICAL PRODUCTS CORP.
3609 Sunset Avenue, Waukegan, Illinois 60085

Cherry Worldwide: (Subsidiaries) Hirose Cherry Precision Co., Ltd., Tokyo • Cherry Mikroschalter GmbH, Bayreuth, Germany • Cherry Electrical Products (U.K.) Ltd., St. Albans, Herts • (Licensee) G.W. Engineering Pty. Ltd., Sydney

INFORMATION RETRIEVAL NUMBER 98

Time-share graphics plotted automatically on a scope

Megatek, 1055 Shafter St., San Diego, Calif. 92106. (714) 224-2721. See text; stock to 30 day.

Plotting curves from data received on a time-shared computer terminal is tedious if you do it by hand. It can be done automatically on any oscilloscope or other X-Y display with the BP-734 Timeshare Graphics Interface, by Megatek. The unit operates directly from a computer's RS-232 communications port.

Installation requires no mechanical or electrical modifications either to the time-shared terminal or the oscilloscope. You merely apply either a current loop or RS-232 serial data to the terminal's data-set connector, switch to the desired baud rate and connect the analog outputs to the X, Y and intensity inputs of your display.

An optional semiconductor memory provides refresh to display from 256 to 1024 points in a flicker-free mode. Vectors can be drawn with 16 combinations of vector and end-point intensity. With 8 and 10-bit versions of the interface, resolutions of ±0.2% and ±0.05%, full scale, are available. Selected parts of the display can be changed at will without need to erase and rewrite the entire display.

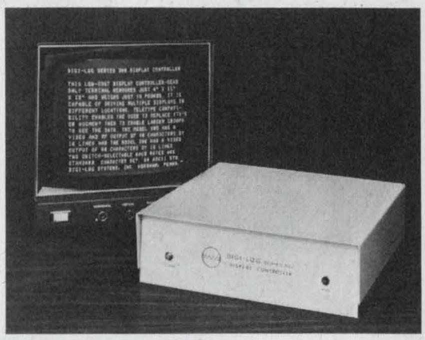
The baud rate is selectable to provide 10 or 30 characters per second for time-share users or up to 2400 baud for direct connection to a local computer.

Megaplot, a subroutine callable from Fortran or Basic, is supplied with the system for use on the major time-sharing services. Entry or change of a displayed vector requires the transmission of six characters, which are generated by the subroutine when called in place of a Print statement in the user's program. When operated in parallel with a 30-character-per-second terminal, the BP-734 can plot five vectors a second. Forty vectors a second can be plotted when the interface is used with a high-speed communications line at 2400 baud.

Prices range from $1595 for the 8-bit model, with 256-vector capacity, to $2495 for the 10-bit model, with 1024-vector capacity.

CIRCLE NO. 255

Display controller makes TV a CRT terminal



Digi-Log Systems, Babylon Rd., Horsham, Pa. 19044. (215) 672-0800. See text; 30 days.

A portable ASCII display controller/RO terminal capable of outputting data to both video monitors and ordinary TV sets, the Series 300 Display Controller measures 4 × 11 × 12-in. and weighs 10 pounds. The Series 300 is capable of driving multiple displays (up to 10) in different locations. The user can replace the existing Model 33 TTYs where a keyboard is not required, or use both the TTY and the controller so that large groups can observe what is taking place at the TTY. Standard units provide a 7-bit parallel interface with an asynchronous data rate to 1200 char/sec. Optional serial interfaces (RS 232 and current loop) are available. The Model 305 ($790) displays up to 40 characters by 16 lines, the Model 306 ($875) outputs 80 characters by 16 lines.

Booth No. 478, 480 Circle No. 280

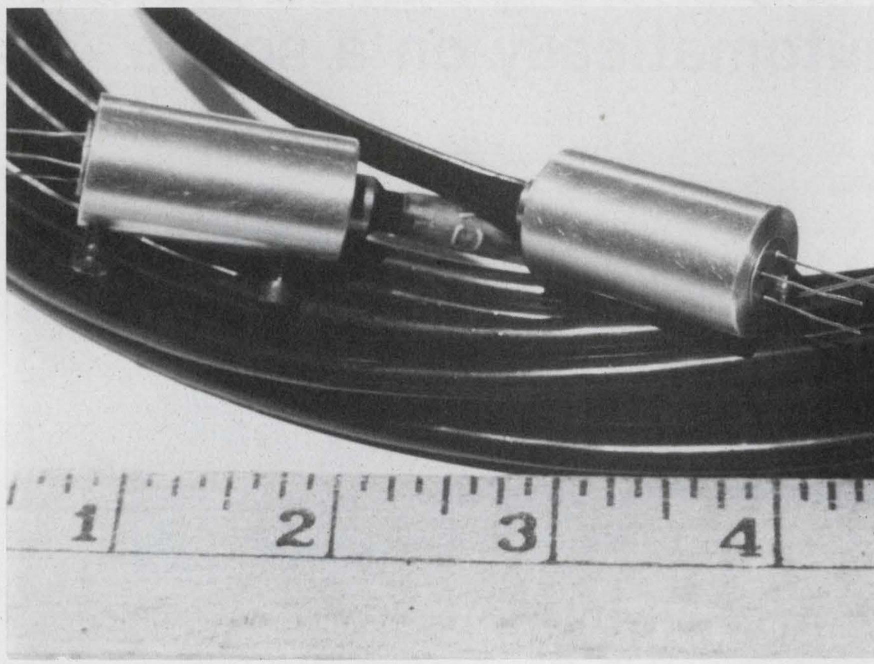
Digitizing system has 0.001-in. resolution

Broomall Industries, 682 Parkway, Broomall, Pa. 19008. (215) 353-4610. $8900.

The model D100 digitizing system includes a 40 × 60-in. table plus all electronics. The system records sequentially numbered points of x-y coordinate data on card or tape punches, TTYs or magnetic tape. Resolution is 0.001 in. Data are accepted in parallel and presented sequentially (one character at a time) to the output recorder. The data are sequenced in accordance with a patchboard program format. The unit features multiple output to any number of customer selected devices.

CIRCLE NO. 281

Fiber-optic link transmits data at 80 Mbit/s for 100 ft.



Meret, 1815 - 24th St., Santa Monica, Calif. 90404. (213) 828-7496. See text; stock to 2 wk.

Data rates of up to 80 Mbit/s can be transmitted up to 100 ft. with little signal degradation with the Modal cable from Meret. This tops the performance of its closest competitor—the Opticable from Quadri (2950 W. Fairmont, Phoenix, Ariz. 85017). The latter handles 5 Mbit/s for 10 ft. or 900 kbit/s for 100 ft.

In the MDL300 Modal Series, various cables are available, depending upon the data rate required. For a 100-ft. length of 4 Mbit/s cable, the signal-to-noise ratio at the output terminal is better than 2000:1. For the 50 Mbit/s cable, the S/N is better than 50:1, and for the 80 Mbit/s cable, it's 10:1.

The transmitter and receiver terminations of the cable are housed in modified 3-pin, TO-5 header packages. These electrically terminate ferrule-ended fiber-optic cables 1 to 3 mm in diameter, with minimum loss at the 850-to-900-nm signal wavelength. The transmitter requires +5.5 V, and it has a current drain at 50% duty cycle of 200 mA at maximum power output. Trigger signals are applied at the third pin on the header.

Power-supply requirements for the receiver are for a single B+ of between +5.5 and +15 V at a current drain of less than 6 mA. The single power supply provides bias for the p-i-n photodiode and for the voltage requirements of the receiver transimpedance amplifier.

A 100-ft. cable, including the terminating modules, weighs less than 250 grams.

Prices for the Modal cable assemblies range from $270 to $600 in single quantities, depending upon the data rate. Though designed for TTL digital input, the transmitter can be converted to an analog emitter for about $100.

Quadri's Opticable sells for $185 for a 10-ft. length and $197.50 for 100-ft.

For Meret **CIRCLE NO. 256**
For Quadri **CIRCLE NO. 257**

Stable modem needs no alignment

Timeplex, 100 Commerce Way, Hackensack, N.J. 07601. (201) 646-1155. From $205; 30 days.

The Timeplex 202 modems feature zero foldover distortion with operation to 1800 bit/s over direct-dial phone lines at very low error rates. And the unit, compatible with Bell System 202C and 202D units, operates at 2000 bit/s on private lines with C2 conditioning. The stability attained by use of crystal-controlled transmitters and receivers eliminates the need for alignment or retuning. Available options include a synchronizer for synchronous data and a 5-bit/s or 50-bit/s reverse channel. Other products to be shown include a 96-channel time division multiplexer, Model T-96, and a channel concentrator that allows 32 calling terminals to contend for up to 16 computer ports.

Booth No. 358-360 Circle No. 282

Card-to-tape converter boasts high speed

Datatex Corp., 10935 S. Wilcrest Dr., Houston, Tex. 77072. (713) 495-3100. From $7000; 60-90 days.

A tape converter designated the Model CTP-60 punches at rates to 75 char/s and reads 60 to 150 cards/min. Paper tape output can be in EIA, ASCII or Modified codes. Card input formats of up to 65 characters are decoded. And the unit rejects cards with punch errors. Mark-sense capability is also available.

CIRCLE NO. 283

Low-cost modems can replace Bell datasets

Tele-Dynamics, 525 Virginia Dr., Fort Washington, Pa. 19034. (215) 643-3900. See text.

Priced in the $200 to $400 range, the 7103-LC series of low speed modems can replace Bell 103 and 113 series data sets. The units provide full duplex operation over private line, or over the DDD network when used with the Dial Access Arrangements. The interface to the business machine can be either EIA, TTY 20 ma, TTL, or MIL-188C. The models in the 7103-LC Series include types for originate only, answer only, originate/answer, and automatic originate/answer. All accept asynchronous serial data at rates up to 300 bit/s and use FSK modulation. A switch provides loopback of terminal output to input for isolated tests of terminal equipment. Desk top and rack-mounted units are available. With integral power supply, the desk top unit measures 4 high by 6 wide by 12-in. deep.

CIRCLE NO. 284

Terminal's IQ ranges from dumb to genius

Incoterm Corp., 6 Strathmore Rd., Natick, Mass. 01760. (617) 655-6100.

The SPD-20/20 can be anything a user wants it to be—from a dumb communications terminal to a powerful remote data processing system. A single SPD-20/20 processor is capable of controlling the passage of data to and from up to 56 different devices simultaneously—including eight I/O channels, 16 printers, 16 keyboards and 16 visual display units. Each of the major components of a SPD-20/20—memory, controllers, keyboard, and display—can be operated completely under software control. From 8-k to 32-k bytes of programmable main memory are available with the terminal. Complementing the flexible processing power of the system is a full range of peripheral equipment and communications options that allow the system to perform the following terminal processing functions, including: inquiry, data entry, remote batch and transaction processing.

CIRCLE NO. 285

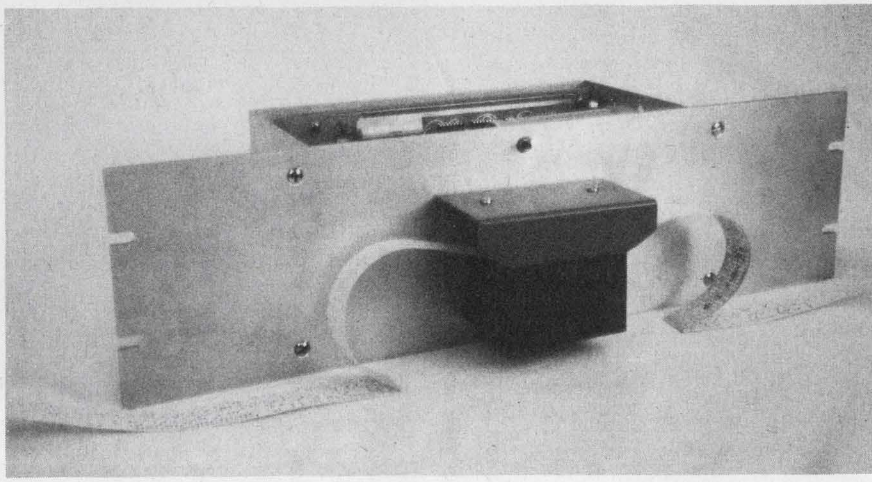
Plug compatible core memory holds 16 × 16 k

Dataram, Princeton-Hightstown Rd., Cranbury, N.J. 08512. (609) 799-0071. $2840.

The DR-1200, 16 × 16 kbit core memory fits on one 15 × 15 in. circuit board. It is plug-compatible with the Data General Nova 1200, 1210 and 1220 minicomputers and all standard Nova 1200 peripheral devices. It is also compatible with Digital Computer Control's 116875 memory used in its D-116 and D-116E minicomputers. System construction permits 0.5 in. center-to-center spacing between adjacent memory modules. Cycle and access times are 1200 and 400 ns, respectively. Half-cycle read or write operations require 600 ns. Address strapping is accomplished by appropriate wiring of a 16-pin IC socket which is accessible via a cutout in the protective shield which covers the entire component side of the memory module. Temperature range is 0 to 55 C.

Booth No. 269, 271 Circle No. 286

Optical tape reader speeds at 450 characters a second



Teleterminal Corp., 12 Cambridge St., Burlington, Mass. 01803. (617) 272-8504. $625 (1 to 10)); stock to 60 day.

The Fly Reader 45, a photoelectric punched-tape unit, has a continuous or random read speed of 450 characters per second. It can handle standard 1-in. punched tapes, as specified by ANSA × 3.18, with tape transmissivities of up to 60%.

The reader uses an on-the-fly read technique and is bidirectional. It accepts either randomly spaced pulse input commands or level inputs for continuous reading. Control outputs consist of ready/busy levels, a tape jam/out alarm and an output that indicates an open read head during tape loading.

The tape-drive is a sprocket-and-stepper-motor assembly with sealed, heavy-duty roller bearings. The sprocket engages the tape with seven teeth and is said to give traction without tape wear or tearing.

All control signal inputs are TTL-positive true, and they feed Schmitt triggers. This gives the input lines a 2-V noise immunity. Data and control outputs are all buffered TTL signals.

Options for the unit include open-collector TTL outputs that can provide a 4-mA sink at 30 V for driving CMOS or long lines and capability to read both 1-in. and advance-feed-hole typesetting tapes.

The Fly Reader 45 operates over 10 to 50 C. It uses a nine-transistor optical array and an incandescent lamp, rated for 15,000 hours. The reader is completely modular: all sections interconnect with plugs for easy servicing.

The unit mounts on a 5.25-in-high panel, that fits 19-in. racks. The depth behind the panel is 5.5 in., while the external panel protrusion is 2.5 in. Optional fanfold trays occupy a total of 7 in. of panel height. The unit weighs 8 lb. Power requirements are 105 to 124 V ac, 60 Hz at 1/3 W, or 210 to 240 V ac, 50 Hz.

A close competitive unit is the Model 2031 from Digitronics (1 Albertson Ave., Albertson, N.Y. 11507). It has a continuous-read speed of 400 char/s and a random-read speed of 300 char/s. This unit costs $730. A less-expensive unit, the TR6303, is available from Oktronics Data (12000 E. Skelly Dr., Tulsa, Okla. 74128). It has a max random or continuous-read speed of 300 char/s and costs $580. Both are bidirectional readers that use stepper motor drives, and the prices include the electronics and power supplies.

Teleterminal **CIRCLE NO. 252**
Digitronics **CIRCLE NO. 253**
Oktronics **CIRCLE NO. 254**

Bowmar KEYBOARDS

Sure, we make keyboards for calculators — some are mighty sophisticated, too.

But we are also applying Bowmar keyboard technology to TV control tuners, appliance controls, machinery controls, telephone equipment, point-of-sale equipment, and many other applications . . . unlimited!

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Bowmar

Bowmar Instrument Corporation
8000 Bluffton Road
Fort Wayne, Indiana 46809
Phone 219/747-3121

INFORMATION RETRIEVAL NUMBER 106

Minicomputers also do remote-job entry

Varian Data Machines, 2722 Michelson Dr., Irvine, Calif. 92664. (714) 833-2400. From $60,000.

A new applications program is part of a system that allows Varian 70 Series computers to have concurrent communications with a large host while performing a full range of foreground and background tasks. The system which includes synchronous communications hardware interfaces with IBM 360/370 computers that use HASP and ASP remote job entry procedures. The system supports data rates to 50 k bit/s. The minimum configuration which includes 24-k memory V70 CPU, printer, disc and card reader costs less than $60,000.

CIRCLE NO. 287

Memory modules come in 16 or 32 k stacks

Ampex, 401 Broadway, Redwood City, Calif. 94063. (415) 367-4151. 0.5¢/bit, 90 to 120 day.

The 1600 Series modules are available in a variety of capacities, access times and cycle times. For 16 k word modules access times vary from 300 to 450 ns and cycle times from 650 to 900 ns. The 32 k modules have access times of 550 and 650 ns and cycle times of 1200 and 1500 ns. Up to eight 1600 series modules can be combined to provide a 128 k system using 16 k modules or a 256 k system using 32 k modules. Module select decoding and negative-true open-collector outputs simplify interface requirements. Each 1600 series module is two boards, a timing-drive board and a plug-in 16 k or 32 k planar stack. The module is 15.76 × 11.5 in. with a thickness of either 0.95 or 1.3 in., for 16 k or 32 k, respectively. The modules operate from 0 to 55 C without current compensation. The 1600 module requires a 5 V dc logic supply and either + or − 15 V dc drive supplies at the customer's option.

Booth No. 645 Circle No. 288

Compact reader handles 300 card/min silently

Mohawk Data Sciences, OEM Marketing, Box 362, Utica, N.Y. 13503. (215) 337-1910. $1300; 60-90 days.

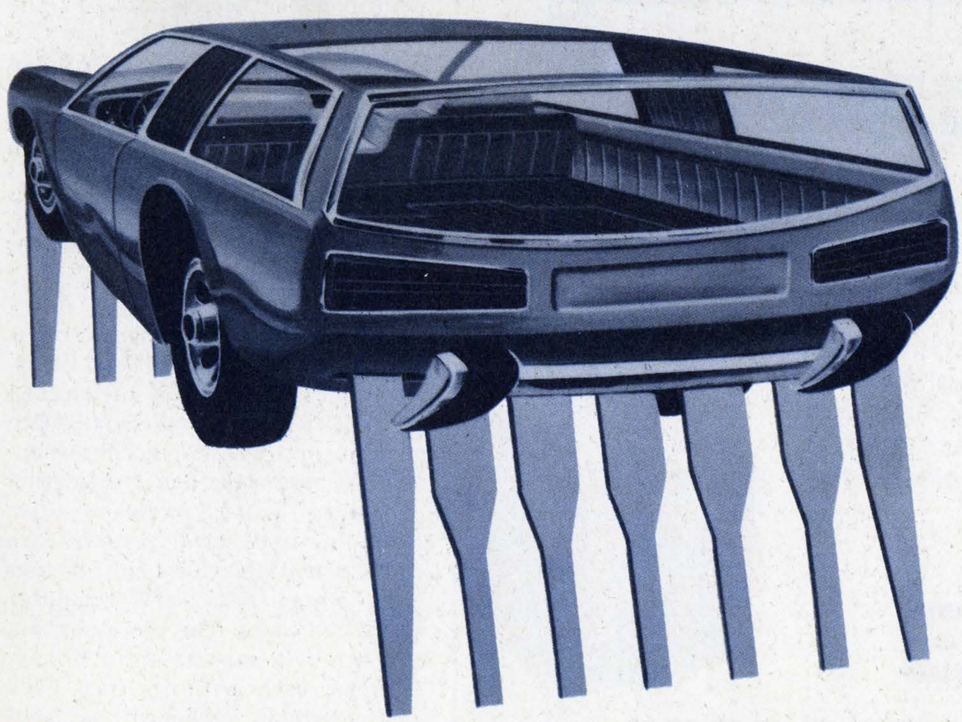
The desk-top Model 6050 card reader offers 300 card/min along with speed quiet operation. The 6050, priced at $1300, is designed for low-cost OEM applications. The input hopper holds 1000 cards and the output hopper holds 1100. Reader functions include a double-strobe read of each column, a resynch on data and a light and dark current check.

CIRCLE NO. 289

Who's got the track record for automotive IC development?

When you need custom-developed integrated circuits for automotive applications, why go with a company that hasn't won its spurs? Pick ITT instead. We've already developed circuits for speedometers, tachometers, digital clocks and flashers; they're being installed daily by the automotive industry. And we have more developments on the way. When you need custom circuits for electronic ignition, instrument voltage regulators, fuel injection, automatic dimmers or any of the other automotive applications, look up the company that has the track record. Write today for details of our custom circuit capability.

ITT...Logically



semiconductors

ITT Semiconductors is a division of International Telephone and Telegraph Corporation, 500 Broadway, Lawrence, Mass. 08142 Phone 617-688-1881. Factories in West Palm Beach, Florida · Lawrence, Massachusetts · Footscray, England · Colmar, France · Freiburg, Germany · Cascais, Portugal · Taipei, Taiwan · Sydney, Australia

ITT

INFORMATION RETRIEVAL NUMBER 108

INFORMATION RETRIEVAL NUMBER 109

INFORMATION RETRIEVAL NUMBER 110

Electrostatic printers speed at 1000 lpm

Versatec, 10100 Bubb Rd., Cupertino, Calif. 95014. (415) 326-2000. $5600 (1175); $6400 (1110).

The LP1175 electrostatic printer and the 1110 or 1110A plotter print at 1000 lines per minute and plot at 2.4 ips, respectively. All of the units are 19 × 18 × 38 in. and weigh 160 lb. Power requirements are 115 V ac, 60 Hz; 100 V ac, 50 or 60 Hz; or 230 V ac, 50 Hz; 600 W maximum. The printer font is 132, 7 × 9 dot matrix characters per line. A MOS ROM character generator produces a standard 64 or optional 96 (upper and lower case letters) character set. The unit has both parallel TTL voltage level and serial RS 232 standard input connectors for accepting ASCII input data. The 1110 is a raster scan plotter which operates in an asynchronous mode. Plotting may be done in an area 10.24 in. wide by any length up to 500 ft. The 1110A printer/plotter operates in three separate modes: printing, plotting, or optional simultaneous printer/plot. It has the same plotting characteristics as the 1110 plotter, plus the printing characteristics of the 1175.

Booth No. 937, 939 Circle No. 290

Intelligent key entry system has 16 stations

Inforex, 21 North Ave., Burlington, Mass. 01803. (617) 272-6470. From $780/mo.

The 1303 intelligent key entry system has binary synchronous communication capabilities. Printing or communication of blocked or unblocked tapes may take place on System 1303 without interruption of data entry and verification procedures, in local or remote sites. Both line and serial printers are fully formattable for printing listings, edited data, and computer formatted tapes. The processor and software will support up to 16 keystations, each with its own CRT and electronic keyboard. All keypunch and keytape functions are supported plus a large number of automatic functions.

Booth No. 671 Circle No. 291

CRT terminal allows extensive editing

Lear Siegler, Electronics Instrumentation Div., 714 N. Brookhurst St., Anaheim, Calif. 92803. (714) 774-1010. $3000; 90 days.

Flexibility of format, editing, interface, and transmission characterize the ADM-2 CRT terminal. The operator can change, insert and delete characters or insert and delete entire lines. Cursor control permits the user to skip, backspace, forespace, move up, down, return, home and originate a new line. A "field protect" mode enables the unit to retain forms, instructions, or other fixed data, while transmitting only the "unprotected" information. The terminal has the standard 53-TTY keys, 16 function keys, and a numeric 10-key pad. The 12-in. CRT can display 960 or 1920 characters on a 12 or 24-line format in upper and lower case.

CIRCLE NO. 292

Line monitor helps debug data lines

Digi-Log Systems, Babylon Rd., Horsham, Pa. 19044. (215) 672-0800. $1420 to $1995; 30 days.

The Series 400 line monitor is a compact ASCII device which displays all line and data information flowing between two separate EDP devices. This information can be displayed on either a video monitor or an ordinary TV set. In the line monitor mode, all information is displayed on the screen including the alphanumeric equivalents of normally transparent control characters. The unit can also be switched to operate as a read-only terminal with control signal display suppressed. Either receive, transmit, or both receive and transmit data may be displayed. Both parity and framing errors are detected and indicator lights report various data set control lines. Synchronous and asynchronous models are available. Asynchronous versions include switch-selectable baud rates of 110, 150, 300, 600, 1200, 2400, 4800, and 9600 as well as page and roll mode switches. Display formats include 40 and 80 character by 16 line configurations.

Booth No. 478, 480 Circle No. 293

Spectrum analyzer takes dynamic input range title

Adret Corp., 1887 Lititz Pike, Lancaster, Pa. 17601. (717) 569-7059. P&A: See text.

With a dynamic range of 120 dB from 0 to 11 MHz, Adret's 6303 spectrum-analyzer plug-in leads all others in input range.

From 1 to 110 MHz, the dynamic range of the Adret unit drops to 100 dB—a spec that's matched, but not exceeded, by Marconi's recently introduced 110-MHz analyzer, the TF 2370.

The two units don't compete head-on, however. The $10,375 Adret unit is a plug-in for a frequency-synthesizer mainframe, has no CRT display and offers limited features compared with most analyzers.

The $14,750 Marconi (Englewood, N.J.) is a complete, top-of-the line unit, with such features as digital storage, a TV-like display, counter readout and automatic computation and setting of sweep rate and other performance factors.

But if you need a super-wide dynamic range—to check high-purity crystal oscillators, for example—Adret's 6303 fills the bill. The minimum input signal is 100 mV rms. And the 6303 doubles as an eight-digit, programmable frequency synthesizer with a range of 10 kHz to 110 MHz and a resolution of 1 Hz.

The total frequency range of the Adret unit is covered by two sub-module plug-ins: the 0-to-11-MHz 63032 and the 1-to-110-MHz 63031. Total dispersion of the lower-frequency module ranges from ±200 Hz to ±10 kHz, while the high-frequency unit disperses from ±200 Hz to ±100 kHz. Noise in a 1-Hz bandwidth is listed as 30 nV for the 11-MHz 63032 and 0.3 μV for the 110-MHz 63031.

Once the user sets the dispersion, he loses control of sweep time—that is, the sweep is a function of the dispersion and ranges from 100 to 2000 s.

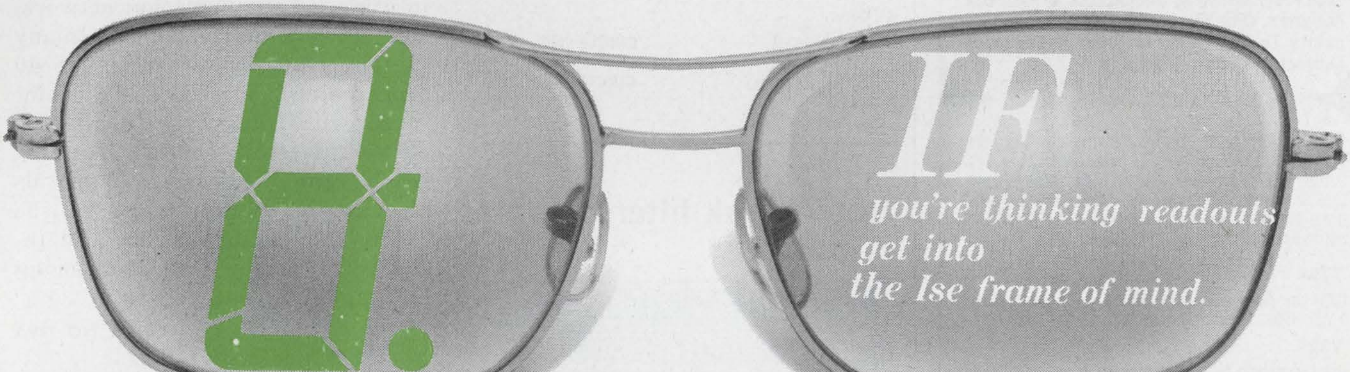
The 6303 outputs a signal that drives a storage scope or an X-Y plotter. A front-panel attenuator and vernier, coupled to a level meter, lets the user adjust the out-

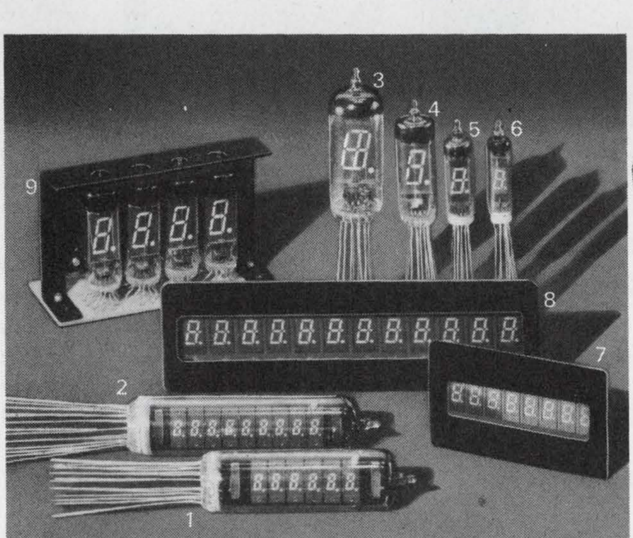
(continued on page 238)

Frame them any old way

Or any new way.

Then sit back and watch your Ise display electronics get your ideas across. Beautifully.
In an eye-easy fluorescent green glow.
At the same time, they're low on voltage and current drain.
High on stability.
Pick the readouts that offer more of everything, including variety, for a whole host of digital display ideas.
They're a difference you can see.





1. DP60A
2. DP90A
3. DG19E
4. DG12H
5. DG10F1
6. DG 8F
7. DP 89A
8. DP127F
9. DMCL12H (NEW)

Display module w/counter & latch

- Fluorescent green glow.
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INFORMATION RETRIEVAL NUMBER 113

INSTRUMENTATION
(continued from page 236)

put to a plotter's full-scale reading.

An averaging mode, also selected by panel button, smooths any instantaneous minor fluctuations in the output signal.

Other important specs of the Adret 6303 include a filter, or analysis, bandwidth of 10 Hz; a filter shape factor of 10 (ratio of 60-dB to 3-dB bandwidths) and a frequency accuracy of ±5 Hz.

Amplitude accuracy from 0 to 11 MHz is ±2 dB to 100 dB down and ±4 dB to 120 dB down. With the 1-to-110-MHz module, accuracy is ±2 dB.

The 6303 costs $10,375, which includes both sub-modules. With just one module, the price drops to $9975. Delivery is stock to 30 days.

For Adret **CIRCLE NO. 250**

For Marconi **CIRCLE NO. 251**

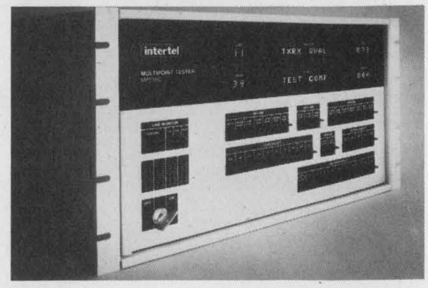
Notch-peak filter is tunable

SEG Electronics, 120-30 Jamaica Ave., Richmond Hill, N.Y. 11418. (212) 441-3200. $545; stock.

Model 850A tunable notch-peak filter tests and analyzes voice-band telephone channels over the 35-to-3500-Hz range. The portable unit can be used for notched noise measurements and waveform analysis with 3.5 and 35-Hz bandwidths. Originally designed per the Bell Telephone Reference Guide PUB 41009 for harmonic wave analysis, the 850A can also make other measurements on standard telephone measuring equipment. An interesting feature is a front-panel controlled switchable ouptut amplifier with selectable 0, 10, 20 and 30-dB gain to facilitate low-level measurements.

CIRCLE NO. 294

Tester diagnoses data networks



Intertel, 6 Vine Brook Park, Burlington, Mass. 01803. (617) 273-0950. $7500; 60-90 days.

MPT500 Multipoint Tester is a compact diagnostic center for data communication networks. The unit allows communication personnel at a central site to immediately diagnose and isolate a wide variety of fault conditions at any remote site in a large communication network. The network may include as many as 12 private lines, with up to 40 drops on each line. The Multipoint Tester runs diagnostics while the network is fully operational. Test results are displayed in numerals and English abbreviations at the Tester front panel, which also includes a speaker for monitoring line signals.

CIRCLE NO. 295

Measure height to accuracies of 0.0002 in.

LK Tool Co. Ltd., Lodge Works, Aston-on-Trent, Derby DE7, 2AJ, England.

The Mini-Check One, single-axis electronic inspection instrument, eliminates calculations and vernier readings. The unit incorporates an 8 character digital readout and offers repeatability on a solid contact probe to within ±0.0002 in. All marking-out operations normally done with a height gauge can be carried out, including direct measurement of hole centers. The measuring element is a tape transducer along which a multi-element reader traverses to measure the deflection of a magnetic field. Signals are transmitted to a solid-state electronic pulse counter and displayed on the digital readout panel. Two versions are available to measure maximum heights of 20 or 40 in., and interfaces can be supplied for coupling to teletypewriter units and computers.

CIRCLE NO. 296

FUJI

Non Volatile, Low Cost & High Reliability

SMALL CAPACITY RAM PERFECTION

POS TERMINAL, CASH DISPENSER, MICRO PROCESSER, CREDIT CARD CERTIFIER, ELECTRONIC CASH REGISTER

It has been generally assumed that MOS IC memory systems are less expensive and more suitable to use than a ferrite core memories to employ in a field of small-capacity random access memories whose capacities are smaller than 8K bytes.

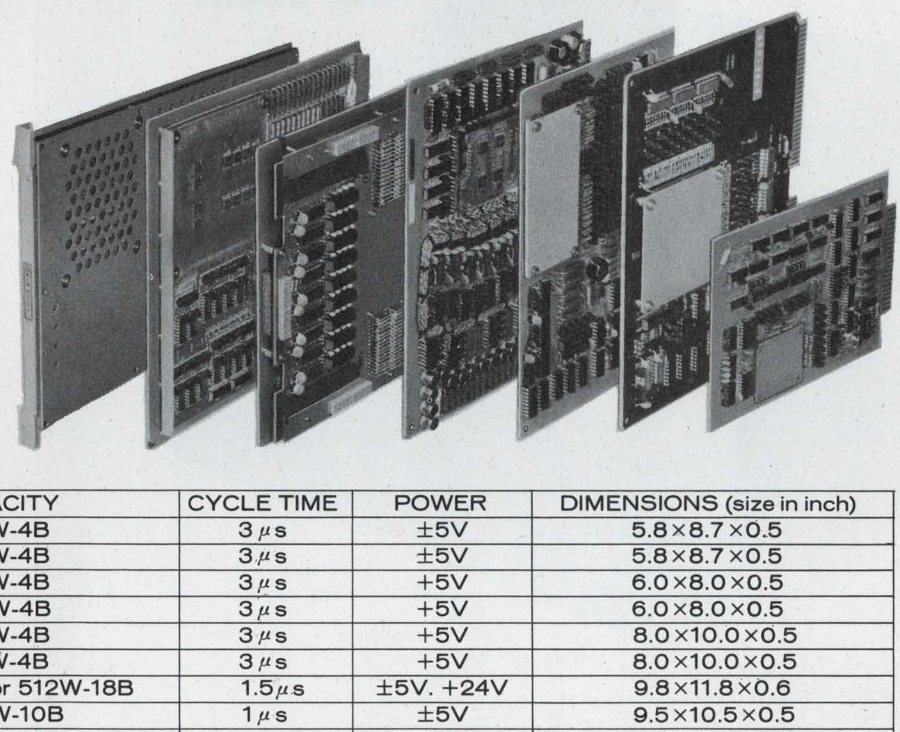
However, today this assumption shall be contradicted. FUJI's new series of memories, Small-capacity Ferrite Core Memory Modules, incorporated with Hybrid integrated circuit as its peripheral circuits, offering a more economical price and better reliabilities rather than MOS IC memories.

Everyone knows that volatility and reliability of stored information is the most important factor in handling of cash transactions at banking system as well as operating cash registers, POS terminal mechines, and on-line devices. Consequently, at least the last digits of calculation must be nonvolatile.

Which do you think is more rational...a system designed by a MOS IC memory with the last calculated digits to be stored by a nonvolatile core memory or a whole entire system simply designed with a nonvolatile core memory? Answer is clear, that is FUJI Core Memory!

STANDARD MODELS

A wide variety of standard models are available over a wide range of memory capacities from 128 words-4 bits to 8K words-9 bits. Furthermore, we are ready to design and manufacture special systems with quick delivery service, according to your requirements.



MODEL	CAPACITY	CYCLE TIME	POWER	DIMENSIONS (size in inch)
CMS2101A	128W-4B	3 μs	±5V	5.8×8.7×0.5
CMS2101B	256W-4B	3 μs	±5V	5.8×8.7×0.5
CMS2112	512W-4B	3 μs	+5V	6.0×8.0×0.5
CMS2113	1024W-4B	3 μs	+5V	6.0×8.0×0.5
CMS2114	2048W-4B	3 μs	+5V	8.0×10.0×0.5
CMS2115	4096W-4B	3 μs	+5V	8.0×10.0×0.5
CMS2116	1024W-9B or 512W-18B	1.5 μs	±5V. +24V	9.8×11.8×0.6
CMS2201A	1024W-10B	1 μs	±5V	9.5×10.5×0.5
CMS2201B	2048W-10B	1 μs	±5V	9.5×10.5×0.5
CMS2107	1024W-18B	1.5 μs	±5V. +24V	7.4×8.3×1.4
CMS2401	4096W-18B or 8192W-9B	1 μs	±5V. +15V	10.0×15.0×0.5
CMS2403	4096W-18B or 8192W-9B	1.5 μs	+5V	10.0×15.0×0.6

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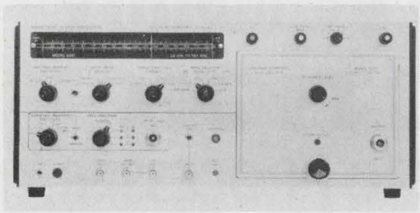
Los Angeles, TEL: (213) 620-1640 SAM. YOSHINO
Dusseldorf, TEL: (211) 89031 TAD. KOMURO

INFORMATION RETRIEVAL NUMBER 115

Unit covers 2 to 18.5 GHz in one sweep



Wiltron, 930 E. Meadow Dr., Palo Alto, Calif. 94303. (415) 321-7428. $11,700 (plug-in); 5 wk.

Model 6237 plug-in sweeps 2 GHz to 18.5 GHz in one continuous sweep. The unit is said to be considerably less expensive than any previous sweeper covering this frequency range. Leveled power output is 7 dBm compared to a typical 2 dBm for the nearest competitor and the leveling flatness of ±1 dB is said to be the best offered by any manufacturer.

CIRCLE NO. 297

INFORMATION RETRIEVAL NUMBER 116

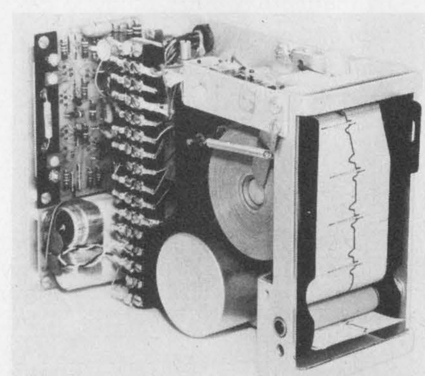
S/d unit offers scale-factor choice

ILC Data Device, 100 Tec St., Hicksville, N.Y. 11801. (516) 433-5330. 3 digits, $450; 4 digits, $550; 6 wk.

SR300 is a solid-state four-digit synchro-resolver angle indicator. The unit may be purchased with custom scale factors, permitting the display of actual engineering units. Worst case error of the 3-digit and 4-digit indicators are ±30′ ±1 LSB, and ±6′ ±1 LSB, respectively, over 0 to 70 C. The SR-300 uses a sampling s/d with 40 conversions/sec as standard for degrees of rotation. Input signals are transformer isolated and transient protected. A DTL/TTL-compatible BCD output is standard.

CIRCLE NO. 298

12-V recorder works in remote location



MFE Corp., Keewaydin Dr., Salem, N.H. 03079. (603) 893-1921. Starts at $520; 60-90 days.

This 12-V-dc single-channel OEM or packaged recorder is for applications requiring complete isolation or remote operation. Features include: built-in 12-V inverter; power consumption of 1.5 A; event marker; simple paper loading; inkless thermal recording; 50-mm wide chart; speed accuracy of ±2%; frequency response full scale dc to 40 Hz; 10 mm D-P dc to 100 Hz.

CIRCLE NO. 299

$9225 buys this complete high-performance computer system from Texas Instruments

Combine a *Silent 700** Model 733 twin-cassette ASR data terminal and a 980A minicomputer with 8K of memory. You have a fast, powerful computer system, including a cassette operating system, for much less than you would normally expect to pay.

And delivery is only 30 days.

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By adding a disc, you can run the powerful DX980 operating system. This way, for less than $25,000, you get a system that is substantially equivalent to other systems with price tags of $35,000 or more.

With *Silent 700* ASR terminals, you get the speed, quietness and reliability that have made them a standard of comparison. And, the convenience of tape cassettes and non-impact printing make the *Silent 700* terminals a powerful alternative to conventional paper-tape teletypewriters.

Want more information? Call the nearest TI office listed below or contact Texas Instruments Incorporated, P.O. Box 1444, Houston, Texas, 77001.

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TEXAS INSTRUMENTS
INCORPORATED

Backplane tester checks 120 points

Automatic Production Systems, Inc., 1602 Hylton Rd., Pennsauken, N.J. 08110. (609) 663-7812. $7500; 60 days.

OmniTester 600 is a fully automatic comparator tester for production checkout of cables, wired harnesses and backplanes. The unit requires no input device or program tapes. A known good product or simulated sample is used as a reference to determine the testing pattern for the unit under test. Test speed is 2400 continuity tests per minute. The standard unit includes front panel programmable continuity and leakage resistance at hipot values up to 500 V dc, including test capacity for 120 access points.

CIRCLE NO. 300

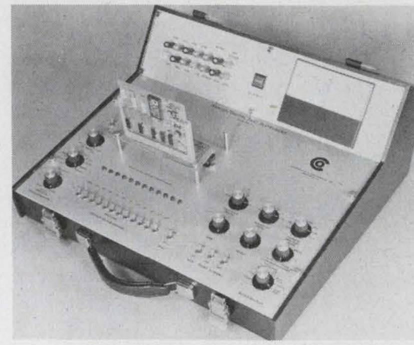
OEM synthesizer programs remotely

Rockland Systems, 230 W. Nyack Rd., West Nyack, N.Y. 10994. (914) 623-6666. $1880; 4 wk.

Intended for use by OEMs, the Model 5110 synthesizer features direct digital synthesis, a frequency range of dc to 2 MHz, 0.001 Hz resolution, remote binary or BCD programmability with integral buffer storage, and programming speed of less than 1.5 μs. Spectral purity includes −70 dB spurious and −55 dB harmonic. Standard features include fixed 1-V rms output with 50-Ω source impedance, 1-MHz reference output and front-panel output monitor connector.

CIRCLE NO. 301

Unit tests converters and displays errors

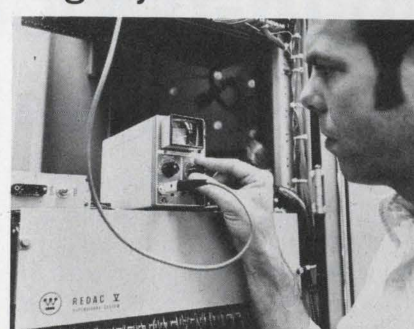


C-O Manufacturing Co., 646 Summer St., Brockton, Mass. 02403. (617) 584-4710. $4400; stock.

Model ADF1A tests both a/d and d/a converters. The unit measures and displays converter accuracy, monotonicity and noise. Analog inputs and outputs are displayed on a precision zero-centered meter. Direct error readings are also displayed, with a two-bit full-scale sensitivity. LED indicators provide a digital display of number inputs and outputs. Dynamic operation may be displayed as a two-dimensional CRT presentation of input vs output or input vs error.

CIRCLE NO. 302

Miniature scope weighs just 4 lb.



Telonic Industries, 21282 Laguna Canyon Rd., Laguna Beach, Calif. 92652. (714) 494-9401. Start at $595; 30 days.

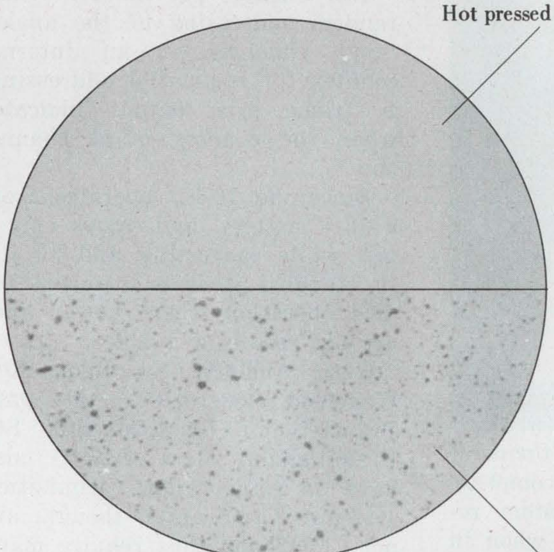
Weighing only 4 lb., this miniscope, Model 9601A, can be hand-held or hung from a neck strap. The unit measures 3.5 × 5 × 7.75 in. and contains a 1.5-in. CRT screen that is enlarged to 2.25 in. by a snap-on magnifier. It is powered by ac or a battery pack. Bandwidth is dc to 5 MHz and sensitivity is 10 mV per division. Max sweep rate is 0.3 μs per division.

CIRCLE NO. 303

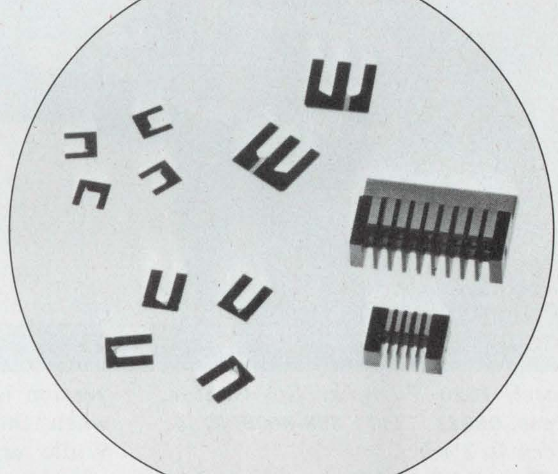
HOT PRESSED FERRITE

Mn-Zn hot pressed ferrites with excellent high frequency characteristics.

Hot pressed ferrite (Micrograph: ×100)

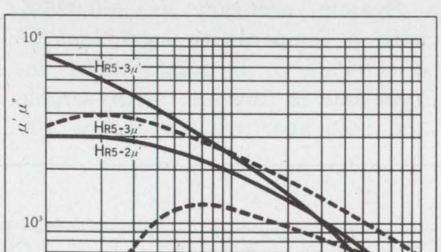


Conventional ferrite (Micrograph: ×100)



TDK is now producing manganese-zinc ferrite combinations with optimum performance characteristics for computer application. The crystalline powder of these ferrite materials is ground to uniform granular size, hot pressed and sintered into molded head pieces of high density. TDK's Mn-Zn hot pressed ferrite head pieces are free of voids, smooth in finish and have excellent contact wear resistance.

TDK also offers high quality head pieces for industrial, audio and video applications. The dual-gap and multi-track configurations are already available. All these new TDK products benefit from TDK's exacting production processes including accurate shaping of sintered pieces and newly developed glass bonding techniques.



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Cable: TDKCORE TOKYO

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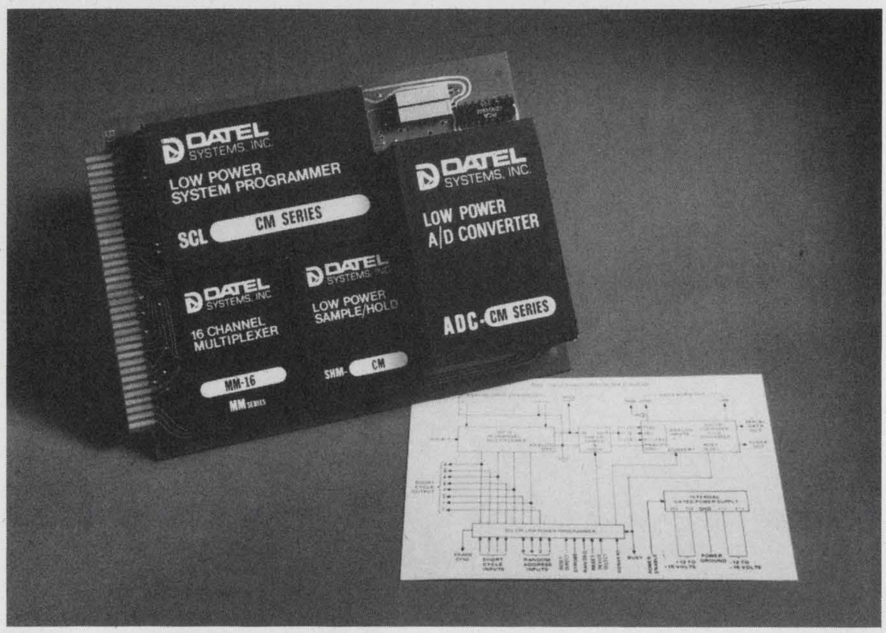
2906 West Peterson Avenue, Chicago, Illinois 60659
Phone: (312) 973-1222
Telex: TWX 910-221-4211 (TDK CHGO)

	Initial permeability	Flux density (at 15 Oe)	Coercive force	Specific density	Material composition
HR3S	18,000±20%	>3,700 gauss	<0.05 Oe	>5.10g/cm³	Mn-Zn
HR5-2	3,000±15%	>4,900 gauss	<0.1 Oe	>5.05g/cm³	Mn-Zn(Hot pressed ferrite)
KR4	1,500±15%	>3,200 gauss	<0.2 Oe	>5.30g/cm³	Ni-Zn
KR6	2,000±15%	>3,200 gauss	<0.15 Oe	>5.30g/cm³	Ni-Zn
KRZ	2 max.	–	–	>5.30g/cm³	–

16 channel acquisition system includes controls



Datel, 1020 Turnpike St., Canton, Mass. 02021. (617) 828-8000. $750; stock to 4 wk.

The DAS-16-LP is a complete 16-channel data acquisition system. It contains a 16 channel analog multiplexer, a sample-and-hold module, an 8 or 12 bit analog-to-digital converter along with all the necessary control logic for both random and sequential channel selection.

The system uses a gated power supply that turns on when a conversion is requested, and turns off when the conversion is complete. While operating, the system requires only 100 mW and when in the standby state less than 120 μW. The 16 single-ended analog input channels can accept either +5 or ±5 V swings and have a 10^9 Ω input impedance.

System accuracy is ±0.025% with a temperature coefficient of ±0.004%/°C. Dynamic input acquisition is 150 μs, with sample and hold aperture time below 100 ns. Data conversion time is 450 μs so the maximum system throughput rate is 2.2 kHz. The control logic includes input command storage that allows party line or computer bus operation.

The controls provide for either random addressing of the analog input channels or an internal counter for sequential addressing. A frame sync output indicates when the counter is at channel one.

Since the 16-LP operates from a 12-V battery, and draws only 8 mA while converting and 10 μA in standby, it is well suited for field operation where power lines are not readily available.

Both Analogic (Audibon Rd., Wakefield, Mass. 01880) and Data Translation (109 Concord St., Framingham, Mass. 01701) also have 16-channel data acquisition systems. Their units, though, are not CMOS and thus require many times more power. The 6912 from Analogic has a 100 kHz throughput and sells for $695, and the 1640 from Data Translation has a throughput of 25 kHz but sells for a low $495.

Datel	**CIRCLE NO. 317**
Analogic	**CIRCLE NO. 318**
Data Translation	**CIRCLE NO. 319**

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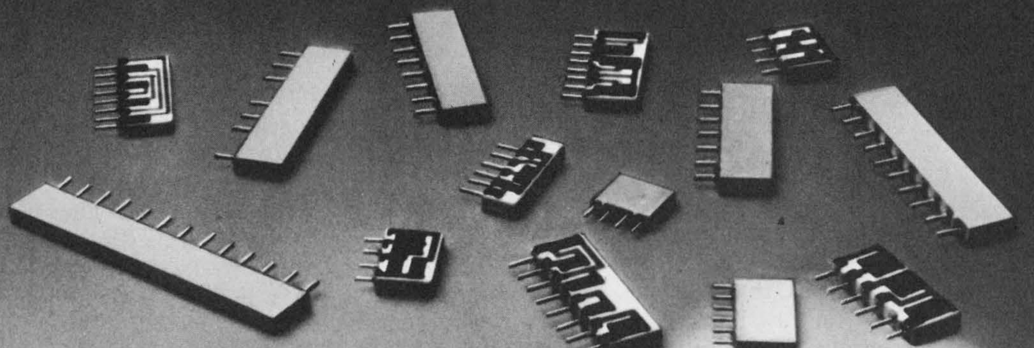

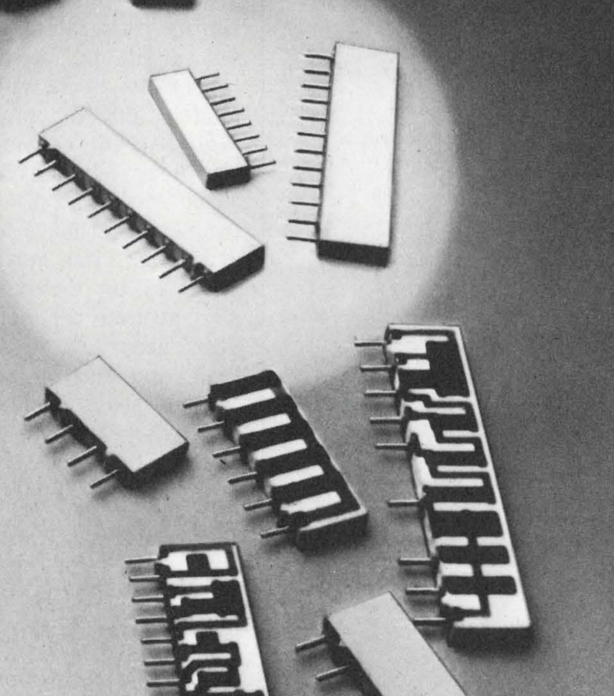

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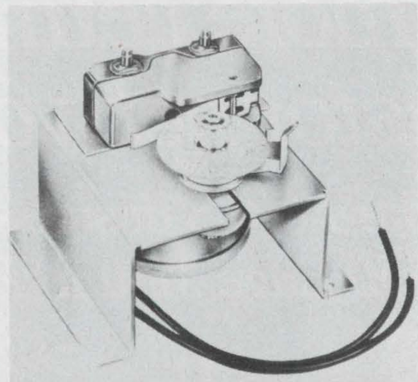
INFORMATION RETRIEVAL NUMBER 122

Mechanical reset timers offer many variations



360 C-Z

Conrac Corp., Mill Rock Rd., Old Saybrook, Conn. 06475. (203) 388-3574.

Model 360 is a fully adjustable, automatic, surface mounted reset timer. It is designed for applications that require time delay, interval timing and if two timers are interconnected, repeat cycle timing. Several models of the 360 are available. Model 360A-A incorporates an instantaneous switch. Model 360C-Z employs a single, high current capacity load switch for heavy industrial control circuits, rated at 20 A. Four time ranges, from 5.5 s to 5.25 min. are available. Time settings are easily adjusted by moving the indicator arm around the notched dial. Repeat accuracy is 0.75% of full scale and setting accuracy is 5% of full scale exclusive of human setting error. The timer is available in operating voltages of 115 or 220 V and 50 or 60 Hz.

CIRCLE NO. 305

Active notch filters offer five bandwidths

Polyphase Instrument Co., Bridgeport, Pa. 19405. (215) 279-4660. $45 (1 to 4).

The series 8000 active filter modules have useful notches to 40 dB (1% of 3 dB rejection bandwidth). Five 3 dB bandwidths of 10%, 25%, 50%, 75% and 100% of center frequency are available. All filters are complete function modules with no additional circuitry required and are made for PC board mounting. Case size is 1.9 × 1.25 × 0.5 in.

CIRCLE NO. 306

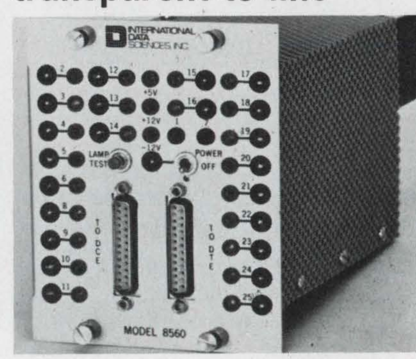
Tunable oscillators use a single resistor

Controlec, Box 48132, Niles, Ill. 60648. (312) 966-8435. $79 (unit qty.).

The Model 73 tone generator uses separate switched resistors to determine the operating frequency. Continuously variable frequency can be obtained by using a variable resistor. Tuning resistor termination may be a spst switch to ground, an open collector gate or a transistor collector. Resistance changes of 5% result in only a 0.05% frequency change, so economy pots and/or 0.5-W carbon resistors can be used to set frequency. Output frequency is almost independent of power-supply voltage and of signal output loading. Eleven modules cover the range of 300 to 3000 Hz. The output signal is a 1-V-rms sine wave.

CIRCLE NO. 307

Monitor module is transparent to line

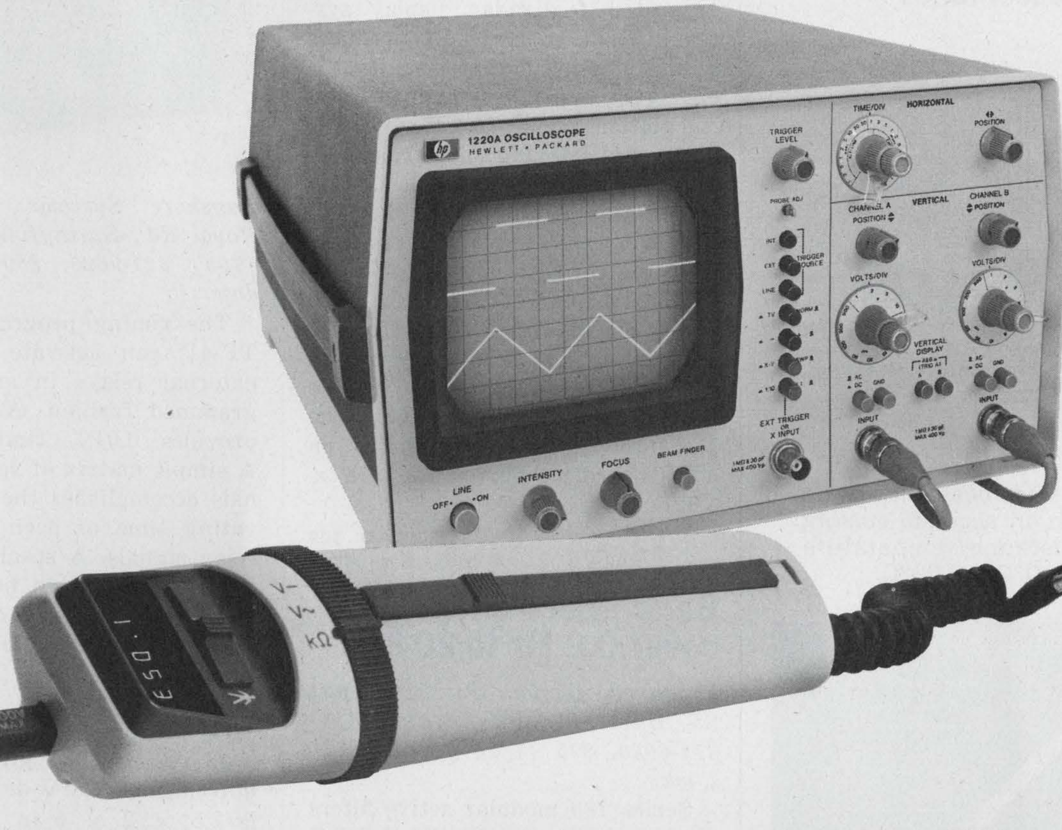


International Data Sciences, Inc., 100 Nashua St., Providence, R.I. 02904. (401) 274-5100. $635; stock.

The Model 8560 bridge and monitor module allows on-line monitoring of data communications traffic. It handles all 25 leads in the EIA data interface between modems, terminals and multiplexers. The unit is transparent and is installed on line between the modem and terminal. Installation takes seconds and is accomplished merely by plugging the modem and terminal into two connectors located on the front panel. Each of the 25 signals is monitored by a test point and a visual LED indicator. Supply voltages of +5 V and ±12 V and a lamp test pushbutton are also provided. The dimensions of the unit are 8 × 5-1/4 × 7-1/2 in.

CIRCLE NO. 308

Get Less For Your Money.



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Or get our bright, full 5-inch diagonal display oscilloscope that gives you a whole lot less of those squinting, guessing, knob-tweaking measurements you'd just as soon do without. It's a dual channel, 15 MHz lightweight (only 15 pounds) with the sensitivity, accuracy, and big-scope conveniences most troubleshooters are likely to need. And best of all, it sells for only \$695*.

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ED4/26/74

INFORMATION RETRIEVAL NUMBER 124

Sine/cosine converters deliver dc or binary

Transmagnetics, 210 Adams Blvd., Farmingdale, N.Y. 11735. (516) 293-3100. $495 (NV); stock to 6 wk.

The Model 655NV sine/cosine converter produces a dc output that is suited for radar display systems. Model 655NVDIG produces a digital output that permits the engineer to perform many digital calculations prior to storing the data. Multiplexing of various inputs is easily accomplished with either unit. Accuracy for the 655-NV is 6 min. and 5 min. for the 655NVDIG. Either model can be supplied to operate over 0 to +70 C or −55 to +85 C. They can also meet all applicable military specifications. Size of the 655NV module is 3.2 × 3.4 × 0.82 in. while the Model 655NVDIG is supplied on a PC board measuring 4.5 × 8 × 5.82 in.

CIRCLE NO. 309

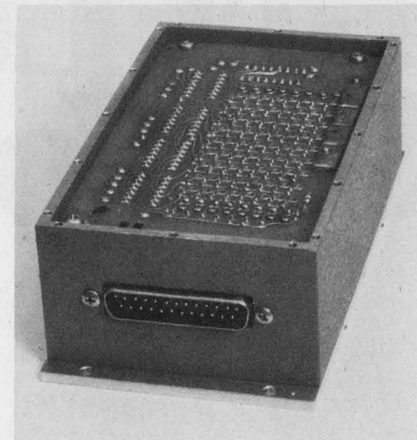
Band-reject filters cover 0.2 Hz to 20 kHz

Frequency Devices, Inc., 25 Locust St., Haverhill, Mass. 01830. (617) 372-6930. $75 (1 to 9); stock to 4 wk.

Series 780 modular active filters have resistive tunable band-reject transfer functions. The design permits tuning over a 1000:1 frequency range. The notch depth is independent of the accuracy or matching characteristics of the frequency tuning resistors. Three models cover overlapping frequency ranges from 0.2 Hz to 20 kHz. Frequencies are set via two external resistors. Q is externally adjustable from 0.5 to 100. Notch depth of 50 dB (Q = 0.5) is maintained over the entire frequency tuning range and is adjustable to 70 dB via an external potentiometer. Power requirements are ±5 to ±18 V at 8 mA and the input voltage swing is ±10 V. The input impedance is 20 kΩ and the output impedance is less than 10 Ω with a voltage swing of ±10 V at 5 mA. The operating temperature range is 0 to 70 C while the size is 1.5 × 2 × 0.4 in.

CIRCLE NO. 310

Timing programmer has 0.01% timing accuracy



Bayshore Systems, 5406A Port Royal Rd., Springfield, Va. 22151. (703) 321-9625. $890; 45 to 60 day.

The timing programmer, Model TP-41, can activate up to eight external relays in an easily programmed fashion. A digital clock provides 0.01% timing accuracy. A simple matrix of screw-in terminals accomplishes the desired activating time of each of the eight relay signals. A special feature allows the relays to be actuated in numerical sequence or all of the relays to be actuated relative to the starting time. Timing capability is selectable internally in 0.25, 0.5, or 1 s increments up to over 1000 s. The input power requirement is 28 V dc. Over-all size is 2.5 × 2 × 5 in. and the unit is constructed to MIL and NASA specifications.

CIRCLE NO. 320

Instrumentation amp has ±1 μV/°C temp drift

Optical Electronics, P.O. Box 1140, Tucson, Ariz. 85734. (602) 624-8358. $47.50 (10-up); stock.

The 9071 differential instrumentation amplifier uses a single resistor to fix voltage gain over a 1000:1 range. The amplifier has a voltage drift of ±1 μV/°C and a nonlinearity of ±0.003% of full scale, maximum. The unit's offset voltage is ±100 μV maximum, adjustable to zero. Other features include: a 1 MHz gain-bandwidth product, ±10 V out into a 1 kΩ load, 1.125-in.-square-by-0.44-in.-high package and operation over a ±4 to ±20 V supply voltage range.

CIRCLE NO. 321

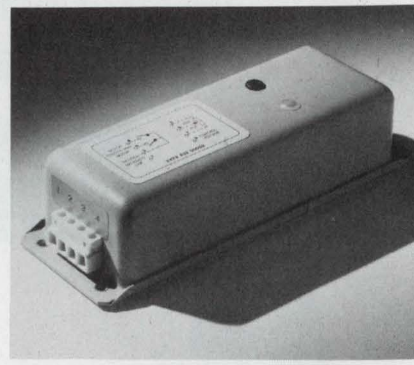
Data acquisition system fits on single card

Data Translation, 109 Concord St., Framingham, Mass. 01701. (617) 879-3595. $495; 4 wk.

The DT1640 data acquisition system provides 16-channels of multiplexing, sample/hold, 12-bit analog-to-digital conversion, and all programming/control logic in a small, compact 0.375 in. high plug-in module. The DT1640 has a throughput rate of 25 kHz for each 12-bit word. Both single-ended and differential inputs are available at an over-all system accuracy of ±0.03% worst case. The unit's temperature coefficient is ±30 ppm/°C, and full scale voltage inputs of ±5, ±10 and 0 to +10 V are pin selectable.

CIRCLE NO. 322

Regulator module drives motor adjusted Xformer



Philips, P.O. Box 523, Eindhoven, the Netherlands.

The automatic stabilizer module accepts the output voltage of a motor driven variable transformer rectifies it and compares it with an adjustable dc reference voltage. The reference is derived from an internal regulated power supply fed from the input to the transformer. The difference voltage output from a comparator controls a switching amplifier which operates either of two reed relays. The relays control the drive motor of the variable transformer which turns and thus reduces the comparator output voltage to zero. A wide range of variable mains transformers, motor drive units, and accessories is available.

CIRCLE NO. 323

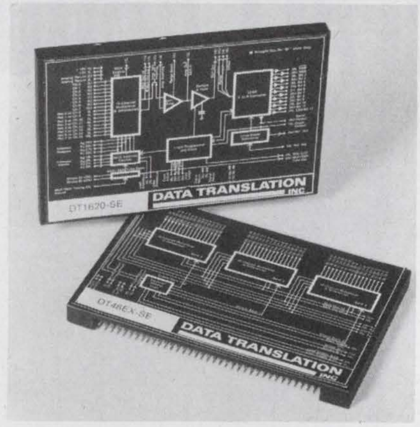
Crystal clock oscillator operates at ECL levels

Vectron Labs, 121 Water St., Norwalk, Conn. 06854. (203) 853-4433. Stock to 60 days.

The CO-233ME crystal oscillator operates from a −5.2-V-dc supply. It provides a stable ECL compatible output at any specified frequency in the 5-to-200-MHz frequency range. The 1.5-in-square-by-0.625-in. high module is designed for PC board mounting and provides a stability better than ±0.0025% over 0 to 70 C. The oscillator is preset to within 0.001% of the specified frequency, but a frequency adjustment to within 0.0001% is optionally available. Other options include the MIL range CO-233ME-2 with stability of ±0.005% over −55 to +125 C and the high stability CO-233ME-3 with stability of ±0.0003% over 0 to 50 C.

CIRCLE NO. 324

64 channel acquisition system fits 2 ckt cards



Data Translation, 109 Concord St., Framingham, Mass. 01701. (617) 879-3595. $1195 per system; 4 wk.

A complete modular 64-channel data acquisition system includes a basic DT1620 data acquisition module and a DT-4EX expander module, all in two compact 0.375 × 3 × 4.6 in. plug-in packages. The 64-channel DATAX system provides a throughput rate of 50,000 12-bit words per second at a system accuracy of ±0.03%. Alternately, operation can be short-cycled to a lesser resolution than 12-bits with a corresponding increase in throughput speed—short-cycling by pin strapping to 10-bits, yields a 40% increase in throughput. The units are housed in metal cases to prevent electrostatic and magnetic coupling from affecting the analog circuits inside.

CIRCLE NO. 325

Rf thick-film amplifier spans 5 to 300 MHz

Optimax, P.O. Box 105, Advance Lane, Colmar, Pa. 18915. (215) 822-1311. $75 (1 to 9); stock to 2 wk.

Model AH-60 thick film rf modular amplifier provides high linear output power of +20 dBm. These units are designed for direct insertion into microstrip circuitry and are encased in a hermetically sealed TO-3 package. They operate over a broad bandwidth of from 5 to 300 MHz, and have a nominal gain of 9 dB at +24 V dc, and an 8 dB noise figure with a 50 Ω line impedance.

CIRCLE NO. 326

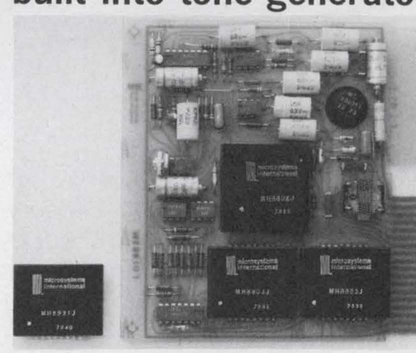
D/a resolver module has 1/2 LSB accuracy

Perkin-Elmer, Main Ave., Norwalk, Conn. 06856. (203) 762-1000. $520 (11 bits), $670 (12 bits); 12 wk.

The Varidac-4 d/a resolver module provides outputs that can be summed to generate sin ($\alpha + \beta$) and cos ($\alpha + \beta$) from four separate inputs. The unit uses two dual transformer-based linear MDACs in a 2.4 × 2.4 × 0.5 in. case. The module's output provides axis rotation without translation by accepting the analog sin α and cos α from a resolver, and two digital inputs, sin β and cos β. It provides 11 bits of resolution and 1/2 LSB of absolute accuracy for each output channel over −55 to +125 C. It is TTL/CMOS compatible and will operate in either a unipolar or bipolar mode. Also available are units with 12 bits of resolution with 1/2 LSB absolute accuracy for each output channel.

CIRCLE NO. 327

Temp compensation built into tone generator

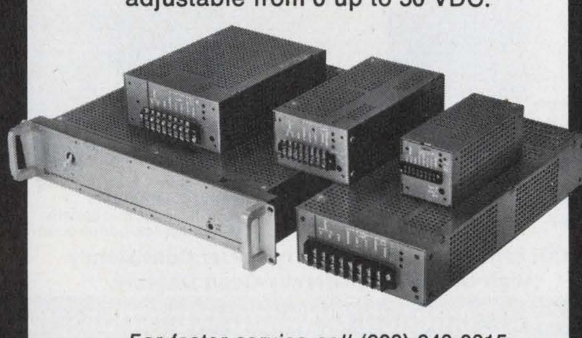


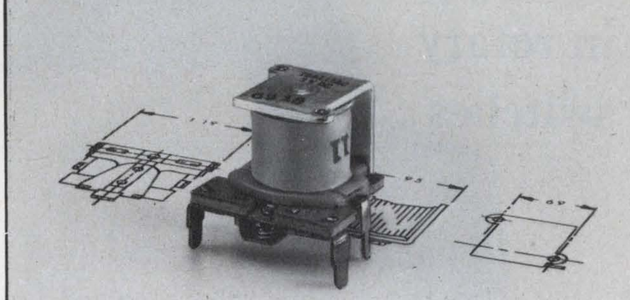
Microsystems International, Box 3529, Station C, Ottawa, Canada K1Y4J1. (613) 828-9191. Unit qty. prices: $18 (8900) $295 (8800); stock.

The dual frequency tone generator, MH8900, is a compact (less than 1.5 × 1.2 in.) 16-pin dual-in-line style case. It can be keyed by most pushbutton assemblies or interfaced to key electronically. Temperature compensation, wide supply range and optional polarity protection are among the other features. The tone receiver, ME-8800 series, is a small (5 × 5 in.) circuit board assembly with all the functions of prefiltering, agc, active filtering and detection. A two-of-eight open collector transistor array is provided on the output.

CIRCLE NO. 328

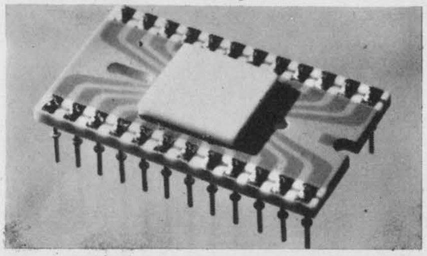

FAULT
NO-FAULT





INTEGRATED CIRCUITS

MOS chip generates rhythms

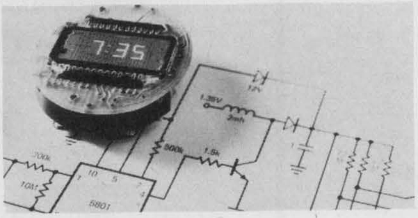


SGS-ATES Semiconductor, 435 Newtonville Ave., Newtonville, Mass. 02160. (617) 969-1610. $15 (100-999); stock (sample qty.).

A single-chip rhythm generator, called the M250, is arranged as a ROM with an internal automatic row decoder that allows one of 32 rows to be scanned at a time. By means of an appropriate program, 12 rhythms can drive eight single outputs. An internal reset allows the counter to stop at any point from 1 to 32 to fit the number of beats required by a given rhythm. The output can directly drive eight blocking oscillators simulating the percussion instruments.

CIRCLE NO. 329

Chip set for watches dissipates 15 μW

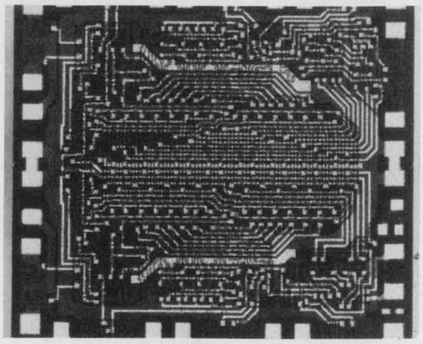


Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051. (408) 246-7501. 5801/5201: $27.50; 5801/5202: $25 (sample units).

A two-chip digital watch set, using silicon-gate ion-implanted CMOS technology, has a total average power consumption of less than 15 μW. When used with a 32-kHz crystal, they operate for greater than one year from a single 1.35-V battery cell maintaining an accuracy of better than one minute per year. The two-chip set consists of the 5801 oscillator/divider circuit and a decoder/driver circuit available in two versions: the 5201, featuring hours, minutes and seconds on-command, and the 5202, displaying the conventional hours and minutes.

CIRCLE NO. 330

16-bit register reads while it writes



Motorola Semiconductor Products, P.O. Box 20924, Phoenix, Ariz. 85036. (602) 244-3465. $29 (100-999); stock.

A 16-bit multiport register file can read 4-bits and/or write 2 bits at the same time. Called the MC-10143L, the MECL RAM offers an access time to any four bits of 10 ns, while simultaneously writing in new data. Clock to data out is typically 5 ns, and read enable to data output is 3.5 ns, typically. Power dissipation is 610 mW and the IC comes in a 24-pin ceramic DIP for the −30 to +85 C temperature range.

CIRCLE NO. 331

Serial analog memories make debut

Reticon Corp., 450 E. Middlefield Rd., Mountain View, Calif. 94040. (415) 964-6800. $100 (sample qty.); stock.

The SAM 64 series represents the first commercial line of monolithic serial analog memories. A typical device provides 64 capacitive memory cells, each of which is individually addressable by two independent shift registers—for read-in and read-out. Several devices can be cascaded to store a complete TV line. Over 10-MHz sampling rates and 50-dB S/N ratio are reported.

CIRCLE NO. 332

Calculator chip set handles hard problems

MOS Technology, Valley Forge Corporate Center, 950 Rittenhouse Rd., Norristown, Pa. 19401. (215) 666-7950. $32.50 (100 k).

A set of two MOS arrays, for full-function scientific calculators, permits the entry of problems with up to two levels of parenthesis. Called the MPS 2525-001 and the MPS 2526-001, the chip set performs basic arithmetic, as well as more complex functions such as inverse trigonometric functions and common and natural logarithms. Entry and result data are prepared for entry on a 14-character display. Supplies required are ±6 and ±8.5 V. The chip set dissipates 200 mW.

CIRCLE NO. 333

COS/MOS divide-by-N counter makes debut

RCA Solid State Div., Route 202, Somerville, N.J. 08876. (201) 722-3200. $13.60 (1000).

The first 4-decade divide-by-N counter using complementary MOS technology can be programmed to divide a clock frequency by any number from 3 to 15,999. Three mode-select controls are used for programming flexibility. Called the CD4059AD, the IC comes in a 24-lead ceramic package and operates from 3-to-15-V supplies. The output has TTL drive capability. Applications include digital frequency synthesizers, and a variety of program-counter, instrumentation and industrial-counter needs.

CIRCLE NO. 334

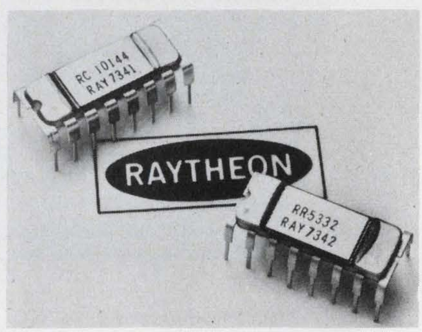
McMOS static RAM holds 256 bits

Motorola Semiconductor, Box 20924, Phoenix, Ariz. 85036. (602) 244-3465. CL version: $35 (100-999).

A 256-bit static RAM offers the medium-speed and micropower-operation features of complementary MOS. The MCM 14537 McMOS circuit consists of eight address inputs, one data input, one write-enable input, one strobe input, two chip-enable inputs, and one data output. Use of both chip-enable inputs permits a 10-bit address scheme. Four of these devices may be used to build a 1024-bit RAM without additional address decoding.

CIRCLE NO. 335

256-bit bipolar RAM accesses in 30 ns



Raytheon Semiconductor, 350 Ellis St., Mountain View, Calif. 94040. (415) 968-9211. TTL versions: $24; ECL versions: $32.50 (100); stock.

A 256-bit bipolar RAM comes in both TTL and ECL versions. TTL versions of the new RAM are called RC 5332/42 for three-state or open-collector outputs and feature a typical access time of 37 ns. They are interchangeable with similar memories, such as the 74S200/206 and 82S16/17. ECL versions run at 30 ns typical. Their designations are RC 10144 (MECL 10k compatible), RC 95410 (Fairchild 95k compatible) and RC 10410 (Fairchild 10k compatible). The RAMs dissipate 250 mW, have a chip select time of 13 ns, and operate over the 0-to-75-C temperature range. They are available in a ceramic 16-pin DIP.

CIRCLE NO. 336

Linear IC simplifies AM radio receivers

RCA Solid State, Route 202, Somerville, N.J. 08876. (201) 722-3200. $1.23 (1000).

The CA3123E linear IC AM receiver provides an rf amplifier, i-f amplifier, mixer, oscillator, agc detector and voltage regulator on a single chip. Intended for superheterodyne AM-radio applications, the CA3123E comes in a 14-lead DIP and operates over the full military-temperature range of −55 to 125 C. Features include a low-noise rf stage in cascode connection, mixer-oscillator stage with internal feedback and frequency-counter-type agc circuit.

CIRCLE NO. 337

PLL stability spec'd at 20 ppm/°C

Plessey Semiconductors, 1674 McGaw Ave., Santa Ana, Calif. 92705. (714) 540-9979. $17.60; stock.

A phase-locked-loop chip, the SL650C, contains a current-controlled oscillator, phase comparator, 2-bit binary interface circuit and an auxiliary amplifier that provides a CCITT interface. The IC has a temperature stability of 20 ppm/°C and its oscillator frequency can be swept over a 1000:1 range by an external control current. The SL650C operates from a supply that can range from ±4.5 to ±9.0 V and comes in a ceramic 24-pin DIP.

CIRCLE NO. 338

8-bit latch offers 22-ns delay

Advanced Micro Devices, 901 Thompson Pl., Sunnyvale, Calif. 94086. (408) 732-2400. 9334PC: $3.57 (100 up).

An 8-bit addressable latch, the Am 9334, offers a typical average data propagation delay of 22 ns and operates from a 5-V supply, drawing a typical current of 56 nA. The latch is pin-compatible with the like-numbered circuit from Fairchild and features four separate modes of operation—addressable latch, memory, 8-channel demultiplexer and clear. The IC contains eight individual parallel outputs and has an active-low common clear and input enable.

CIRCLE NO. 339

Bipolar pROMs expand line

Fairchild Semiconductor, 464 Ellis St., Mountain View, Calif. 94042. (415) 962-3816. $22 (100-999).

Two TTL 1024-bit programmable ROMs, called the 93416 and the 93426, are now offered by the company. The pROMs are fully decoded, high-speed devices, organized as 256 words × 4 bits. The 93416 has uncommitted collector outputs, while the 93426 has three-state outputs. The pROMs have typical access time of 45 ns at 25 C and 5 V and two chip-select inputs for memory expansion and wired-OR capability.

CIRCLE NO. 340

16-k ROM accesses in 450 ns

MOS Technology, Valley Forge Corporate Center, 950 Rittenhouse Rd., Norristown, Pa. 19401. (215) 666-7950. $14.50 (100 k); 12-14 wk.

A 16,384-bit read-only memory, the MCS 2026, features an access time of only 450 ns. The ROM can operate in either a static or dynamic mode. A special clocking system allows direct feedback of output signals to the input, permitting the use of the MCS 2026 for a variety of logic functions. The ROM operates from +5 and −12-V supplies. It dissipates less than 500 mW, even when operating at the highest speed—2.2 MHz.

CIRCLE NO. 341

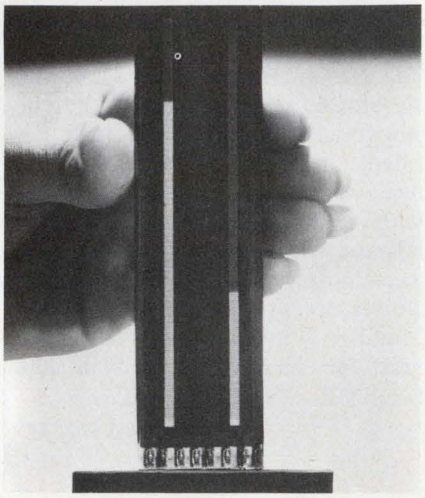
256-bit RAMs access in 30 ns

Signetics, 811 E. Arques Ave., Sunnyvale, Calif. 94086. (408) 739-7700. Plastic: $28 each (100 up); 4 wk.

Two 256-bit RAMs consist of the 82S16, which has Tri-State outputs, and the 82S17, a version with open-collector outputs. Access time is less than 30 ns in both models. Read time is also 30 ns. Write time is 20 ns. Each model dissipates 1.5 mW per bit typical. Input loadings consist of 25 μA (logic ONE) and −100 μA (logic ZERO). The memories operate from a single 5-V supply.

INQUIRE DIRECT

Neon bar graph provides 0.5% resolution



Burroughs Corp., P.O. Box 1226, Plainfield, N.J. 07061. (201) 757-5000. $29 (1000 up).

Self-Scan, an electronic bar-graph analog display, has two separate 4-in. bar graphs and each contains 200 elements that provide 0.5% resolution. The display-element glow blends into a continuous, but precisely controllable, bar length. This device is the first of a series of digitally-controlled analog displays that can substitute for a panel meter. The unit's neon-orange glow is flicker free and can be easily seen in direct sunlight. By using gas-discharge technology, thick-film processing, and an internal self-scanning technique, this bar graph eliminates the need for most drive electronics and requires only eight connections to control the two independent 200-element displays. The device is only 0.2 in., excluding tubulation, and can be provided in special shapes and different configurations for custom applications.

CIRCLE NO. 342

Neon lamp responds in less than 100 μs

Glow-Lite Corp., Pauls Valley, Okla. 73075. (405) 238-5541.

A new technique for neon lamps guarantees a response time of less than 100 μs, regardless of ambient light conditions. The technique can be applied to any of Glow-Lite's indicator lamps, if a minimum voltage of 25% above breakdown voltage is supplied.

CIRCLE NO. 343

Ferrite reader head has 10 μs rise time

Information Magnetics Corp., 5743 Thornwood Dr., Goleta, Calif. 93107. (805) 964-6828.

A glass-bonded ferrite head for use with standard oxide-coated cards, designated the FCH-3, is a single-track, read-after-write head. Its ferrite-head structure with glass gaps and glass bonding prevents epoxies from contacting the medium surface. This results in improved card wear. Designed for a surface-to-head speed of 20 ips, the head provides a packing density of 400 fci, a read output of 15.8 mV and a track width of 0.0180 in. Write current is 18 mA with a rise time of 10 μs. The write-head track width is 0.0410 in. Resolution is greater than 80% and cross-talk is less than 5%. Self-erasure, after 50 passes, is less than 6%.

CIRCLE NO. 344

Light controlled door opener is trip-proof

Scott Automatics, 86 Broadfields Ave., Edgware, Middsex, England.

Hinged or overhead garage doors can be opened and closed from inside a car with a high-security remote control system. The system employs a hand-held gun tuned to emit one coded beam from any of 40 light frequency variations. The wide band of frequencies ensures a high degree of security for the user. Effective range is 25 ft. The coded beam, fired through the windshield, is received by a photoreceptor and passed to a receiver inside the garage, where it is analyzed. The receptor can be mounted behind a glass panel or behind a hole in the garage wall.

CIRCLE NO. 345

Oval speakers use ferrite magnets

International Importers Inc., 2242 S. Western Ave., Chicago, Ill. 60608. (312) 847-6363. 128EF-02: $0.93 (5000 up); stock.

A new family of nine ferrite-magnet oval speakers, the EF series manufactured by Hokutone (Japan), are available in a wide range of sizes from 2-3/4 by 4 in. through 4 by 10 in. The Hokutone 128EF-02 Model, for example, has a nominal size of 3 by 5 in. Resonant frequency is 170 Hz over a frequency range of 7000 Hz and maximum power is 2 W. The ferrite magnet weighs 1.94 oz. All speakers are available in 3.2, 8 and 16-Ω impedances, as well as 30 and 45-Ω versions for solid-state applications.

CIRCLE NO. 346

Cross-bar switch makes use of optical isolation

Opto-logic Corp., 3250 E. Spring St., Long Beach, Calif. 90806. (213) 595-1631. 180 days.

These opto-electronic cross-bar switches can connect any input signal line to any output line. A removable optical slide determines the interconnection matrix which for some models is as large as 256 × 256. An optical system links LEDs driven by the input signals to p-i-n photodiodes that sense the data signals. The unit handles signals with bit rates to 2 MHz. Standard TTL logic levels are provided at the input and output interfaces.

CIRCLE NO. 347

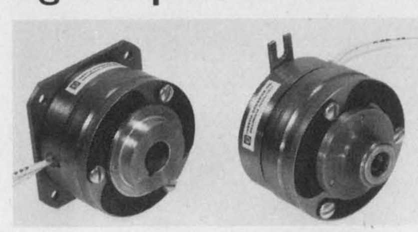
Chip thermistors match to ±0.2 C or better

Western Thermistor Corp., 303 Via El Centro, Oceanside, Calif. 92054. (714) 433-4484. See text.

According to Western Thermistor, the chip thermistor's electrical predictability, stability and miniature dimensions (less than 0.100 in.) make it a low-cost alternate to small disc and bead-type thermistors for use between −50 and 150 C. The economy of chips over beads and small discs may be greater than 60%, since phenolic-coated chips with a 10% resistance tolerance may sell for as little as $0.25 each in 1000 quantities. Chip thermistors can be matched to ±0.2 C or better, with resistances at 25 C of 500 to 50,000 Ω. Wider tolerance chip thermistors, in five negative temperature coefficients and with resistance at 25 C of 2 Ω through 200 kΩ are available from stock to four weeks.

CIRCLE NO. 348

Clutch-brake units have high-torque-dia. ratio



Inertia Dynamics Inc., P.O. Box 295, 12 Bridge St., Collinsville, Conn. 06022. (203) 693-0203. $15 to $30; stock.

A new electromagnetic clutch and brake line, Series 22, which has a high torque-to-diameter ratio (50 lb-in. vs 30 and 40 lb-in. for competitive units), employs an axially-slotted magnet that accommodates more ampere turns per unit of body diameter. Units are equipped with sintered-bronze bearings, UL approved lead wire, zinc and yellow-chromate finish and long-life friction material. The unit's high static torque rating allows design engineers to use smaller size units and save anywhere from $10 to $25 per unit. Four standard dc voltages; 90, 28, 24, and 12 and two standard shaft sizes: 3/8 and 1/2 in. are offered. Special shaft bores up to 5/8 in. are also available.

CIRCLE NO. 349

Quiet Power

TINY PACKAGE TINY PRICE

Small, high performance power packages at the right price -- with regulation, ripple and temperature stability of larger, more expensive units. That's Anadyne's Series 400 miniature power supplies. Wrapped up in just 1" x 2" x 3", for instance, is our Model 401, with ± 15 V, 100 ma outputs, 115VAC input and ripple of only 1.4 mV pk. to pk. Operating temperature range is 0-70° C with line regulation ± 0.005% max. Our tiny regular price is $31.50 (250-999). For 1st time customers the price is an even tinier $25.00 for a single unit. Call or write today for complete specs and details.

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INFORMATION RETRIEVAL NUMBER 143

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new

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New Model LP-576 tells you everything you need to know in 5 through 15V COS/MOS circuits: lows, highs, open circuits and pulses are all indicated. Send for free literature. For a 30 day Free trial Probe or special information, telephone Tom Barth, General Manager, Kurz-Kasch, Inc., Electronics Division, 2876 Culver Avenue, Dayton, Ohio 45429, Telephone: (513) 296-0330. Department ED.

Free test data

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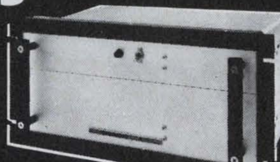
ELECTRONICS DIVISION
2876 Culver Avenue
Dayton, Ohio 45429
Telephone 513/296-0330

INFORMATION RETRIEVAL NUMBER 144

DC to AC Sine Wave Inverters



SPECIFICATIONS

Output Voltage Regulation:
less than ±5% for line and load

Frequency Stability:
±0.5% of fixed frequency; 0.05% optional

Total Harmonic Distortion:
less than 5% at full load and nominal line

GW Series — Typical 60 Hz Models

Power (VA)	Input (VDC)	Output (VAC)	Priced from	Delivery
250	12/24, 28, 48, 125	115, 230	$ 695	Stock
500	12/24, 28, 48, 125	115, 230	1195	Stock
1000	12/24, 28, 48, 125	115, 230	1700	Stock
2000	12/24, 28	115, 230	3000	3 days
3000	12/24, 28	115, 230	4400	3 days

(50 and 400 Hz models available)

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INFORMATION RETRIEVAL NUMBER 145

LOWEST COST COMPACT PAGE PRINTER FACIT 4553

Available with or without RS232C Interface and/or power supply.

- 15 cps
- 80 column
- 5 x 7 dot matrix for character flexibility
- Few moving parts — easy operation, quiet running
- Single print hammer
- No ribbon
- Easy paper loading
- Contains drive circuits and control electronics with character generation
- ASCII code standard
- Also same print method in a strip printer-4552
- Delivery from stock

Facit-Addo, Inc.
501 Winsor Drive **FACIT-ADDO, INC.**
Secaucus, N.J.

Gentlemen: I am interested in receiving detailed data on your ☐ 4553 Page printer ☐ 4552 Strip printer

Name Title
Phone
Company
Address
City State Zip

INFORMATION RETRIEVAL NUMBER 146

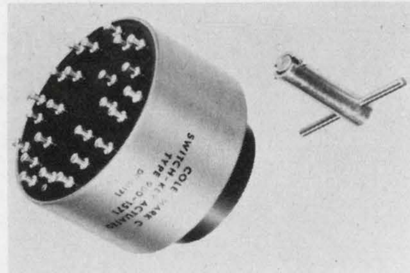
Audible signal source provides 1000 Hz

C. A. Briggs Co., P.O. Box 151, Glenside, Pa. 19038. (215) 885-2244.

A new Bleeptone, Model BT-101 that emits a 1000-Hz audible signal (formerly 2500 Hz) is now available. This less strident, lower frequency is particularly desirable and useful as an alerting tone for business machines and medical equipment. The device produces a 70-to-86-dB-sound-pressure signal at 1 m when 8 to 16 V are applied. No RFI is produced and the current drain is 5 to 9 mA. A nylon, panel-mount adapter provides mounting versatility.

CIRCLE NO. 350

Line of switches needs key for actuation

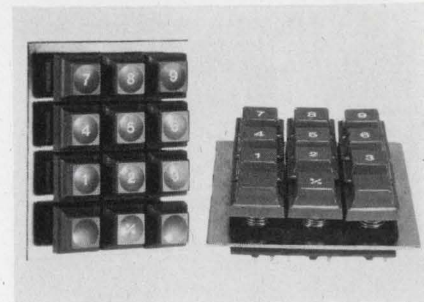


Cole Instrument Corp., 2034 Placentia Ave., Costa Mesa, Calif. 92627. (714) 642-8080.

Key actuated switches guard against accidentally turning equipment on or off, once the switch has been actuated. When the switch is turned to the desired position, a spring-loaded key ejects itself from the switch and the key must be reinserted before the switch can be turned again. These switches are available in a wide selection of configurations. A spring-return position for test purposes can also be added. The switches can be enclosed in dust and dirt-proof enclosures.

CIRCLE NO. 351

Keyswitches mounted on metal plate



Stackpole Components Co., P.O. Box 14466, Raleigh, N.C. 27610. (919) 828-6201.

Arrays of Stackpole's Lo-Pro keyswitches can now be provided premounted and completely aligned in a metal plate, ready for insertion into a PC board. This eliminates the handling of individual switches, an extra PC board, cables and connectors. The preassembled keyswitches are available in 1 × 4 to 4 × 4 arrays. The mounting plates are also available in special shapes to receive other components such as LED indicators.

CIRCLE NO. 352

Proximity switch detects any metal

Electronic Automation Inc., 732 Crofton St. S.E., Grand Rapids, Mich. 49507. (616) 949-0779.

The Auto-Prok self-contained proximity switch is a solid-state device that produces a digital signal in the presence or absence of any metal within its sensing range. Stable operation is provided over the range of −40 to 185 F. It has an electrically adjustable sensing distance and an uncommitted 200 mA dc output. Wiring to the unit can be run with other wiring through standard 1/2-in. fittings. Its wiring length is limited only by losses in the cable. The physical construction permits installation with standard 1/2-inch electrical fittings.

CIRCLE NO. 353

Pressure transducers deliver 5-V-dc output

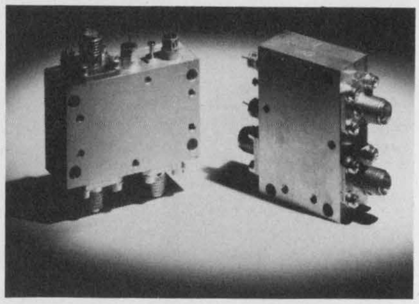
Consolidated Controls Corp., Bethel, Conn. 06801. (203) 743-6721.

Type 41SG30, precision, miniature, bonded, strain-gauge, pressure transducers deliver 0-to-5-V-dc output from an unregulated 28-V-dc input power supply. Within their compensated temperature range of 0 to 150 F, the total error band, including nonlinearity, hysteresis and nonrepeatability, is within ±0.100 V dc. The total operating temperature range extends from −65 to 250 F. Variation of output signal with changing line voltage is within 0.03% of full-scale-per-volt change in input level. The effects of acceleration are minimal. They vary from 0.01% of full scale per g for a 100 psi unit to 0.0005% for a 5000 psi unit. The units are 1-3/8 in. in diameter and approximately 3-in. long. Weight, depending on the pressure range, is from 5 to 6-1/2 oz.

CIRCLE NO. 354

INFORMATION RETRIEVAL NUMBER 151

Linear p-i-n modulator has 50-dB range

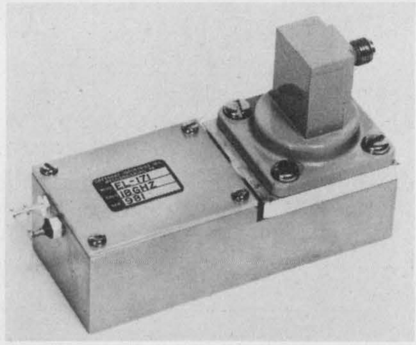


GHz Devices, 16 Maple Rd., Chelmsford, Mass. 01824. (617) 256-8101. $510 (small qty.); 4 wk.

A series of p-i-n diode modulators provides linear attenuation vs voltage over a 0-to-50-dB range (with voltage drive of 0 to 5 V), while maintaining drive modulation to rf-envelope response time of 40 ns. Typical characteristics over the 0.5-to-1.5-GHz bandwidth include a maximum insertion loss of 2.5 dB and a maximum VSWR of 1.5:1. Maximum spec for pulse width is 200 μs; for pulse repetition rate, it's 2000 pps.

CIRCLE NO. 355

Ku-band oscillator outputs 60 mW



Greenray Industries, 840 W. Church Rd., Mechanicsburg, Pa. 17055. (717) 766-0223. $1128 up; 6-8 wk.

The Model EL-171 cavity-stabilized Gunn-diode oscillator has a ± 150-MHz mechanical tuning range in the 12-to-18-GHz frequency range. Power output is specified as 40 mW minimum with typical outputs of 60 mW. Frequency stability is ±0.5% over the entire −54 to +72 C temperature range. The oscillator package measures only 3.2 × 1.3 × 2.0 inches.

CIRCLE NO. 356

X-band Gunn oscillator outputs 30 mW minimum

Thomson-CSF Ltd., Bilton House, Uxbridge Rd., Ealing, London W5 2TT, England.

An X-band Gunn oscillator module provides an output power of 30 mW minimum—50 mW typical—with a supply voltage of less than 10 V and supply current under 400 mA. The oscillator operates at a center frequency between 8.5 and 10.6 GHz; a mechanical adjustment permits a ±250-MHz variation. Frequency drift is less than 0.5 MHz/°C.

CIRCLE NO. 357

SWR bridge spans 7.9-to-18.5-GHz range

Wiltron Co., 930 E. Meadow Dr., Palo Alto, Calif. 94303. (415) 321-7428. $725; 3 wk.

The company's new SWR bridge combines a frequency range of 7.9 to 18.5 GHz with a directivity of 35 dB. The improved directivity means that the bridge has a residual SWR of only 1.04. Typical reflectometers used with the best available directional coupler reportedly provide a directivity of only 26 dB.

CIRCLE NO. 358

Chip capacitor line operates up to Ku band

Varian Solid-State East Div., Salem Rd., Beverly, Mass. 01915. (617) 922-6000.

A line of chip capacitors for MICs—the VCC-600 through 604—provides capacitances ranging from 5 to 125 pF. Blocking voltages are 70 and 50 V dc. Frequencies range up through high Ku band.

CIRCLE NO. 359

5-channel multiplexer covers two octaves

Frequency Contours, 3140 Alfred St., Santa Clara, Calif. 95050. (408) 984-7820.

A five-channel multiplexer covers two octaves in the 200-to-800-MHz frequency range. The multiplexer has one common port and five output ports, with each channel centered at 300, 400, 500, 600 and 700 MHz, respectively. Each channel consists of a 6-pole bandpass filter with a minimum bandwidth of 60 MHz, insertion loss of 1.0-dB maximum and VSWR of 1.5:1 maximum.

CIRCLE NO. 360

Coax attenuators work up to 18 GHz

Systron-Donner, 14844 Oxnard St., Van Nuys, Calif. 91409. (213) 786-1760.

A series of compact, coaxial attenuators can be used at frequencies up to 18 GHz. The Model 441A uses Type N connectors, while the Model 447 uses APC-7 connectors. Fixed attenuation values of 3, 6, 10 and 20 dB are available. The VSWR is typically less than 1.15 at 12.4 GHz and less than 1.25 at 18 GHz. Frequency sensitivity is normally less than 0.05 dB/GHz.

CIRCLE NO. 361

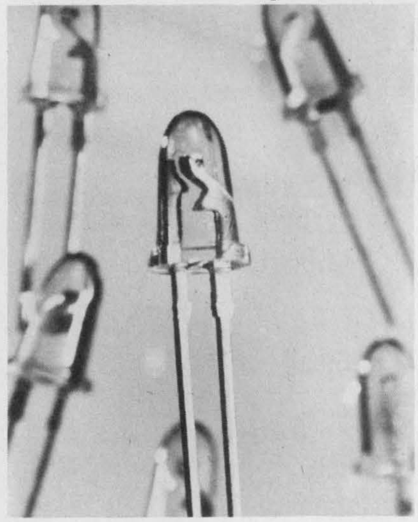
Hardy coax rotary joint spans 1.7 to 2.4 GHz

Sage Laboratories, 3 Huron Dr., Natick, Mass. 01760. (617) 653-0844. $1500; 90 days.

A noncontacting junction coaxial rotary joint, the Model FRJ1007, reportedly provides premium performance from sea-level to deep space environments. Over the frequency range of 1.7 to 2.4 GHz, insertion loss is 0.25 dB maximum and VSWR is 1.35. Starting torque is only 10 oz-in maximum, and continuous rotational speed is 50 rpm. The unit can handle 20 W of cw power.

CIRCLE NO. 362

Infrared LEDs have a choice of lens options



Monsanto, 3400 Hillview Ave., Palo Alto, Calif. 94302. (415) 493-3300. From $1.30 (1 to 9); stock.

The ME712x series of infrared LEDs has four lens options that range from a wide angle power spread for noncritical detector location to sharp-angle concentration of power for detectors located a significant distance from the emitter. For all products in the ME712x series, the typical total external radiated power is 3 mW at 50 mA with a wavelength of 940 nm. Light turn-on and turn-off time is 500 ns with a 50 Ω load. The ME7161 is an IR source, only 0.09 in. at the narrowest base point. Its total external radiated power is typically 2 mW. The ME7140 is mounted on a TO-46 header. It has a 100 mA drive current and a total external radiated power of 4 mW.

CIRCLE NO. 363

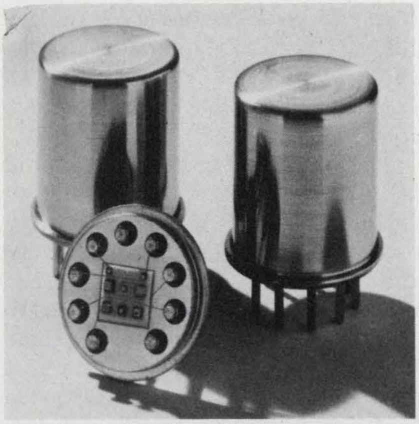
Transistor arrays reduce temperature drift

Sescosem, 101, B^D Murat, Paris XVI, France.

Three transistor-array ICs provide improved matching characteristics and reduced temperature drifts. The SFC 2018 contains a Darlington stage plus two insulated transistors. The SFC 2046 is a double Darlington and the SFC 2054 offers a double differential with current souce. The ICs feature a ΔV_{BE} of ± 5 mV maximum and a $\Delta V_{BE}/\Delta T$ of 2 mV/°C.

CIRCLE NO. 364

Solid-state JFET kits replace vacuum tubes



Teledyne Semiconductor, 1300 Terra Bella Ave., Mountain View, Calif. 94043. (415) 968-9241. HP-400 kit: $48; CA: $110 (1-5); stock.

FETRON kits, for the solid-state conversion of both the HP-400 voltmeter and the Tektronix CA oscilloscope plug-in module, are the first two of a series of kits designed for replacing vacuum tubes in electronic instruments with solid-state devices. The FETRON duplicates vacuum-tube performance with a hybrid JFET circuit, which plugs directly into the tube socket. Unlike vacuum tubes, the FETRON doesn't drift and doesn't require filament, screen grid or support power. The HP400 VTVM conversion kit replaces all five meter-circuit tubes. The CA plug-in kit replaces all 15 tubes.

CIRCLE NO. 365

Rectifiers use disc packages

Westinghouse Electric, Gateway Center, Pittsburgh, Pa. 15222. (412) 255-3329.

The R620 and R920 Pow-R-Disc rectifiers come in disc-type packages for single or double-sided cooling and reversible mounting polarity. The Type R620 rectifiers feature average current ratings ranging from 300 to 500 A, surge-current capabilities to 6500 A and reverse-blocking voltages as high as 3000 V. Type R920 rectifiers, reportedly the largest commercially available solid-state diodes, have an average current of 2000 A, surge-current rating to 22,000 A and blocking voltage of 3000 V.

CIRCLE NO. 366

INFORMATION RETRIEVAL NUMBER 158

DISCRETE SEMICONDUCTORS

Laser diodes operate at 25 or −196 C

RCA Commercial Engineering, Harrison, N.J. 07029. (201) 485-3900. $45 (3001), $500 (C30020), $715 (C30021); stock, 30 to 60 day.

A gallium-arsenide stacked diode laser, Model SG3001, and two gallium laser diode array modules, Models C30020 and C30021, can operate at room or cryogenic temperatures, respectively. Typical peak radiant flux (peak power output) from the SG3001 is 30 W at a drive current of 40 A and room temperature. The radiant flux is emitted at the peak wavelength of 904 nm. It is supplied in a coaxial stud package. Typical average radiant flux (average power output) from the C30020 and C30021 is 1 and 2 W, respectively, at a drive current of 6 A and a temperature of 77 K (−196 C). The wavelength of peak radiant intensity for these modues is 852 nm.

CIRCLE NO. 367

Ultra low current TC diodes work with 0.1 mA

Codi Semiconductor, Pollitt Dr., Fair Lawn, N.J. 07410. (201) 797-3900.

The C8000 and C8001 series of reference diodes operates at currents as low as 100 μA. The temperature coefficients of these devices are as low as 5 ppm/°C over a temperature range of −55 to 100 C, and as low as 10 ppm/°C with a 50% change in operating current. The diodes are encapsulated in hermetically sealed DO-7 glass packages and can be provided with long-term stabilities as low as 10 ppm/year.

CIRCLE NO. 368

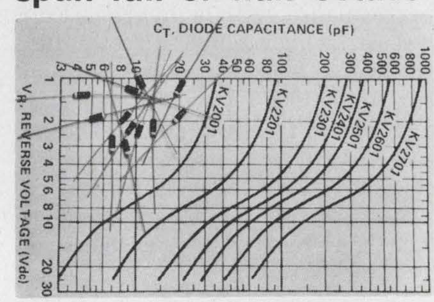
Stripline transistors 50% efficient at 400 MHz

Motorola Semiconductor, P.O. Box 20924, Phoenix, Ariz. 85036. (602) 244-3466. 1 to 24 prices: $6 (5174), $12.50 (5175), $17 (5176); stock.

The MRF5174, MRF5175 and MRF5176 are three rf transistors designed for 28-V-dc transmitter use. The MRF5174 delivers 2 W and 12 dB of gain at 400 MHz, while the MRF5175 provides 5 W and 11 dB of gain at the same frequency. The MRF5176, highest powered of the three devices, has 15 W at a gain of 10 dB. All outputs and gains are at 50% efficiency. These devices are in stripline, opposed-emitter, ceramic stud packages with low inductance dual emitter bonding. All are characterized from 200 through 600 MHz and for series equivalent impedances to facilitate broadband amplifier design.

CIRCLE NO. 369

Hyperabrupt vhf diodes span full or half octave



KSW Electronics, S. Bedford St., Burlington, Mass. 01803. (617) 273-1730. From $0.93 (100-up); 60 day.

The KV2001-2701 series of hyperabrupt vhf diodes offers a full octave tuning range, or, alternatively the KV2002-2702 diodes have half-octave tuning with straight-line frequency performance. The 2001 series has capacitance ratios as high as 7:1 and capacitances from 20 to 500 pF at 4 V. They are for octave tuning over a 4 to 20 V bias range or for half-octave tuning with ultra-high Q applications over an 8-to-20-V range. The 2002 devices are tuned over 2 to 8 V to give straightline frequency performance with typical linearity of ±1%. Diodes are available as close tolerance parts (±5%), or for economy applications.

CIRCLE NO. 370

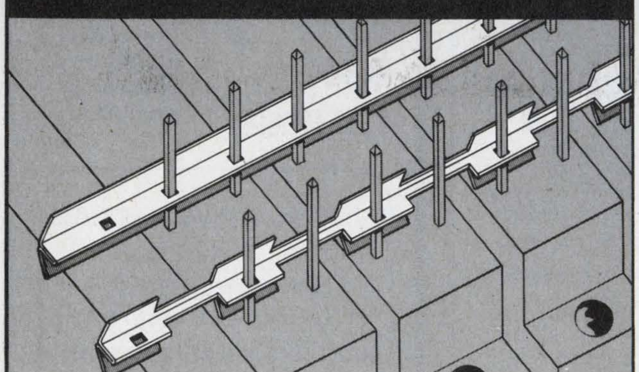
New PM

The people at Bodine have a new permanent magnet field D-C motor line: The 42A. Powerful and compact: Only 4.3" in diameter with continuous duty ratings of 1/8, 1/6 and 1/4 hp at 2500 rpm, 115V D-C. Plus parallel-shaft gearmotors in ratios up to 300:1. Output torques to 350 lb-in.

Delivers: exceptionally consistent output; high starting torque; low-speed operation; self-braking; surprising control capabilities; cool and quiet operation; outstanding brush life. Write for bulletin.

Bodine Electric Co., 2528 W. Bradley Place, Chicago, Illinois 60618
INFORMATION RETRIEVAL NUMBER 159

NOW! SOLDERLESS STRIP/BUS*
by Rogers



- Easy installation and removal
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- High current-carrying capacity

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INFORMATION RETRIEVAL NUMBER 160

THE MOST RELIABLE STANDBY POWER SYSTEMS HAVE

A HEART OF GOLD.

GENERAL ELECTRIC GOLDTOP® BATTERIES ... THE MAINTENANCE-FREE POWER SOURCE FOR LONG LIFE DEPENDABILITY IN YOUR STANDBY POWER APPLICATION

In addition to maintenance-free dependability and long life, Goldtop rechargeable nickel-cadmium batteries offer you:

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These are just a few reasons why you should put a heart of gold into your next standby power system. For more information circle the reader service card, or write General Electric Company, Section 452-05, Schenectady, N. Y. 12345

GENERAL ELECTRIC

INFORMATION RETRIEVAL NUMBER 161

DISCRETE SEMICONDUCTORS

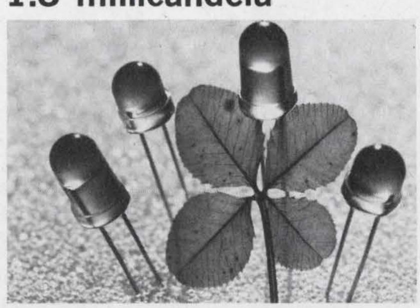
High-power SCR handles 40 A from 200 to 1200 V

Brown Boveri, 1460 Livingston Ave., North Brunswick, N.J. 08902. (201) 932-6066. For 400 V and 100-pcs. $18.80 (39/49), $7.28 (35); stock.

SCR type CS39/49 can handle an average current of 40 A. It is available with voltage ratings from 200 to 1200 V in a TO-94 or modified TO-48 package. The SCR has a t_q of less than 20 μs. Diode type DSD 35 has a 30-A average current rating and is available in the same voltage ratings as the 39/49 but in a DO-5 package. The diode has a 0.3 μs recovery capability.

CIRCLE NO. 371

Green LEDs provide 1.8 millicandela

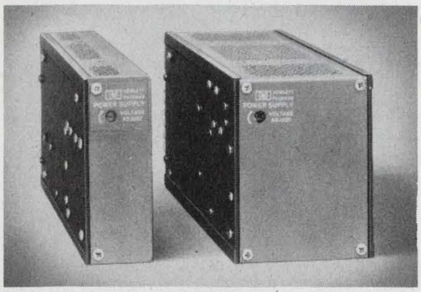


General Electric, Nela Park, Cleveland, Ohio. 44112. (216) 266-2258. From $0.35 (10 K).

The SSL44-2 and the slightly longer SSL44L-2 green LEDs provide a guaranteed minimum initial light output at 20 mA of 1.8 millicandela with a typical output of 2.4 mcd. Equivalent guaranteed light outputs for the lower priced SSL44-1 and SSL44L-1 are 0.8 minimum and 1.4 mcd typical at 20 mA.

CIRCLE NO. 372

Dual output supplies have 0.01% regulation



Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. 94304. (415) 493-1501. From $165.

The HP 62200 series of dual output power supplies includes four models covering two voltage ratings: ±12 V at 1.4 or 3.3 A; and ±15 V at 1.25 or 3 A. A single front-panel control provides ±5% adjustment of both outputs. These series-regulated supplies deliver full-rated output from 0 to 40 C with derated operation up to 71 C. All four models are specified at 0.01% line or load regulation, 1 mV rms, 5 mV pk-pk ripple and noise, ±1% tracking accuracy and 50 μs transient response following a load change from 100% to 50% and 50% to 100%. Cutback current limiting, overtemperature, reverse voltage protection, and remote sensing are standard features on all models.

CIRCLE NO. 373

28-V dc/dc converters output 5 to 5000 V dc

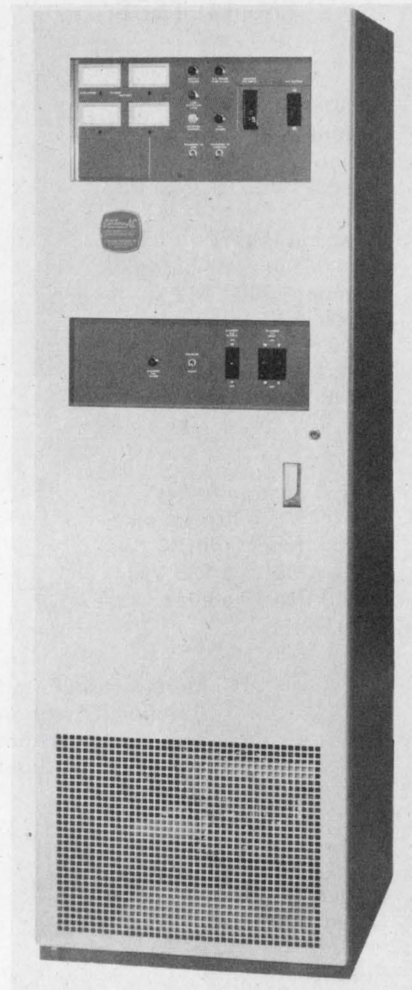
Tecnetics, P.O. Box 910, 1625 Range St., Boulder, Colo. 80302. (303) 442-3837. 9591: $186 to $306; 9586: $200 to $324; 4 wk.

Two new series of dc-dc regulated converters operate from 28 V dc nominal input and include models from 5 to 5000 V dc, plus four dual-output models. The 9591 Series provides 6 W and the 9586 Series has 10 W output. The cases are all metal with black anodizing to increase thermal dissipation. Features common to both series are an output voltage adjustment range of ±10% at full power, and to 60% of the nominal output voltage at reduced power; input-output isolation; and short-circuit protection by current limiting.

CIRCLE NO. 374

INFORMATION RETRIEVAL NUMBER 165

Uninterruptible power with reserve battery

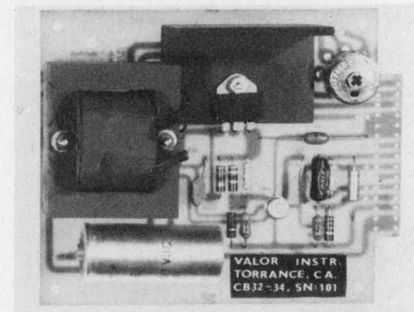


Lorain Products Corp., 1122 F St., Lorain, Ohio 44052. (216) 288-1122.

The Lorain Model 202CAB uninterruptible-power system operates as a continuous monitor/buffer with a reserve battery plant between the commercial ac power source and a minicomputer to guarantee regulated voltage and frequency despite failures and fluctuations on the commercial ac line. A minicomputer protected by the Lorain UPS is unaffected by blackouts, brownouts, or transients on the commercial ac line. The unit is a standard 2-kVA system with static switch. Other systems are available in capacities ranging from 500 VA to over 600 kW to accommodate almost any computer installation.

Booth No. 122-124 Circle No. 375

Dc card supplies operate up to 70 C

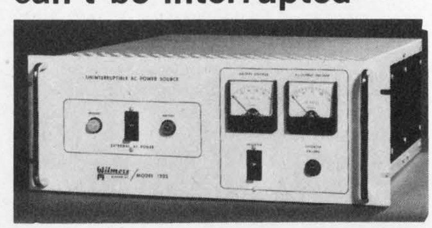


Valor Instruments, Inc., 1122 Llewellyn, Torrance, Calif. 90501. (213) 320-5471. $138; stock to 3 wk.

The CB series of modular card regulated power supplies include foldback short-circuit protection. Thermally self-contained, the supplies will operate in temperatures to 70 C. The printed-circuit card is designed to bolt on a chassis or mount in standard 5.25 in. racks with 2 in. centers. Connector pads are provided for direct solder connections or a PC connector. The input voltage range is 105 to 125 V ac, 47 to 400 Hz. Outputs are factory preset from 5 to 32 V dc. Line and load regulation is 0.1% and the ripple and noise is 2 mV rms max. The temperature coefficient is 0.02%/°C.

CIRCLE NO. 376

Ac power source can't be interrupted



Wilmore Electronics Co., Box 2973, West Durham Station, Durham, N.C. 27705. (919) 489-3318. $975; stock to 60 days.

Model 1202 is an uninterruptible ac power source (UPS) that provides regulated 115-V sine-wave output. Features include built-in "float" battery charger and sealed long-life batteries and electronic overload protection. Model 1202 is rated at 250 VA. Depending upon load, reserve time for internal-battery operation varies from a minimum of 10 min. to more than one hour.

CIRCLE NO. 377

FOR THE UTMOST IN RELIABILITY

INTERVAL TIMERS Series PAB.

This is an automatic reset interval timer with an extremely accurate timing mechanism built to stand up under hard usage in modern manufacturing processes. Due to the simplicity and reliability of its special clutch we can offer it in a range of time intervals from 1 second (1/60″ dial divisions) to 3 hours (3′ dial divisions), twelve in all. It is also available in a panel mount model PAF.

All of our timers are made to give you service far beyond what you'd reasonably expect. Our line consists of 17 basic types, each available in various mountings, voltages, cycles, circuits and load ratings . . . and with whatever special wrinkles you may need.

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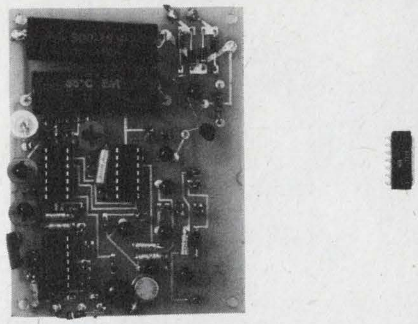
Industrial Timer Corporation, U.S. Highway 287, Parsippany, N.J. 07054

INFORMATION RETRIEVAL NUMBER 167

The Kluge Vs. Monochip



Costs		**Costs**
Parts and material	$4.50	$2.90 total (or typically 50% less than a discrete assembly).
Assembly and testing	3.00	
	7.50	
Delivery		**Delivery**
2 to 16 weeks if you can get all the components.		Prototypes in 2 weeks followed by volume delivery. Fully tested.
Performance		**Performance**
It works if all the parts work.		Monolithic IC reliability. Equivalent performance.

Monochip contains all the components you might use in a wide variety of circuits. But the last metalization layer is left unfinished to make the exact circuit you want. A designer's kit for $39 complete with easy-to-use design rules and parts gets you started. You can design your special circuits into a standardized product available at standard prices. And the Monochip is multisourced.

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INFORMATION RETRIEVAL NUMBER 168

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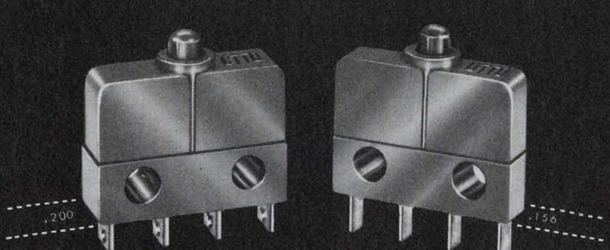
Sub-subminiature Switches



snap-action • precision • 8 A. to dry circuit!

Less than 10 milliohms contact resistance in a ten million cycle switch! That's the OTTO B3 series with patented* design featuring high contact force and minimal contact bounce. Commercial or military, your options include "thin" and "very thin" sizes, contact arrangements to form Z, terminals, and contact materials. Load ratings to 8 A. resistive. Actuators available, too.

For full details including prices and local distributors, write for Bulletin B3.

*U.S. Pat. No. 3,612,793

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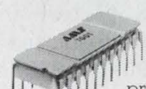
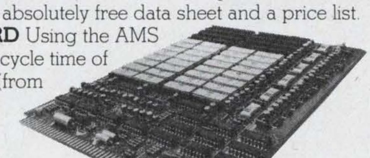
INFORMATION RETRIEVAL NUMBER 169

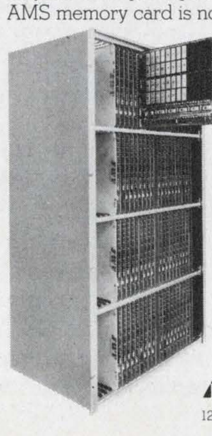
THE WORLD'S FASTEST N-MOS RAM
Delivering now as a device, card or memory system



AMS 7001 STATIC MOS RAM 60 ns access time and 180 ns cycle time make this the fastest 1K MOS RAM (1024 words by 1 bit). The 7001 RAM has been proven in a working system where it has been exercised with all standard patterns under wide operating margins. It is static. So there is no need for costly and difficult refresh circuits; and the 7001 consumes less power than equivalent speed bi-polar RAMs. Distributors have the AMS 7001 in stock and it is multiple sourced. Ask us for design help and for an absolutely free data sheet and a price list.



AMS 7001 MEMORY CARD Using the AMS 7001 RAM, this card offers a cycle time of 200 ns, a 100 ns access time (from address) at ECL levels, and only one load per input. This AMS memory card is now in production. Available with up to 48K bits addressable as 1, 2, or 4 bit words. The AMS 7001 card provides the cost and power advantages of MOS plus the speed advantages of bi-polar.



AMS 7001 MEMORY SYSTEM 110 ns access time from address at the backpanel with ECL levels. Cycle time for the 7001 System is 200 ns. The 7001 system can be organized in words or bytes. It is modular and contains up to 4 bays within one integral assembly. Each bay can be organized in 48K × 18 bits, 24K × 36 bits, or 12K × 72 bits. Shipping now.

AMS *Advanced Memory Systems*®
1276 Hammerwood Avenue, Sunnyvale, California 94086 (408) 734-4330

INFORMATION RETRIEVAL NUMBER 170

Dual output mini supply includes power-line cord

Intronics, 57 Chapel St., Newton, Mass. 02158. (617) 332-7350. From $55; stock.

The "SL" series of modular power supplies has an attached line cord with three-wire plug, off-on switch, and output binding-post terminals. Dual units deliver ±12 or ±15 V dc outputs at either 100 or 200 mA. Single output units provide 5 V dc at either 500 or 1000 mA. All units have a line regulation of 0.05% over a 105-to-125-V-ac input and load regulation (no load to full load) of 0.1% for the same input range. These supplies have output short-circuit protection and in addition, the 5 V units include overvoltage protection. An internal transformer provides input/output isolation. Case size measures 3.5 × 2.5 × 1.25 in.

CIRCLE NO. 378

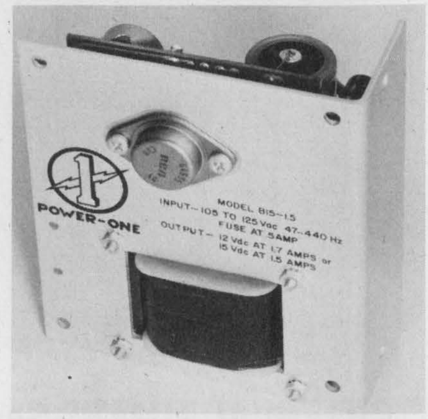
Switching supplies have efficiencies up to 80%

Abbott Transistor Labs, 5200 W. Jefferson Blvd., Los Angeles, Calif. 90016. (213) 936-8185. $230 (1 to 4); stock.

The VN25 high-efficiency series of switching power modules converts 47 to 440 Hz ac lines to 25 W of regulated dc power with up to 80% efficiency. Any output voltage between 4.7 and 50 V dc is available in a package that measures 2.75 × 6.25 × 2.75 in. Line and load regulation are held to 0.4% and ripple to 30 mV rms maximum. A baseplate temperature range of 0 to 71 C and a maximum temperature coefficient of 0.03%/°C assures stable performance. The VN25 models are hermetically sealed and encapsulated to meet the severe environmental requirements of MIL-STD-810B, MIL-E-5400K, and MIL-E-5272C. Standard features for the units include isolated outputs, short-circuit protection, input transient protection, remote error sensing, remote programming and EMI filters. Optional features such as overvoltage protection and military connectors are available.

CIRCLE NO. 379

Single output supply efficient to over 50%



Power One, 6324 Variel Ave., Bldg. E., Woodland Hills, Calif. 91364. (213) 887-1360. $27.95 (1 to 9); stock.

The Model B5-3 is a 5 V (±5%) 3 A series pass, dc power supply. It has an efficiency greater than 50%. The supply is also available in 6, 12, 15 and 24 V models. All units feature reverse voltage protection as standard, with overvoltage protection available as an option. Input power is 105 to 125 V ac, 47 to 440 Hz with an operating temperature range of 0 to 50 C at full output, derated at 70 C to 40%. Line regulation is ±0.01% for a 10 V input change while load regulation is ±0.02% for a 50% load change. Output ripple is 1.5 mV pk-to-pk, 0.4 mV rms. The supplies meet the vibration and shock requirements of MIL-STD-810B. Their over-all size is 2.12 × 4.87 × 4 in. and their weight is 2 lb.

CIRCLE NO. 380

CRT supply offers any output from 10 to 20 kV

Keltron Corp., 225 Crescent St., Waltham, Mass. 02154. (617) 894-0525. Model 810: $115 (100); stock to 3 wk.

Series 800 is a high voltage power supply specifically designed for use in CRT display systems. Up to four optional additional plus-or-minus output voltages can be added with the same line regulation as the high voltage output. Specs include 10-to-20-kV output at 10 W max; line plus load regulation of 0.1%; ripple of 0.05% pk-pk; and a full-load transient response of 0.03% peak, recovering in less than 2 ms.

CIRCLE NO. 381

KEYBOARD-ENCODER

* Fully professional
* 49 Keys
* ASC II Encoder

*For: Terminals, Displays — CATV, Video Titlers, RTTY

At long last, a quality data entry keyboard at a price that everyone can afford. This 49 key system has internal ASC II encoder and debouncer. Keys are full travel typewriter style, in a modified ANSI layout. Spacebar is full length with equalizer system.

ASC code (external Parity), trimode includes shift and control functions. Two user defined keys. Parallel output—will drive RTL, DTL, TTL, MOS, CMOS, etc.

Fibreglass circuit board base with plated through holes, makes assembly quick and sure.

KBD-1 Keyboard Kit - - - - - - - - - - - - - - 3 lbs. $39.595

Southwest Technical Products Corporation,
DEPT. ED
219 W. Rhapsody, San Antonio, Texas 78216

INFORMATION RETRIEVAL NUMBER 462

THE PITTMAN CORPORATION

A Subsidiary of Penn Engineering & Manufacturing Corp.
SELLERSVILLE, PENNSYLVANIA 18960
Phone: (215) 257-5117 • TWX: 510-661-5086
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Pitmo Gearmotors offer d-c servo motor performance combined with a rugged spur gear reducer to provide shaft speeds under load approximately from 5 to 650 rpm. The GM8200 series, now in production, has a gearbox diameter of 1.375" and lengths from 3" 3.4", excluding output shaft extension.

Gears are sintered iron to precision tolerances except for the first gear after the armature pinion which is molded acetal resin to AGMA 8E tolerances. Torque limit on the gearbox is 250 oz. -in.

Three standard motor lengths combined with many possible variations in armature windings permit tailoring of outputs to a wide range of performance requirements.

For more information, write now.

New Pitmo® Gearmotors

INFORMATION RETRIEVAL NUMBER 463

Licon takes the "butterflies" out of holding patterns.

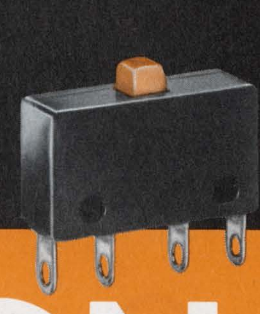
By putting its double-break, double reliable Butterfly® switches to work in today's modern aircraft.

Waiting to touch down. Critical moments for a jet flying a tight holding pattern in heavy air traffic. No room for ordinary switching performance. Which is why Licon® patented double-break Butterfly switches are on board so many jetliners today. Performing with beautiful precision.

Even if you're not designing jumbo jets, you can be sure of the same quality and dependability throughout the entire Licon switch line. Basic Switches, Lighted Pushbutton Switches, Keyboards. Shorten your design time—put Licon's engineering know-how to work for you.

Your Licon representative or distributor has a switch solution for you.

LICON
Division Illinois Tool Works Inc.
6615 W. Irving Park Road
Chicago, Illinois 60634
Phone (312) 282-4040
TWX 910-221-0275



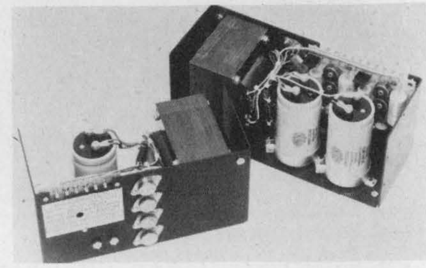
LICON

puts ideas to work in electronics

The Innovative Electronic Group of ITW...
LICON • ELECTRO MATERIALS • PAKTRON

INFORMATION RETRIEVAL NUMBER 464 ▶

Dual output supplies deliver 60 W/output



Abbott Transistor Labs, 5200 W. Jefferson Blvd., Los Angeles, Calif. 90016. (213) 936-8185. From $99 (1 to 24); stock.

The "LLC" series of dc power supplies converts 115 V ac, 47 to 420 Hz to dual outputs of either ±12 or ±15 V dc. These ±12 and ±15 V models can deliver 15, 30 or 60 W of power per output. Line and load regulation are better than 0.1% and ripple is 10 mV rms with a 30 mV pk-pk maximum. Full output power is available up to 50-C ambient with no derating, forced air cooling or heat sinking. Standard features include short-circuit protection, remote error sensing and input transient protection. In addition, both outputs are isolated and nontracking so each output can be used as a completely separate power supply. Overvoltage protection is available as an option.

CIRCLE NO. 282

Line demonstrates power engineering basics

McLean Engineering Labs, 70 Washington Rd., Princeton, N.J. 08550. (609) 799-0100. $3000; 12-14 wk.

This new line of Electro-Mechanical Energy Conversion Equipment is for use in advanced courses of electrical, electronic and electro-mechanical engineering to illustrate power-engineering fundamentals, such as those of Faraday's Law, Lenz's Law and the Constant Flux Linkage Theorem. System elements consist of unitized motor-generator sets; transformers and saturable reactors; and peripheral equipment such as synchronizing panels and metered variac panels. The system is compatible with ampere, volt and wattmeters, oscilloscopes, X-Y plotters, strip chart recorders, variac, and capacitor decades.

CIRCLE NO. 283

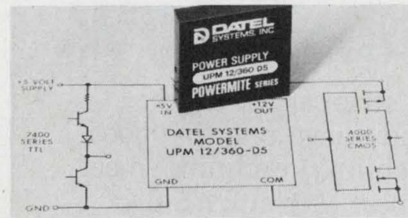
Lab supply gives current, voltage and foldback

Grumil Corp., 4626 Idlewilde Lane S.E., Albuquerque, N.M. 87108. (505) 265-2320. $189; stock.

Model 202S laboratory power supply features a current-foldback mode in addition to the fully regulated voltage and current modes. The supply is rated at 30 V, 1.5 A continuous duty, and features 100% solid-state circuitry. Output impedance can be varied from 4 mΩ through zero to −4 mΩ, and output capacitance can be reduced from 1000 μF to 0.45 μF while maintaining full loop stability. Output is protected against overload as well as positive and negative external forcing within the limits of ±30 V and ±1.5 A.

CIRCLE NO. 384

Converters power 12-V CMOS logic

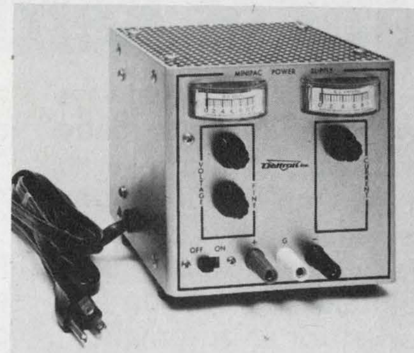


Datel Systems, 1020 Turnpike St., Canton, Mass. 02021. (617) 828-6395. 80-D5: $49; 360-D5: $79.

Two new dc/dc converters power 12-V CMOS logic from the 5-V system supply normally used for TTL/DTL logic. These converters have an input voltage tolerance of −10 to +25% and an efficiency of 50%. Line and load regulation is 0.02% with a tempco of 0.02%/°C. Model UPM 12/80-D5 supplies 80 mA and Model UPM 12/250-D5 supplies up to 250 mA. Both models have current limiting on the outputs. Model UPM 12/80-D5 is a 1.5 × 2 × 0.4 in. encapsulated module and Model UPM 12/360-D5 is a 2 × 2 × 0.4-in. module.

CIRCLE NO. 385

Compact lab supply costs just $89



Deltron Inc., Wissahickon Ave., North Wales, Pa. 19454. (215) 699-9261. $89; stock to 3 wk.

MINIPAC laboratory power supplies feature IC regulation and automatic tracking crowbar. Three models give adjustable voltages of 0 to 12, 0 to 20, and 0 to 40 at a maximum delivered current, respectively, of 0 to 1, 0 to 0.65 and 0 to 0.35 A. Line and load regulation is 0.01% and ripple is 250 μV. Size is 5 × 5 × 5-in. and weight is 4.5 lb.

CIRCLE NO. 386

Heater etched onto Kapton weighs little

Sierracin/Thermal Systems, 13920 S. Broadway, Los Angeles, Calif. 90061. (213) 321-4350.

Spiral Wrap is an electrical heater for aerospace piping systems and other precision applications that features virtually negligible weight and volume, yet produces up to 50 W/in^2. It weighs less than 1 oz/ft^2 and it employs etched-foil techniques to produce intricate heater-element patterns. The 0.001-in.-thick element is etched on a 0.0025-in.-thick Kapton substrate and then is sandwiched by another Kapton layer for a total thickness of just 0.006 in. The heater can operate at temperatures to 550 F and exhibits zero outgassing. It is available in widths of 1/4, 1/2, 1 and 2 in. and lengths up to 42 in.

CIRCLE NO. 387

Teflon tape uses silicone adhesive

Dilectrix Corp., 69 Allen Blvd., Farmingdale, L.I., N.Y. 11735. (516) 249-7800.

A Teflon pressure-sensitive tape with a silicone-based adhesive, designated DF 2200, offers the user better surface conformability, high dielectric strength and a smoother surface profile that is free of skive marks. Also, the silicone adhesive provides high temperature resistance and the tape can be easily wrapped over irregular surfaces. The tape is available in a clear or assortment of colors, and it comes in 36-yd rolls with widths of 1/4 to 22 in.

CIRCLE NO. 388

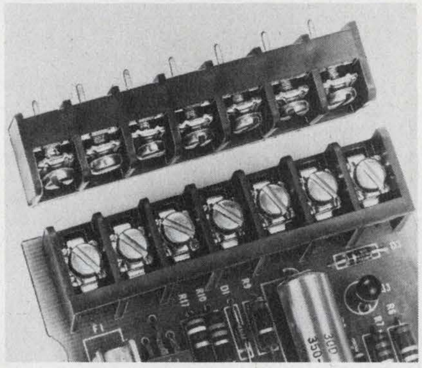
Kit provides all for rapid wiring

United Wiring & Manufacturing Co., 3405 Shiloh Rd., Garland, Tex. 75041. (214) 271-2586. $285; stock.

The Solder-Wrap prototyping kit, catalog #100432, provides a fast way of interconnecting ICs and discrete components. A routing speed, including soldering time, of up to 300 electrical connections per hour is possible. The prototyping kit is packaged in a foam-padded-vinyl attache case. The kit includes wire and a total of 26 components.

CIRCLE NO. 389

Screw-terminal strips fit PC boards

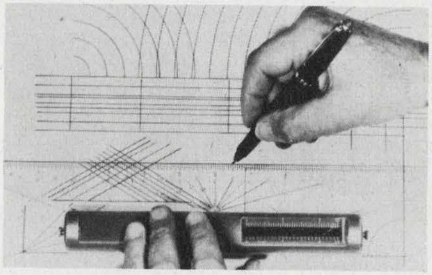


Reed Devices Inc., 21W 183 Hill Ave., Glen Ellyn, Ill. 60137. (312) 858-2050. 10 position: $0.91 (1000 up); stock.

A new terminal strip designed for PC boards features 6-32 screws on 3/8-in. centers. The standard-mount unit is called the 6PCV series, and a right-angle version is called the 6PCR series. In addition to PC pins, thru-panel solder-turrets and wrap terminals are also available. Captive wire-clamp plates eliminate the need for spade or hook terminals. The terminals are available with three to 24 points.

CIRCLE NO. 390

Ruler replaces T-square and triangles

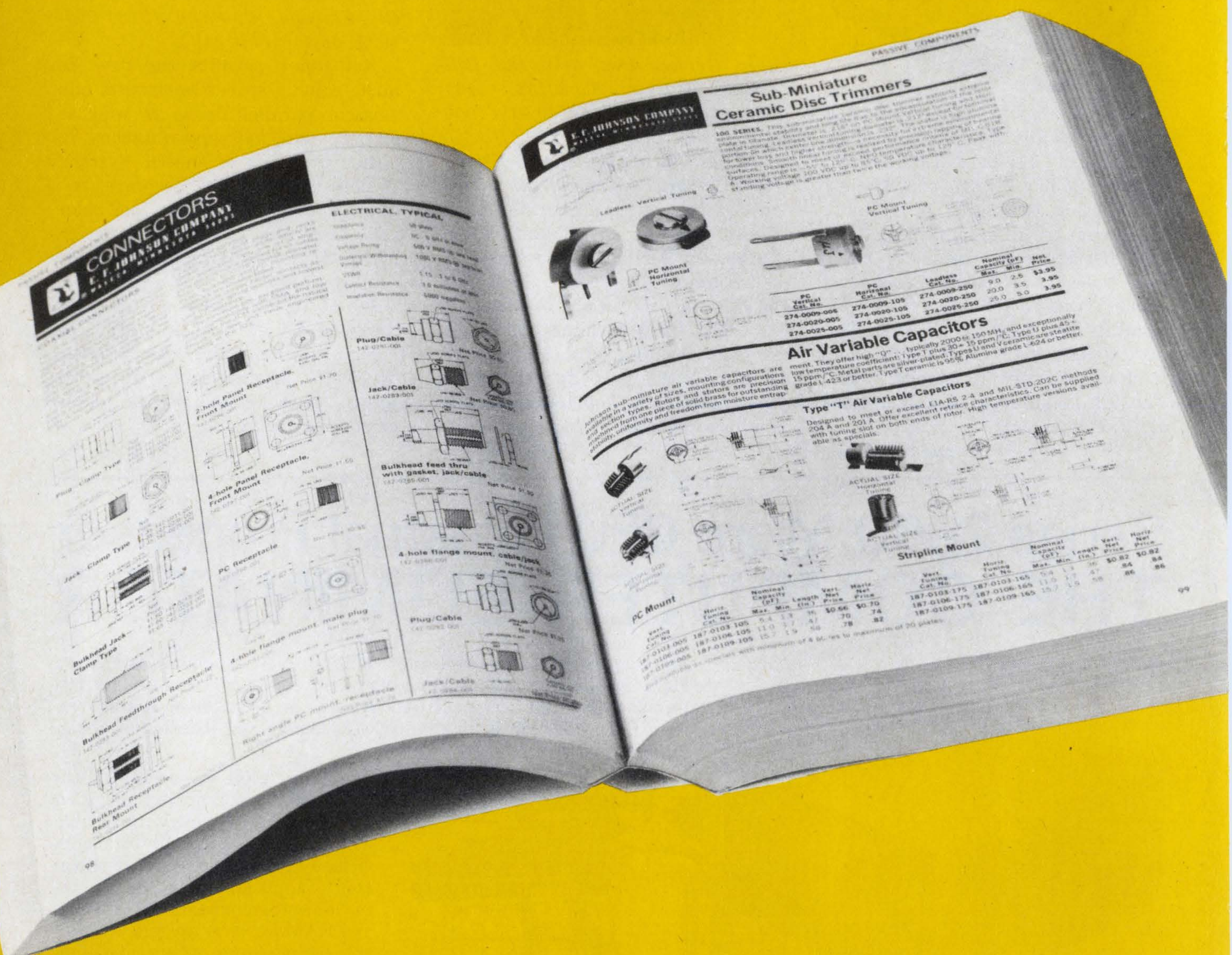


Professional Aids Co., 1 S. Wacker Dr., Chicago, Ill. 60606. (312) 263-7622. $6.95 (unit qty).

Rol Ruler permits the user to make equally spaced horizontal and vertical parallel lines, as well as circles, arcs and cross-hatches in either the inch or metric system. It does the job of a T-square, triangle and parallel ruler. The ruler rolls back and forth with a touch of the finger and a calibrated scale indicates spacing in 10ths and 16ths of an inch. And it eliminates the necessity of "pointing-off." The ruler also allows the user to make uniformly spaced circles and arcs up to 22-in. diameter and other geometric forms.

CIRCLE NO. 391

Electronic Design's



WATCH FOR IT . . . JULY 1974

TO-5 contactor loads with zero force

Wells Electronics, Inc., 1701 S. Main St., South Bend, Ind. 46623. (219) 287-5941. $1 to $4; 2 wks.

A new zero-insertion-force family of TO-5 contactors for test, burn-in and aging, designated Series 608, combs the device leads into grooves of the carrier to minimize the possibility of an open contact. The contactors are available in 8 and 10-lead versions in various materials capable of withstanding continuous temperatures from −55 to 250 C. The unit is operated by raising the lid to its upward stop. This cams the contacts outwards. The carrier containing the TO-5 device is then placed on the contactor. The lid is then pushed downward. This allows the contacts to spring inward and wipe the device leads while combing them into position.

CIRCLE NO. 392

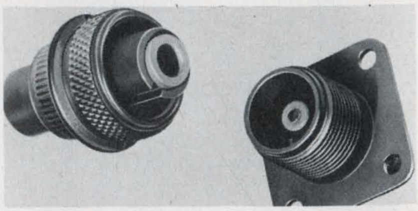
Adhesive repairs glass-to-metal seals

Aremco Products, Inc., P.O. Box 429, Ossining, N.Y. 10562. (914) 762-0685. $25 (1 pint); 2 wks.

Graphi-Bond 551-R is a new graphite-base adhesive that can repair glass-to-metal seals. The adhesive is suitable for use at temperatures to 5400 F. Most other adhesives tried in this application have broken down rapildy when exposed to the sealing atmospheres at temperatures in the 1900-F range. The new adhesive has outlasted the base material in many instances.

CIRCLE NO. 393

High-voltage connector has 20-kV-dc rating

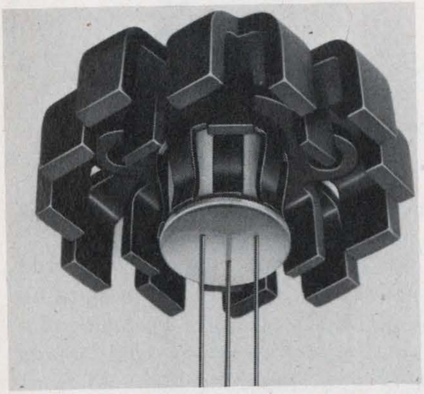


Caton Connector Corp., 425 Northern Blvd., Great Neck, N.Y. 11021. (516) 466-9288. $10 to $25; stock.

A new line of high-voltage connectors features a corona-suppressing interfacial seal with resilient silicone inserts. The connectors have the following characteristics: 1 to 8 contacts; a 20-kV-dc rating, pin to shell; a temperature range of −40 to 65 C; and the shell sizes of #12 through 24 in a modified MS-3100 series with MIL-C-5015 hardware. Molded and potted silicone cable assemblies are available from stock for most applications. These connectors are suited for electrostatic printers, holography, airborne radar, flash-lamp power supplies, infrared and CRT devices.

CIRCLE NO. 394

Heat sink for TO-5 needs no hardware

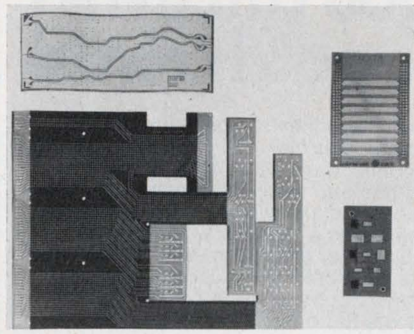


International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif. 91502. (213) 849-2481.

With no mounting hardware, the 3925-1B heat sink slips smoothly onto a TO-5 can and occupies only 1.06 in.^{2} of board space. With this heat sink, a TO-5, 2N1837 transistor can operate at 3 W and hold the case temperature rise to 70 C above ambient. Without the heat sink, the transistor can dissipate only 600 mW for the same temperature rise.

CIRCLE NO. 395

Cut wiring costs up to 50% with flexible PCs

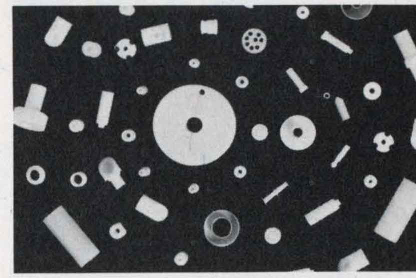


N. V. Philips Gloeilampenfabrieken, Elcoma Division, P.O. Box 523, Eindhoven, the Netherlands.

Savings of up to 50% in overall wiring costs can be achieved with flexible printed circuits. Two processes can meet most customer requirements. A subtractive process uses copper-clad, flexible, polyester and polyimide base materials and obtains the required conductor patterns by an etching. The PD-R process (physical development by reduction) selectively deposits the conductor pattern on a layer of insulating material.

CIRCLE NO. 396

Plastic parts fabricated for electronic use



Severna, 555 Eagle Rock Ave., Roseland, N.J. 07068. (201) 228-0600.

Severna can extrude, machine, mold or otherwise fabricate Teflon, nylon, Kel-F, polystyrene, Delrin and Rexolite to very close tolerances and at high production speeds. They are now producing such parts as capacitor-end seals, coaxial-connector insulators, coil bobbins, electrical insulators, feed-through insulators, multipin-connector insulators, precision dielectric components, stand-off insulators, tube sockets, special shapes and other miniature and subminiature components.

CIRCLE NO. 397

design aids

Photographic glass plates

A chart, "Characteristics of Kodak Plates for Ultraviolet, Visible Light, and Infrared Photography," contains capsule descriptions and applications for each plate, data on availability, safelight recommendations, meter settings and image structure characteristics. All rms granularity data are given in terms of diffuse values. Eastman Kodak.

CIRCLE NO. 398

Darlington transistors

Design tips, application notes, process technology and quick selector guides for Darlington power transistors are included in a wall chart. Motorola.

CIRCLE NO. 399

Silicon power transistors

A wall chart describes high-current high-voltage silicon power transistors. Major specifications of each type are included for device selection. Powertech.

CIRCLE NO. 400

Switches

An eight-page guide to basic switches contains a multicolor, single-page chart designed to provide easy access for selection of standard and miniature snap-action precision switches. Micro Switch.

CIRCLE NO. 401

Conductor calculator

A double-sided slide chart enables users to find conductor resistance and current carrying capacity. It covers single, flat conductors laminated with 0.002-to-0.005-in. flexible laminate and an allowance of a 10-C rise at 20-C ambient. The ruler is also useful to find the current capacity of copper circuits etched in the company's GT5500 polyester or GT17510 polyimide laminates. The user can read current carrying capacity at various temp rises above ambient of 20 C. G.T. Schjeldahl, Northfield, Minn. 55057.

INQUIRE DIRECT

application notes

FET basics

A brochure provides a brief but concise introduction to the nature of field-effect transistors and touches on characteristics, terminology, test parameters and applications. The 20-page brochure covers both major types of FET devices (junction FETs and MOS FETs) in both their n and p-channel configurations. Defined terminology includes drain current, pinchoff voltage, gate-to-source voltage, breakdown voltage, transconductance, capacitance and Y-parameters. Siliconix, Santa Clara, Calif.

CIRCLE NO. 402

Epoxy adhesives

"Epoxy Adhesives" encompasses everything from the basic advantages of epoxy adhesives to methods of application, mixing and storage. Surface preparation is discussed and specific advice given. High Strength Adhesives, Chicago, Ill.

CIRCLE NO. 403

Tangential sensitivity

Tangential sensitivity is a measure of noise performance of a detector. An application note answers questions about various factors involved in making the measurement. A useful production test system using an rms voltmeter to compare signal output to noise output is shown. Hewlett-Packard, Palo Alto, Calif.

CIRCLE NO. 404

CMOS

A brochure describes the characteristics of CMOS logic and how best to apply it. The brochure includes details on the characteristics of CMOS logic elements and system considerations, including information on data bussing, power-supply filtering, and minimizing system power. Data on interfacing CMOS with other logic families are included. National Semiconductor, 2900 Semiconductor Dr., Santa Clara, Calif. 95051

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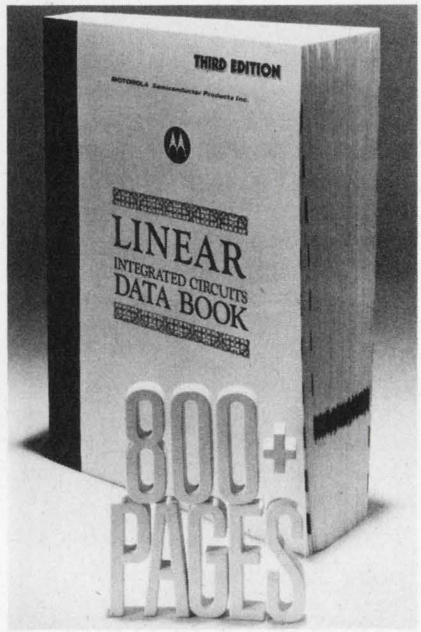
new literature



Linear IC handbook

The third edition of the Linear Integrated Circuits Data Book has been expanded to over 800 pages, 100 pages more than the previous edition. An interchangeability guide and listing of available application notes are included. Package outlines, pinouts and schematics are provided. Quick selector guides for each category of device facilitate the use of this handbook. It is priced at $3 per copy. Motorola, P.O. Box 20924, Phoenix, Ariz. 85306.

INQUIRE DIRECT

Pulse magnetizing system

Specifications and operational description for the Model HE-20 pulse magnetizing system are contained in a two-page data sheet. Indiana General, Valparaiso, Ind.

CIRCLE NO. 405

Linear IC TV circuits

Comprehensive data on three recently announced linear integrated circuits for color and monochrome TV receiver applications—a TV chroma amplifier/demodulator, a TV signal processor and a TV chroma processor—are described in a catalog. RCA, Somerville, N.J.

CIRCLE NO. 406

SCRs

A series of 710-A rms fast switching inverter SCRs is described in a six-page data sheet. The literature contains graphs, ratings, specifications and a dimensional outline drawing. International Rectifier, Semiconductor Div., El Segundo, Calif.

CIRCLE NO. 407

Dielectric ceramics

A high-permittivity dielectric ceramic for microwave applications is featured in a brochure. Hirst Research Center, Wembley, Middlesex, England.

CIRCLE NO. 408

Power converters

Dc-to-dc converters, 115-V-ac, 400-Hz input high efficiency power supplies, ac-to-dc modules and power-supply kits are detailed in a 28-page catalog. Tecnetics, Boulder, Colo.

CIRCLE NO. 409

Instrumentation

"Electronic Precision" provides 20 pages of information on the product line and pioneering activities of Rohde & Schwarz. Rohde & Schwarz, Munich, West Germany.

CIRCLE NO. 410

Magnetic circuit breakers

The fourth edition of "The Choice of Protection" discusses the advantages and disadvantages of protective devices for electrical equipment and electronic circuits. Coverage includes short-circuit capacity considerations, transient tripping, motor protection, environmental conditions, magnetic time-delays, undervoltage protection, ground fault circuit interruption and other topics. Fifty illustrations include performance curves, diagrams, cutaway drawings and photographs. Airpax Electronics, Fort Lauderdale, Fla.

CIRCLE NO. 411

Axial fans

A line of axial fans designed to cool diverse commercial, industrial and military electronic equipment is described in a six-page brochure. Operating characteristics, performance curves and line drawings are provided. Amphenol, Broadview, Ill.

CIRCLE NO. 412

Vibration feeders

A 16-page catalog describes the Viba-Trex line of vibratory feeders. Specifications, bowl dimensions and control unit information are included. Ex-Cell-O Corp. of Canada, London, Ontario.

CIRCLE NO. 413

Data communications

A "data communications primer" graphically explains the company's system's ability to extend digital communications between central IBM System/360-370 computers and remote I/O sites, eliminating the need for remote computers. Computer Transmission, El Segundo, Calif.

CIRCLE NO. 414

Photomultiplier tubes

A replacement guide lists near and direct equivalents of photomultiplier tubes and contains an application index of about 150 tube types. EMI Electronics, Hayes, Middlesex, England.

CIRCLE NO. 415

Instrumentation

Oscilloscopes, digital multimeters, pattern, marker, rf wideband and sine/square wave generators are illustrated in a 24-page catalog. Also included are FM multiplex stereo generators, volt/ohm meters and curve tracers. Leader Instruments, Plainview, N.Y.

CIRCLE NO. 416

Plastic injection molding

A 112-page manual, "Cutting Costs in Short-Run Plastics Injection Molding," covers all phases of prototype and short-run practice. The manual includes parts design, material selection, mold building, part production and other helpful data. The manual is $5. Morgan Industries, 3311 E. 59th St., Long Beach, Calif. 90805.

INQUIRE DIRECT

Radio Shack catalog

A 52-page electronic parts catalog contains more than 2000 hard-to-find electronics items. It includes a variety of special-purpose tubes, transistors, readouts, PC and IC equipment, relays, resistors, capacitors, potentiometers, transformers, sophisticated test instruments, connectors and power supplies. Radio Shack, Fort Worth, Tex.

CIRCLE NO. 417

Bioengineering abstracts

A monthly publication, entitled "Bioengineering Abstracts," is designed to provide up-to-date concise source information on the growing volume of literature in this field. The abstracts contain a summary of article content, title, author, citation source, date, number of article pages and references. Engineering Societies Library, New York, N.Y.

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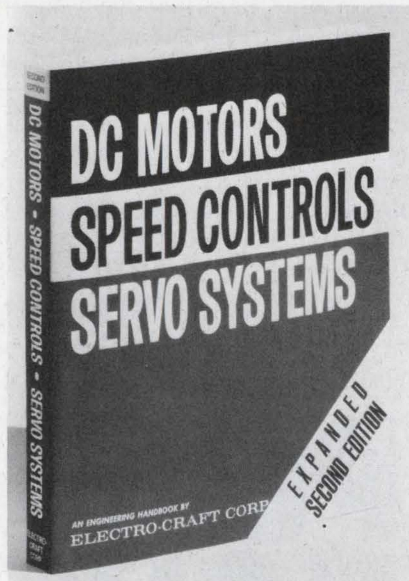

Motor handbook

The 400-page "DC Motors—Speed Controls—Servo Systems" presents theory, design considerations and application notes on various types of dc motors and generators, servo systems and associated control devices. This edition contains all notations in both metric and English values. The handbook can be purchased for $1 to cover handling and postage by engineers writing on their company letterhead or enclosing their business card. Electro-Craft, Box 664, Hopkins, Minn. 55343.

INQUIRE DIRECT

Ac voltage regulators

Technical data on a concept of maintaining truly flat regulation using ac voltage regulators or dc power supplies, with instantaneous attenuation of line and load fluctuations, are given in a 16-page catalog. Advanced Power, Anaheim, Calif.

CIRCLE NO. 419

S/d converters

A 14-page guide covers a continuous tracking or multiplexed s/d converter, binary-to-BCD converter, d/s converter, two-speed s/d or d/s converters, digital-to-synchro converter, two-speed processor, control transformer, control differential transmitter or synchro angle display meter. Analog Devices, Norwood, Mass.

CIRCLE NO. 420

TV cameras

Multi-adaptable single tube color TV cameras for ETV, ITV, CATV and CCTV are described in a four-page data sheet. Cohu, San Diego, Calif.

CIRCLE NO. 421

Miniature reed relays

A four-page bulletin describes the series 46 miniature reed relays which are offered in mercury-wetted, dry reed and magnetic latching types. Specifications, model types, dimensional drawings and contact rating performance curves are provided. North American Philips Controls, Cheshire, Conn.

CIRCLE NO. 422

Connectors

A connector selection guide lists popular connector configurations. The six-page guide includes eight photographs, environmental specifications and model differences. Connectors discussed include rectangular rack/panel, circular, microminiature, PC/input, output, filters and special applications such as audio, CATV and rf. ITT Cannon, Santa Ana, Calif.

CIRCLE NO. 423

PC connectors

Receptacle-type printed-circuit connectors with 0.025-in. and 0.045-in. sq. terminations for wrapped wire are covered in a 16-page catalog. Specifications, outline drawings, illustrations and ordering information are included. Continental Connector, Woodside, N.Y.

CIRCLE NO. 424

Memory system

A four-page brochure describes a compact memory system. Specifications and a schematic diagram are included. Fuji, Minato-ku, Tokyo, Japan.

CIRCLE NO. 425

PVC coatings

A standard describes external plastic coatings which are applied to galvanized rigid conduit and galvanized steel electrical metallic tubing. The standard may be purchased for $1.25. National Electrical Manufacturers Assoc., 155 E. 44th St., New York, N.Y. 10017.

INQUIRE DIRECT

Heat-transfer fluid

Ucon Fluid 500, a synthetic heat-transfer fluid that is miscible with water at temperatures below 110 F, is described in a bulletin. Union Carbide, New York, N.Y.

CIRCLE NO. 426

LED products

A catalog of light-emitting diode products also doubles as a LED second-source directory. The 12-page catalog lists alternate parts, where available, for each type of the company's LED lamp, infrared emitter, opto-isolator, phototransistor, single and multiple-digit numeric and alphanumeric displays. Litronix, Cupertino, Calif.

CIRCLE NO. 427

Zener and TC diodes

Three quick-reference, voltage-regulating diode charts show power dissipation, package type, nominal voltage breakdown and applications. Dickson Electronics, Scottsdale, Ariz.

CIRCLE NO. 428

PC breadboards

An eight-page catalog shows off-the-shelf printed-circuit breadboards. Card racks, instrument cases, connectors, ejectors, IC sockets and computer interface breadboards are described. The catalog illustrates more than 50 IC breadboards for dual inline, TO-5 and flatpack ICs. Douglas Electronics, San Leandro, Calif.

CIRCLE NO. 429

Decoders and receivers

A series of specification sheets describes decoders, receivers, measurement units, power supplies, dividers, squarers, rf wattmeters and a two-channel CB crystal calibrator. Amtron, 20092 Cinisello Balsamo (MI), Italy.

CIRCLE NO. 430

OEM rotating memories

Low-to-medium capacity rotating memory products, including cartridge and "floppy" devices, are featured in an eight-page catalog. Control Data, Hawthorne, Calif.

CIRCLE NO. 431

Laser trimmer

Data on the System-25 laser trimmer are given in a 12-page, fully illustrated booklet. Included are descriptions of the laser beam positioning and measurement subsystems, system operation, process control hardware and software, programming and functional trimming applications and options. Electro Scientific Industries, Portland, Ore.

CIRCLE NO. 432

Liquid-crystal displays

The fundamentals of liquid crystals and LCDs—what they are, how they work, types available (dynamic scattering and field-effect), and their advantages and disadvantages—are covered in an eight-page catalog. Other displays explored are light-emitting diode, incandescent, fluorescent and gas-discharge. Hamlin, Lake Mills, Wis.

CIRCLE NO. 433

bulletin board

An advanced **COBOL source code analysis and optimization system,** STAGE III, has been instroduced by **Tesdata Systems** for IBM OS/DOS/VS users.

CIRCLE NO. 434

A triple line driver and receiver pair, the Am9616 and Am9617 designed to the specifications of the EIA, have been introduced by **Advanced Micro Devices** for use in data terminals, teleprinters and other communications equipment.

CIRCLE NO. 435

Ferroxcube Corp. is marketing **ferrite memory cores, stacks, systems and MOS semiconductor systems** for the computer industry.

CIRCLE NO. 436

A central processor accelerator that increases the performance of IBM System/370 Model 155 computer by up to 28% has been introduced by **Cambridge Memories.** The accelerator is available as an option with the company's 370/STOR 155 add-on main memory system for Model 155 processors.

CIRCLE NO. 437

Complete flexible disc systems including both software and hardware are available for DEC and Data General minicomputers from **Xebec Systems.**

CIRCLE NO. 438

The Peripheral Equipment Div. of Pertec Corp. has raised the prices 3% to 5% on some models of **digital magnetic tape transports, disc drives and spare parts.**

CIRCLE NO. 439

Twelve types of **opto-isolators** manufactured by **Litronix** have received UL approval.

CIRCLE NO. 440

A new **software package** that enables users to write computer-assisted instruction (CAI) materials in IBM's Course Writer language on HP's 2000F and 2000C computers has been developed by **Hewlett-Packard's data systems division.**

CIRCLE NO. 441

With the change of voltage ratings from V_{CBO} = 250 V to V_{CBO} = 350 V and V_{CEO} = 150 V to V_{CEO} = 225 V, **Siemens' BU 114 transistor** is now suited for line-synchronous power packs in black-and-white TV sets as well as for general switching applications.

CIRCLE NO. 442

Fairchild Camera & Instrument Corp. has introduced a line of **complementary MOS logic circuits** that use Isoplanar processing to achieve high density and high performance. First products in the 34000 family are six logic gates.

CIRCLE NO. 443

Metalized Ceramics has developed a quality **technique for spot-plating gold** on the critical device areas of its all-alumina MOS/LSI packages at production rates.

CIRCLE NO. 444

An expanded line of **520 series modular instruments** offered by the **Industrial Instruments Div. of Barber-Colman** has been designed to accept the output of standard thermocouples, resistance bulbs, radiation pyrometers and other millivolt sources.

CIRCLE NO. 445

Price reductions

A 23% price reduction on its **TA11 and TA8 dual DECcassette units** has been announced by **Digital Equipment.** The units have been reduced to $2990 from $3900.

CIRCLE NO. 446

Monsanto has announced price reductions of its **thin and thick-film gallium arsenide phosphide epitaxial materials** to $12 per sq. in. and $14 per sq. in., respectively.

CIRCLE NO. 447

Beckman Instruments, Information Display Operations has cut prices on its **seven-segment planar gas discharge displays.** The SP300 and SP700 series with 1/3-in. and 1/2-in. high characters have been dropped over 21% to $2.33 per digit from $2.95 (100). Other models show similar reductions.

CIRCLE NO. 448

vendors report

Annual and interim reports can provide much more than financial-position information. They often include the first public disclosure of new products, new techniques and new directions of our vendors and customers. Further, they often contain superb analyses of segments of industry that a company serves.

Selected companies with recent reports are listed here with their main electronic products or services. For a copy, circle the indicated number.

Analog Devices. Modular analog circuits, modular converters, linear integrated circuits, DPMs, input/output peripherals and transducers.

CIRCLE NO. 449

Decision Data. Peripheral and data preparation equipment.

CIRCLE NO. 450

Eltra. Electric vehicles, engine electrical systems, batteries, communications equipment and instrumentation.

CIRCLE NO. 451

Cordura. Commercial data processing services and engineering reference books.

CIRCLE NO. 452

Burroughs. Business machines, computer systems and peripheral products and components.

CIRCLE NO. 453

The Superior Electric Co. Numerical tape controls, tables and positioning systems, variable voltage transformers and automatic voltage regulators, synchronous/stepping motors, controls and drives, lighting controls and connectors.

CIRCLE NO. 454

Allied Chemical. Chemicals, metal alloys, insulating materials, plastics.

CIRCLE NO. 455

Bunker Ramo. Telecommunications, data processing systems, connectors and automotive electronics.

CIRCLE NO. 456

Visual Sciences. Facsimile equipment.

CIRCLE NO. 457

Airpax Electronics. Magnetic circuit breakers, tachometers, industrial controls, electronic glass and electroplating, choppers, state-of-the-art video and communications equipment, switches and components.

CIRCLE NO. 458

Computer Communications. Data communications equipment and systems.

CIRCLE NO. 459

Hewlett-Packard. Electronic test and measuring instrumentation, electronic data products, medical electronic equipment and instrumentation for chemical analysis.

CIRCLE NO. 460

Signetics, 811 E. Arques Ave., Sunnyvale, Calif. 94086. Logic, memory and analog circuits and aerospace ICs.

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quick ads

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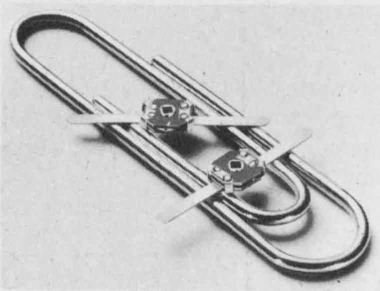

Thin-Trim variable capacitors provide a reliable means of adjusting capacitance without abrasive trimming or interchange of fixed capacitors. Series 9401 has high Q's and a range of capacitance values from 0.2-0.6 pf to 3.0-12.0 pf and 250 WVDC working voltage. Johanson Manufacturing Corporation. Boonton, New Jersey (201) 334-2676.

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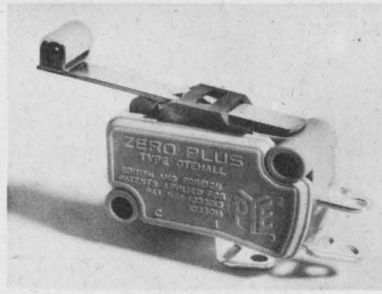
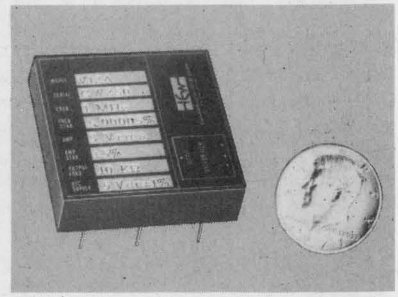


Snap Action Switches (zero plus) available with or without integral actuators. Compatible fixing and size dimensions with comparable types. Screw, solder and 3/16" or 1/4" Faston terminals. Plastic actuator hinge ensures minimum side play. Pye TMC Canada, 15 Sheffield Street, Toronto, Ontario. (416) 249-7044.

INFORMATION RETRIEVAL NUMBER 492



VCXO Crystal Clock Oscillator at freqs. from .00005 Hz to 50 MHz freq. tol. ±.0005% 0°C to +50°C, control voltage range +4V to −4V changing freq. 20 ppm/V, linearity ±2%, 1.75" sq. x 0.5", Supply 5Vdc ±1%, Sq. wave 2.4V into 200Ω at Vdd = 5V, stock to 5 weeks; Conor-Winfield Corp., W. Chicago, Ill. 60185. 312-231-5270

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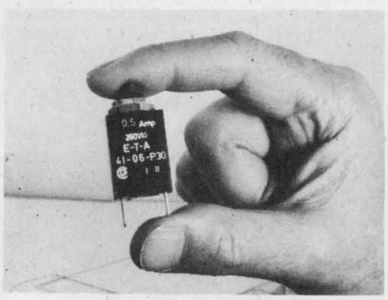

Overcurrent Protector, manual reset eliminates fuse replacement. Convenient panel mounting. 15 fractional ratings from 0.1 to 3 amp. Other models up to 400 amp. Trip-free and fool-proof, UL and CSA approved. High quality, low cost-$1.12 ea. in 1000 lots. E-T-A Products Co. of America, 6284 N. Cicero Ave., Chicago, Ill. 60646. Tel. (312) 545-1553.

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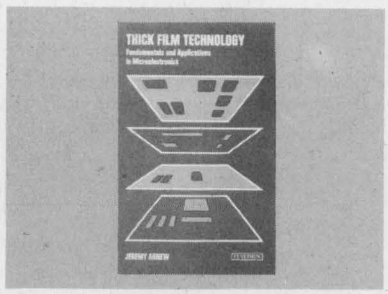

Thick Film Technology—Fundamentals and Applications in Microelectronics, by Jeremy Agnew. From design to finished product, this book details each processing phase, describing what to do and what pitfalls to avoid. 176 pp., 6 x 9, illus., cloth, $8.50. Circle number for 15-day examination copy. Hayden Book Company, Rochelle Park, N.J. 07662.

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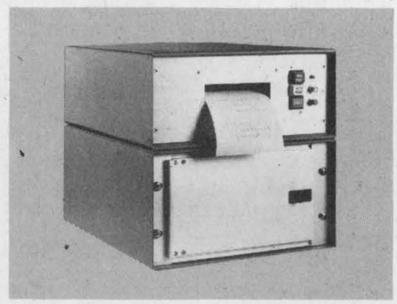

Low cost scanning printer records readouts from several digital data sources (DPM's, counters, machine tool readouts, scales, etc.) sequentially on command. Standard models up to 48 columns per scan. TEL-STAR ELECTRONICS CORP., 700 Hummel Ave., Southold, NY 11971. (516) 765-9292.

INFORMATION RETRIEVAL NUMBER 499

Free catalog of 34,500 power supplies from the worlds largest manufacturer of quality Power Supplies. New '74 catalog covers over 34,500 D.C. Power Supplies for every application. All units are UL approved, and meet most military and commercial specs for industrial and computer uses. Power Mate Corp. (201) 343-6294.

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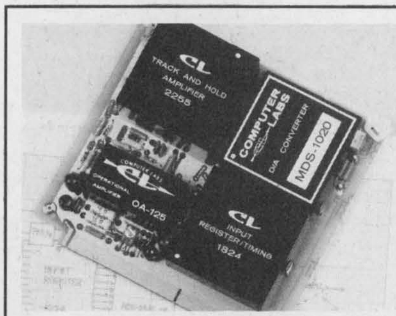

The new Computer Labs DRA Series D/A's eliminate harmonic distortion and produce clean "glitchless" pictures for reconstructed TV or other video signals. Input word rate for all models is 15 MHz with accuracies to ±0.05%. Min. settling time to either 8-bit or 10-bit accuracies. Computer Labs, 1109 S. Chapman St., Greensboro, N.C. 27403.

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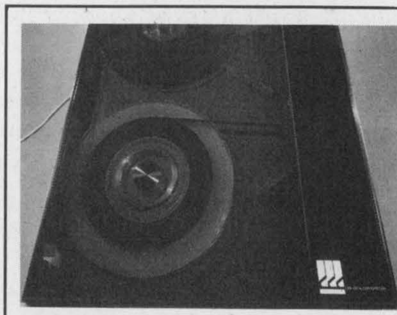

Complete minicomputer mag tape systems for the PDP-8, PDP-11, and NOVA feature IBM compatibility with low price. Three reel sizes to choose from, and all standard densities, including 1600 bpi phase encoded. These systems incorporate the best-designed transports built today. Digi-Data, 8580 Dorsey Run Rd., Jessup, MD 20794, (301) 498-0200.

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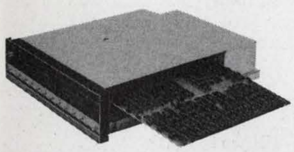

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CIRCLE NO. 175

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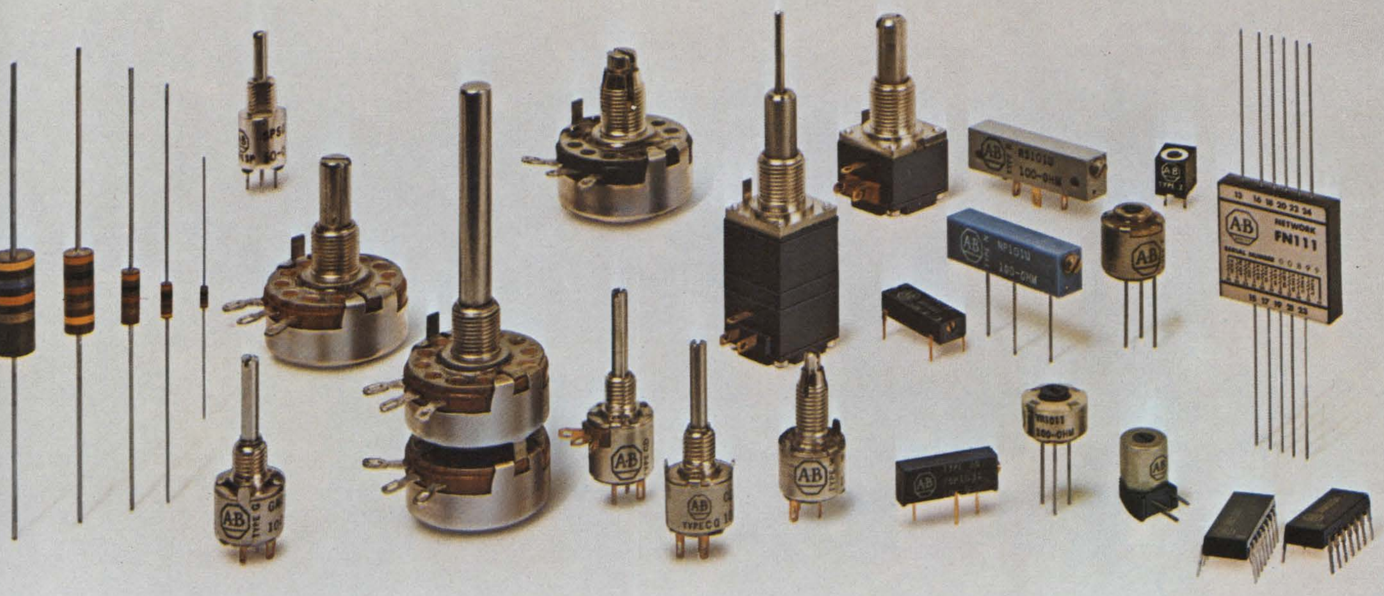
new literature

application notes

design aids

There's more to resistors than resistance



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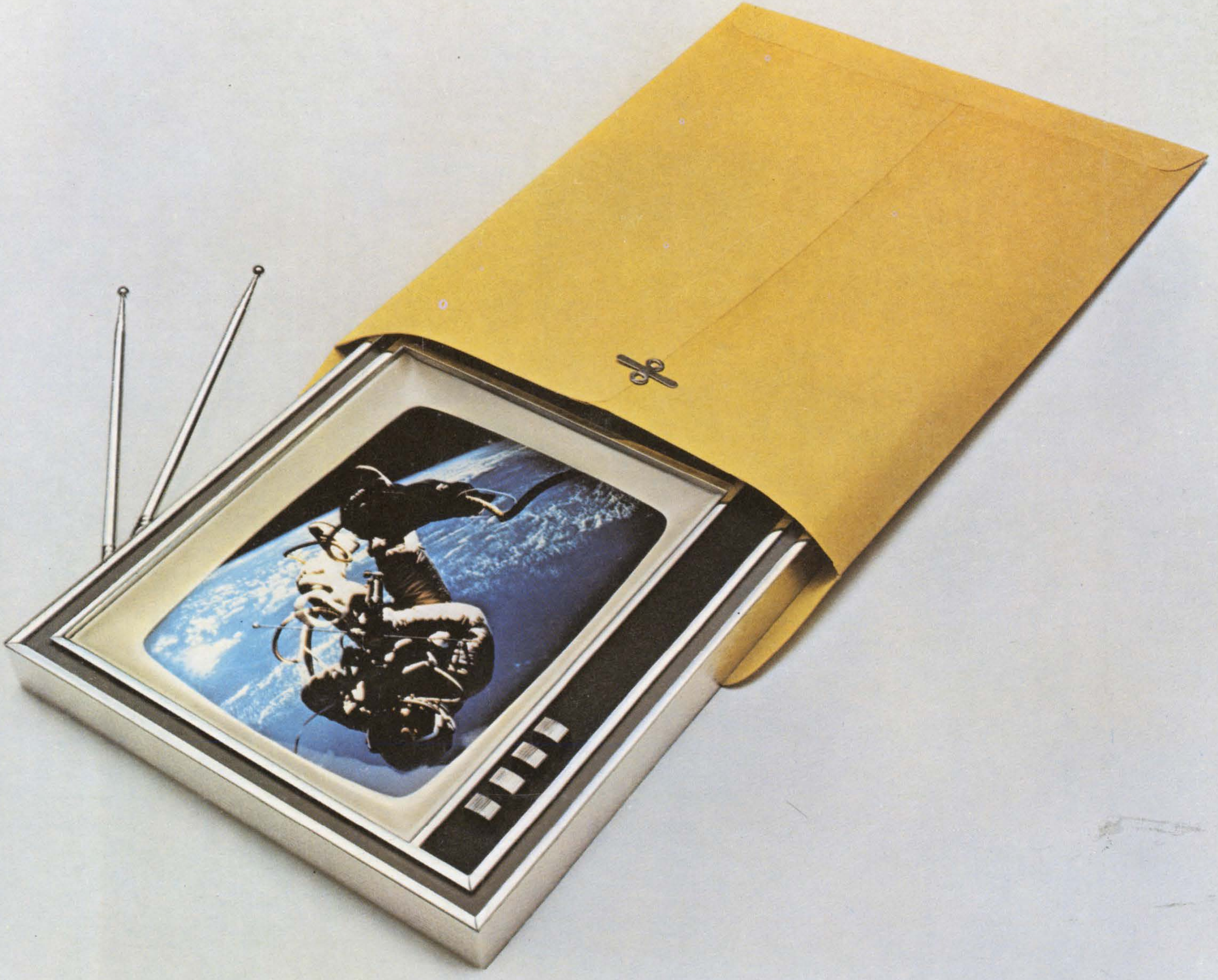

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