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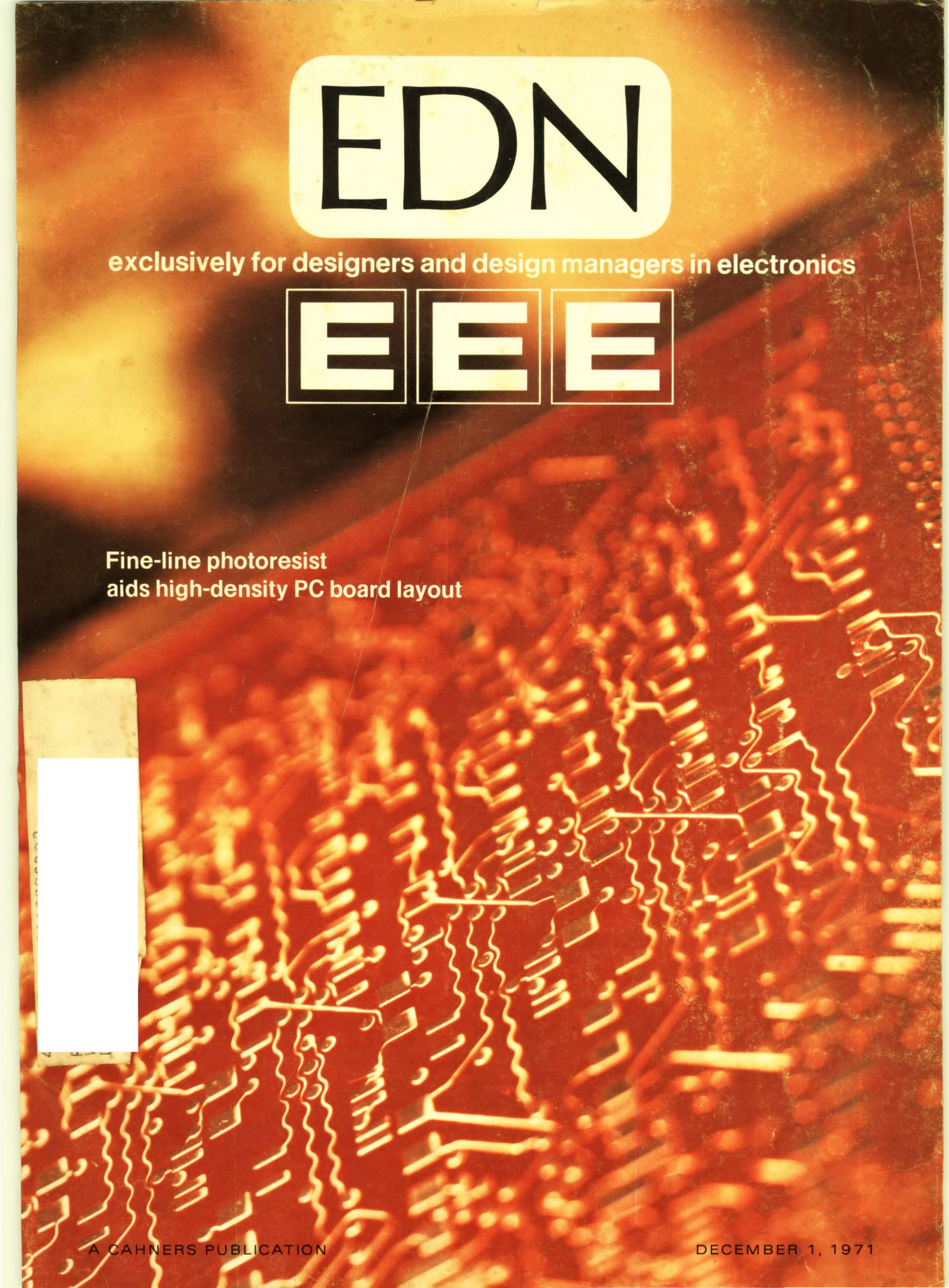
exclusively for designers and design managers in electronics

EEE



Fine-line photoresist aids high-density PC board layout

A CAHNERS PUBLICATION

DECEMBER 1, 1971

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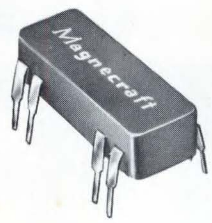
DIP

DUAL-INLINE-PACKAGED REED RELAYS



Magnecraft is proud to announce its new DIP (dual-inline-package) line of 8-pin reed relays. These new relays are designed not only to be compatible with the standard packaging developed for integrated circuits, but to offer Magnecraft quality at a low cost. This unique design gives further savings by offering the user the optimum in automated insertion and other economical installation techniques associated with printed circuit applications.

These fantastic new epoxy molded reed relays are ideal for use in circuits where high density packaging is essential. The 5VDC IC compatible versions of these relays will operate directly from TTL or DTL circuits.

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CIRCLE NO. 2

EASY ECL EVEN EASIER WITH 12 NEW DEVICES

9500 Easy ECL Family offers designers lower power, higher speed, lower cost systems.

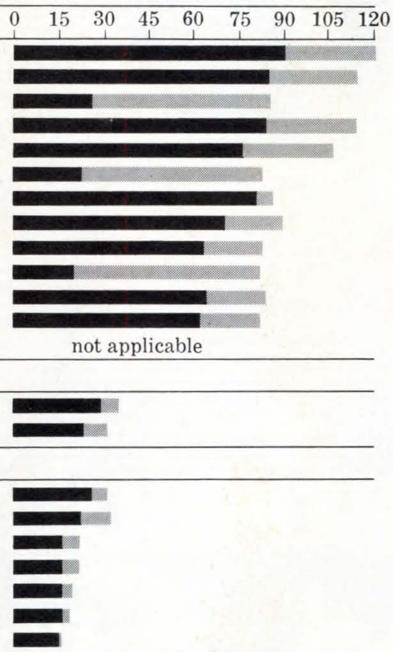
The addition of 4 new MSI circuits – along with 8 new SSI devices – gives our *temperature compensated* ECL family the breadth, depth, variety and flexibility that makes designing with ECL/MSI functions easy as using TTL/MSI.

Since MSI is even more significant in ECL systems design than in TTL, our Easy ECL 9500 series is essentially an MSI family. That's why we now offer 7 key MSI functions – 22 circuits in all. Why all 9500 Series devices are fully temperature compensated for adequate noise immunity to allow problem-free SSI-to-MSI interfacing. Why MSI design in ECL systems is practical for the first time.

ECL/MSI ASSURES LOWEST SYSTEM POWER DISSIPATION

Comparison of unloaded and system power dissipation per gate of 9500 Easy ECL functions. With an MSI function, the termination power is amortized over many gates thereby assuring lowest system power dissipation.

Device	Description	Gates/ Function*
SSI – Gates		
9502	General Purpose Dual OR-NOR	2
95H02	High Speed Dual OR-NOR	2
95L22	Low Power, High Speed Dual OR-NOR	2
9503	General Purpose Triple OR-NOR	3
95H03	High Speed Triple OR-NOR	3
95L23	Low Power, High Speed Triple OR-NOR	3
9582	Triple Line Receiver/Amplifier	3
9504	General Purpose Quad NOR	4
95H04	High Speed Quad NOR	4
95L24	Low Power, High Speed Quad NOR	4
9505	Four Wide OR-AND	5
9507	Quad AND-NAND	5
9595	Dual ECL-TTL Converter	2
SSI – Flip-Flops		
95H29	250MHz J̄-K̄	9
9528	Dual 160MHz D-Type	12
MSI Elements		
9538	1-of-8 Decoder	12
9581	8-Input Multiplexer	12
9578	Quad EX-OR/Comparator	16
9579	Quad 2-Input Multiplexer	16
9534	Quad Latch	24
95H84	High Speed Adder/Subtractor	29
95H90	250MHz VHF Prescaler	29



*Number of on-chip ECL Gates not discrete TTL equivalents.

■ Typical Device Dissipation ▒ Additional Dissipation in system due to termination scheme.

MSI + SSI = EASIEST ECL.

Key to easiest ECL design is the lower power dissipation afforded by maximum use of MSI functions – with ancillary SSI low power gates and flip-flops. That way you get the speed and performance of ECL with economic and reliability advantages of MSI design. You get the most favorable speed/power trade-offs.

For example, basic ECL/SSI gates are approximately two times faster than TTL; but with the design advantages of ECL, the MSI functions are four to eight times faster at similar power dissipation.

NOW NEW IN EASY ECL.

Four new MSI Circuits:

95H84 adder-subtracter with full on-chip carry lookahead that permits addition or subtraction of two 64-bit words in 22nS. Fastest adder function on smallest board area available.

9534 quad latch with gated input and output enable features. Buffering of outputs insures glitch-free operation with approximately 4nS delay. Applications: register, ALU, parallel-serial conversion.

9578 quad exclusive-OR function also for use as 4-bit comparator or dual differential line driver. 3nS delay.

9579 quad 2-input multiplexer with 2.6nS delay. Common select line reduces external wiring for variety of function-generation and multiplexing applications.

Low-Power SSI

New 95L22, 23, 24 low-power gates are pin-identical with standard and high-speed gates. 20mW power dissipation (20% lower than any other available ECL gates), and 2nS propagation delay at no price premium. 60K ohm on-chip pulldown resistors.

For use in an area of high-power density (e.g., memory arrays), and as receiving element at end of long data bus lines.

High-Speed SSI

Three new high-speed gates and a new high-speed flip-flop:

95H02, 03, 04 gates, pin-identical with standard and low-power gates. 1.6nS delays at similar power as standards. For clock-driving with flip-flops, registers, large synchronous arrays, where maximum speed required. Also as high-speed logic function where multiple gate decisions must be made within short clock period (e.g., loading a universal shift register within a narrow clock pulse).

95H29 J̄-K̄ flip-flop with 250 MHz toggle frequency features non-ones catching master-slave circuit with multiple gating on inputs. For high-speed counting, register, data storage.

Low-Cost Standard SSI

9507 quad and 2-input AND, 8-input NAND gate. Eliminates a number of external connections in computing and general logic applications. 2.3nS delays without deterioration in rise-and-fall performance under heavy loading conditions.

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ALLEN-BRADLEY

CIRCLE NO. 4

DECEMBER 1, 1971
VOLUME 16, NUMBER 23

EDN/EEE

EXCLUSIVELY FOR DESIGNERS AND DESIGN MANAGERS IN ELECTRONICS

Cover

Cover photo from Du Pont shows experimental photo-resist made at their "Riston" Products Center. Successful high-density PCB layout depends greatly on improved line definition—an area in which DuPont has been very active. See. p. 20 for an article on planar packaging using large PCBs.

Speakout—Robert P. Henderson of Honeywell Information Systems Speaks Out on Privacy Pollution. See article on p. 36.

Design News

Design Features

Design Ideas

Circuit Design Award Entries 48

Progress in Products

Design Products

Design Departments

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CIRCLE NO. 5

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- ☑ high writing-rate CRT gives a brighter trace
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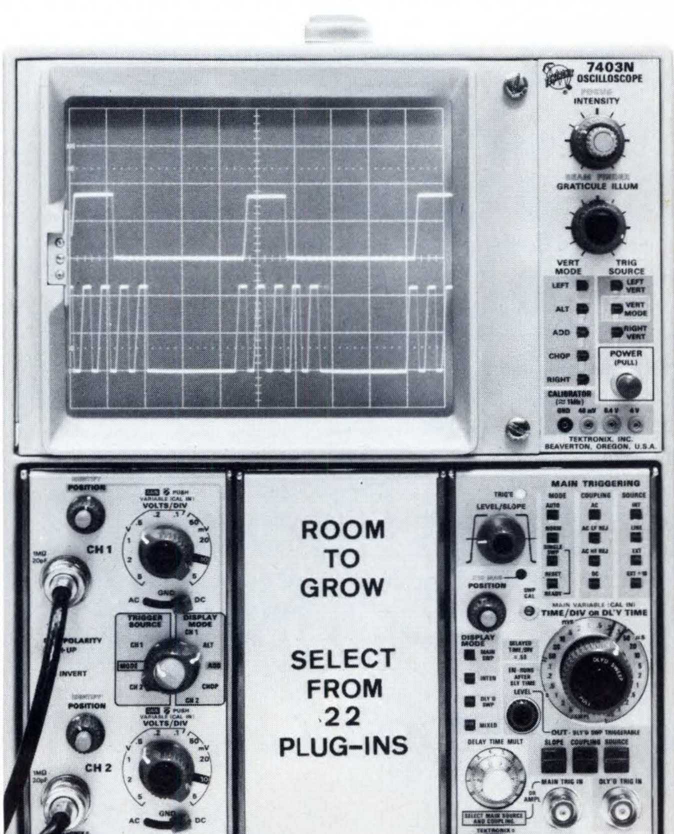

If you wish, select a plug-in for the second vertical compartment to give you 10 μV/div at 1 MHz *or* 1 mV/div at 55 MHz *or* 1 mA/div at 55 MHz *or* another dual-trace unit for 4-trace capability, etc., etc. Plug-in prices start at a low $270. Call your nearby TEKTRONIX Field Engineer today for a demonstration, or write: Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005.

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CIRCLE NO. 6

Editorial

Continuing Education Is Everyone's Responsibility

It appears to be an economic fact of life that participation in any form of continuing education by engineers—or anyone for that matter—depends on the state of the economy. When times are good everyone wants to keep up. But in bad times, interest seems to die.

The first impulse is to blame unemployment, since unemployed engineers have other concerns, not the least of which is finances. But this is only part of the answer. What about the thousands upon thousands of working engineers. Their participation in continuing education has declined considerably during the present economic crunch.

They have attended fewer technical conferences, fewer seminars and fewer university courses than they used to. And this during a period when the world of electronics and the engineer's role in it have changed significantly.

From where we stand, responsibility for this falloff in continuing engineering education is shared by both company managements and working engineers. Company managements, though, are more responsible, inasmuch as they set precedents during the 1960s. Then they offered extensive encouragements to their engineers to keep up with technology, in most cases paying all costs involved.

With business becoming bad, companies naturally have to cut back on expenses, including the costs of continuing education for their engineers. But to over react, as many have done, is extremely short sighted and could greatly affect their technical capability.

Engineers themselves, though, also bear a good measure of responsibility in keeping themselves current. They must do a better job of convincing management that their keeping up to date is in the company's interest, just as is modern, up-to-date production equipment. They also must be willing to share the burden, in terms of both time and money.

The pace of technological change is not going to slacken. And if the electronics industry in the United States is to remain strong in the face of ever stronger competition from abroad, our engineering community must be the technically strongest and most up-to-date anywhere.

Don't Miss Upcoming Seminars

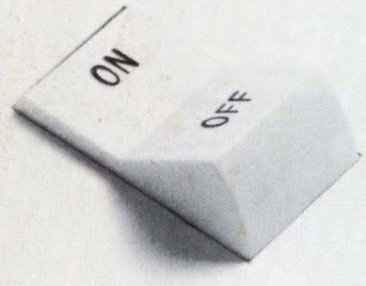
While we're on the subject of keeping up to date, we would be remiss if we didn't mention the two upcoming IC seminars being sponsored by EDN/EEE. One of these will cover Linear ICs, and the other Semiconductor Memories. Both will be heavily applications-oriented, with speakers from major semiconductor manufacturers giving invaluable advice on the use of today's most up-to-date technologies and products.

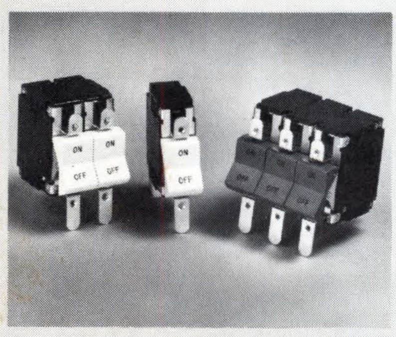
The two 2-day seminars will be held in Los Angeles during January. For details, see p. 64.

Frank Egan

EDITOR

And it doesn't look like a circuit breaker.





Therein lies its beauty.

When you use the JC rocker-handle circuit breaker as a front-panel on-off switch you get overload protection, too. Without the expense of using a switch and a breaker.

Behind that handsome rocker handle is the engineering and construction you know Heinemann for. Hydraulic-magnetic protection. Which means precise ratings from 0.020 to 30 amp. 32, 50, and 65V DC; 125 and 250V at 60 Hz and 400 Hz. Job-matched time delays or non-time-delay response. Temperature-stable trip points. Optional special-function internal circuits. One, two, or three-pole models. And a five-year warranty.

Oh, yes. The rocker handle comes in white or gray.

A pretty attractive package. All around.

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DTS 401	400V	2A*	300V		*I_C Peak=5A Vertical magnetic CRT deflection, has good gain linearity.
DTS 402	700V	3.5A*	325V		*I_C Peak=10A Horizontal magnetic CRT deflection, features fast switching time, high reliability under horizontal sweep fault condition.
DTS 410	200V	3.5A	200V	80W	
DTS 411	300V	3.5A	300V	100W	Voltage regulator, switching regulator, DC to DC converter, class A audio amplifiers.
DTS 413	400V	2.0A	325V	75W	
DTS 423	400V	3.5A*	325V	100W	*I_C Peak=10A High V_{CBO} and V_{CEO} ratings make it practical to operate directly from rectifier 117V or 220V AC line.
DTS 424	700V	3.5A*	350V	100W	*I_C Peak=10A High V_{CBO}, V_{CEO}(sus) ratings make them ideal for use in deflection circuits, switching regulators and line operating amplifiers.
DTS 425	700V	3.5A	400V	100W	
DTS 430	400V	5A	300V	125W	Voltage regulators, power amplifiers, high voltage switching.
DTS 431	400V	5A	325V	125W	
DTS 701	800V	1A	600V	50W	Vertical magnetic CRT deflection circuits.
DTS 702	1200V	3A	750V	50W	Horizontal magnetic CRT deflection circuits operating off-line.
DTS 704	1400V	3A	800V	50W	
DTS 721	1000V	3A	800V	50W	High voltage DC regulators.
DTS 723	1200V	3A	750V	50W	Very high voltage industrial and commercial switching.
DTS 801	1000V	2A	700V	100W	Color vertical magnetic CRT deflection circuits.
DTS 802	1200V	5A	750V	100W	Color horizontal magnetic CRT deflection circuits.
DTS 804	1400V	5A	800V	100W	
2N3902†	700V	3.5A*	325V	100W	*I_C Peak=10A Ideal for switching applications. Can be operated from rectified 117 or 220 volt AC line.
2N5157	700V	3.5A*	400V	100W	
2N5241	400V	5A	325V	125W	For general use in electrical and electronic circuits such as converters, inverters, regulators, etc.
2N2580	400V	10A	325V	150W	
2N2581	400V	10A	325V	150W	
2N2582	500V	10A	325V	150W	
2N2583	500V	10A	325V	150W	
2N3079	200V	10A	200V		
2N3080	300V	10A	300V		

†Mil. qualified units available.

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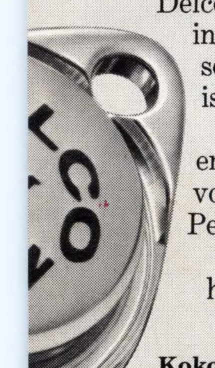

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CIRCLE NO. 9

The National Accelerator Laboratory faced both performance and production problems when it wrote specifications for the 3000 magnet coils used in its 500 GeV accelerator. Electrically, the copper had to carry current densities of 9000 amps per square inch. Physically, conductors had to withstand cooling water pressures of 200 psi. And, the copper had to give uniform results when fabricated by two mills and eight coil builders located in three different countries. Mechanical tolerances were critical and all brazed joints had to be free of hydrogen embrittlement.

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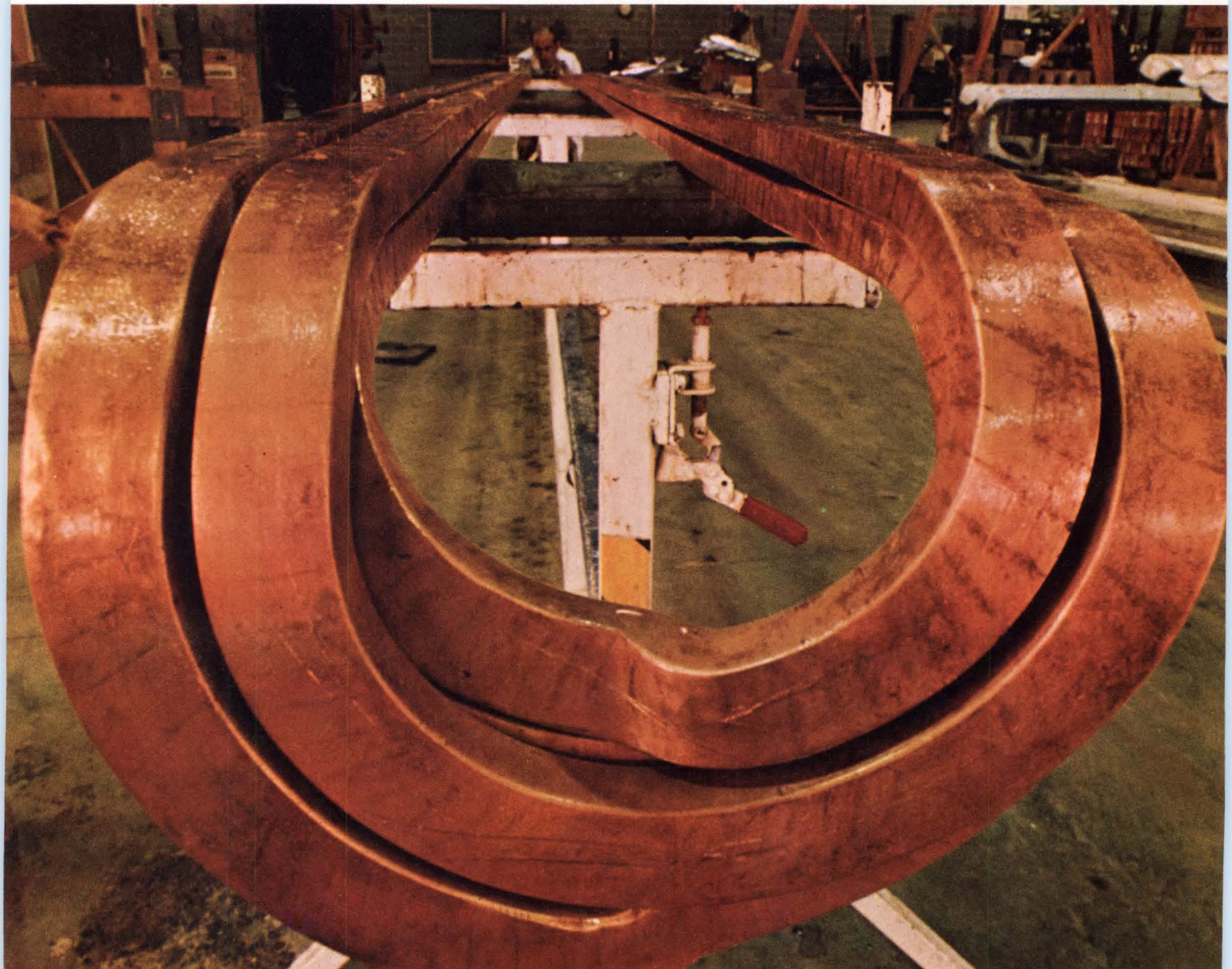


Liquid-Crystal Displays Simplified

A factor-of-four reduction in the number of leads required for driving eight-character liquid-crystal displays is a significant step toward making these displays more attractive for commercial applications. Conventional eight-character-wide liquid-crystal displays require 65 leads, whereas only 16 leads are required in an equivalent display developed by the General Electric Research and Development Center, Schenectady, NY.

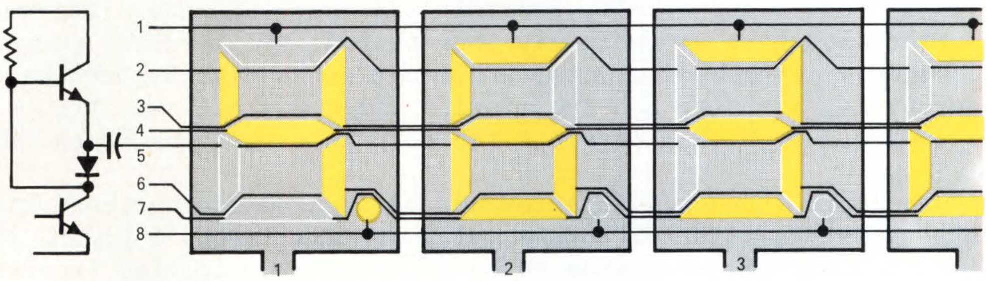
In addition to reducing the number of leads used, the system uses ac instead of dc activation resulting in a longer life unit. Called "ac coincidence addressing for liquid-crystal displays", the system provides simplification of the driving circuitry, and consequently a reduction in cost.

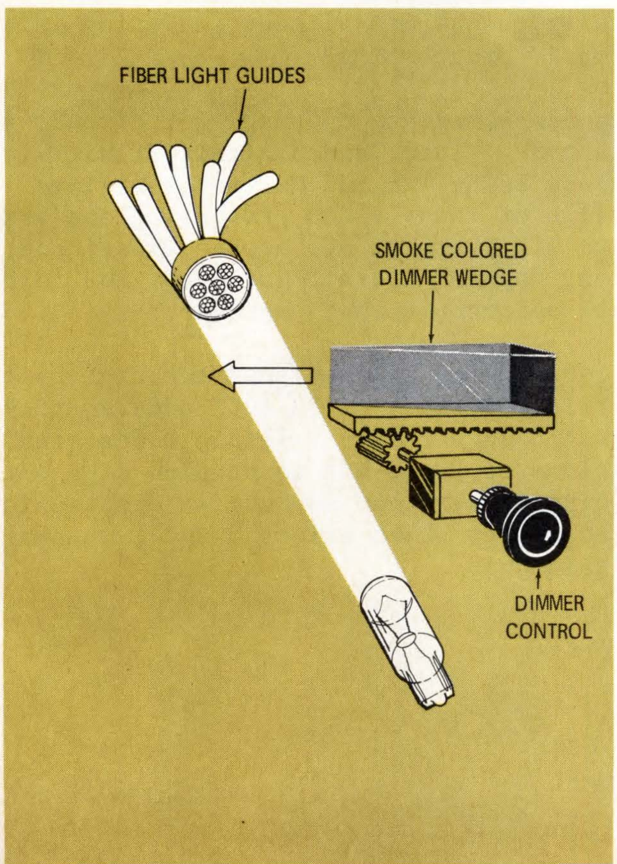
Instead of using one lead to each segment as is normally done, a single lead links all common segments of each character along the horizontal row. One lead is also used to link the decimal points, thus eight leads are required to make connection to all of the segments and decimal points in the display. In addition, each of the eight characters has a separate lead that is common to all segments and the decimal in that character. In use, the characters are scanned electronically in sequence. Signals applied to the horizontal leads at the time a particular character is being scanned determine the segments to be activated.

Numerical characters are generated by changing the frequency of the ac signals on the leads. A high-frequency pulse makes the liquid-crystal film appear transparent, while a low-frequency pulse makes it opaque. The experimental display has characters that are three-eighths of an inch high, but the technique can be applied to units ranging from one-tenth to ten inches high.

Additional information can be obtained from the marketing section of GE's Imaging and Display Devices Products Section, Owensboro, KY.

A single lead links all common segments of each character, resulting in an eight-character display with 16 leads.





Fiber Optics May Soon Ride The Family Bus

A new approach to automotive instrument panel lighting offers a way to simplify wiring, reduce the number of lamps required and reduce cost. The unit developed by Du Pont Company's Plastics Department, Wilmington, Del., uses "Crofon" fiber optics to pipe light from a single source to a number of locations. A variable-density light filter between the bulb and the input of the optical fibers allows light-level control and eliminates the costly rheostat-that is normally used.

Du Pont claims that the light switch, receptacle, for the light source and the dimmer unit can be molded of plastics and assembled with few metal parts. The light guides can be fabricated on standard wire handling equipment and need no special end polishing or cementing.

Instrument panel lighting unit uses fiber optics to guide light to the desired indicators. A smoke-colored translucent plastic wedge is moved into the light beam to control the lighting level.

SCIENCE/SCOPE

Laser rangefinders for the U.S. Army's M551 Sheridan armored reconnaissance vehicle will be built by Hughes under a contract awarded recently by Frankford Arsenal in Philadelphia. The Sheridan rangefinder consists of a ruby laser, telescope-like optics, and associated control panels and electronics. The production award followed the successes of the prototype program, which was begun in February 1970, and of the laser for the M60A1E2 tank, for which Hughes produced 300 systems.

Infrared fusing of tin-lead circuits on printed circuit boards is faster, better, and safer than the conventional hot oil immersion technique, declared a Hughes engineer in a paper he delivered last month before the California Circuits Association Symposium in Los Angeles. In the new Hughes method, circuit boards are automatically conveyed through an 11-foot-long oven where infrared lamps heat them to 350 or 400 degrees, fusing the lead and tin into solder. The infrared oven produces more in one hour than the immersion method does in eight, insures operator safety, and because of its lower temperatures almost eliminates damaged boards.

The Phoenix weapon system which Hughes is developing for the F-14 fighter has so far "demonstrated all major design performance requirements" during flight tests in a TA-35 test-bed aircraft, according to the U.S. Navy. Its successes include: launches and hits at extremely long ranges; two missiles guided simultaneously to two widely separated targets; a hit against a tightly turning drone simulating a maneuvering fighter; and one missile fired against two targets in close proximity to each other which picked out the correct target and passed within lethal range.

Mutual radio frequency interference between communications satellites and terrestrial point-to-point microwave relay systems in the 6 gigaHertz range they share will be measured and evaluated by a computer-controlled receiver/analyzer system Hughes is developing for NASA's Goddard Space Flight Center. The system will be tested following the launch of NASA's Applications Technology Satellite F in 1973. Purpose of the experiment is to determine the minimum size of ground antenna systems and the minimum transmitter power satellites can use without suffering interference from terrestrial microwave links for TV programming.

Circuit and logic design engineers: Hughes has immediate openings for circuit designers with experience in electronic warfare RF, video, and digital circuitry, and for logic designers with recent experience using TTL and MSI for real-time digital processing, preferably in logic design of radar video processing and associated equipment. Requirements: BSEE, two to six years of applicable experience, U.S. citizenship. Please write: D.K. Horton, Hughes Aircraft Co., P.O. Box 3310, Fullerton, Calif. 92634. Hughes is an equal opportunity M/F employer.

New products from Hughes include a full-wafer bipolar LSI designed for high-speed signal processing and digital filtering; it is comprised of 52 full adders and 96 gates for an equivalent of 616 gates integrated on a 1½-inch silicon wafer, and operates at a rate of 8 million multiplications of two 8-bit words plus sign per second....and a low-voltage 16-stage CMOS circuit designed for use in electronic watches; it utilizes Hughes' low-voltage technology which allows N and P channel MOS transistors to be manufactured on the same chip.

Creating a new world with electronics

HUGHES

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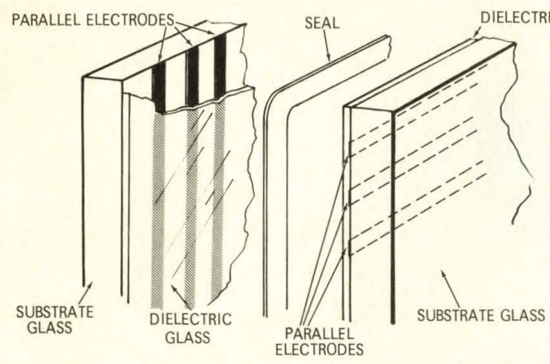
Design Briefs

Light Beams Activate Plasma Display



Basic display/memory panel has two dielectric layers. In the light-activated unit one layer is replaced by a photoconductor-glass layer.

Light beams selectively address and turn on display patterns in a new plasma display panel developed by Owens-Illinois, Inc., Okemos, Mich.

The new unit is similar to the company's conventional panels (See June 15 EDN/EEE p. 14-15) except that the glass dielectric of one wall of the panel is replaced by a photoconductor-glass composite layer. In conventional units metallic conductors are deposited on two sheets of glass, a dielectric layer is applied over the electrodes and the plates are mounted opposite each other with their conducting lines at right angles, forming a matrix. The space between the plates is filled with an inert gas and sealed. Digital signals from a computer or keyboard select the appropriate matrix intersections to energize, forming visible gaseous discharges in a desired pattern.

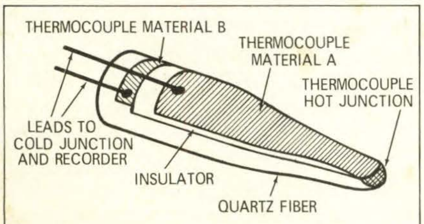
Utilizing the same basic principles, the light-activated display panel is operated in the dark with the matrix leads at a sustained voltage slightly below that required for gas ignition. Interaction of light with the photosensitive layer causes ignition of selected panel cells. Light write-in to a plasma panel is thus achieved. Long stay-on time and erasure by light and/or voltage pulsing can be obtained.

Applications for this type of display include light pen data inputs for computers, optical readouts for data processing equipment and analog-to-digital image conversion.

Tiny Thermocouple Has Two-Micron Diameter

A thin-film temperature sensor smaller than most living cells and capable of responding to sub-microsecond events has been produced by scientists of Sandia Laboratories, Albuquerque, N.M. and the University of Texas, Austin, Tex.

Vacuum deposition is used to deposit dissimilar metals on a fine pointed filament of fused quartz. The metals are separated by an insulating material except at the tip of the quartz, where they overlap to form the sensing junction. Sensitivity of the microthermocouple is comparable to that of larger units.



Design Briefs

HP Expands Computer Line

At the same time that RCA was making its widely publicized announcement to pull out of the general-purpose computer market, Hewlett-Packard was quietly making plans to announce its entry. HP's bid is based on its experience in minicomputers, and applications in scientific and educational systems.

The company's new System/3000 is heavily software oriented with multi-language capability to make things easy for the user. It provides simultaneous operation in real-time, time-sharing and batch-processing modes. It also has a large memory capability and a wide range of peripherals.

According to the company, the new system allows HP to serve its traditional market and, in addition, offer the advantages of a general-purpose computer. With the ability to do scientific work and administrative tasks simultaneously, the System/3000 should broaden HP's marketing horizons.

Engineer/Scientist Demand Index Up Slightly

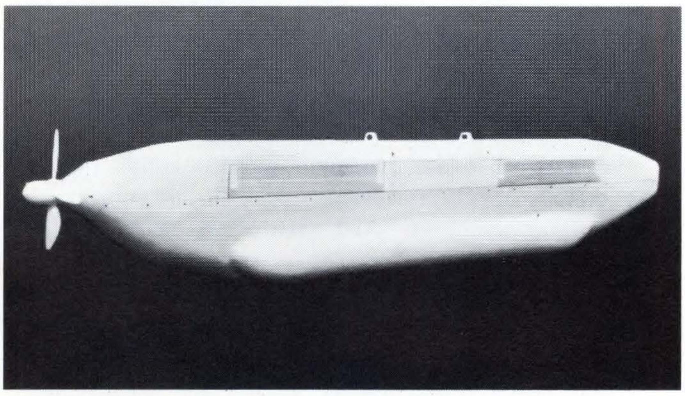
A slight advance brought the Engineer/Scientist Demand Index to 44.7 in August. This is the highest the index has been so far in 1971, and is also the highest since August 1970. Each of the preceding two years has shown a small gain in August so the current increase is not seen as indicating any major change from the low, but stable, demand level.

	1961	1966	1970	1971
June	94.3	191.9	51.9	37.3
July	97.4	217.8	44.2	42.7
August	102.1	185.1	49.0	44.7

Engineer/Scientist Demand Index (1961 = 100)

AiResearch electronic cooling systems are built into the F-14.

We have designed and built complete electronic cooling systems for hundreds of airborne applications —both on board and pod mounted. In fact, a Garrett AiResearch built electronic cooling system is on board the Grumman F-14 air-superiority fighter. ☐ Whatever your specific airborne electronic cooling requirement, come to Garrett AiResearch for total system optimization.



Garrett AiResearch enclosures are also cooling the pod mounted ALQ-76 and ALQ-99 electronic countermeasures systems. The enclosure in the ALQ-99 pod (shown above) for the EA-6B utilizes surface heat exchangers as the ultimate heat sink.

GARRETT

AiResearch Manufacturing Co.
9851 Sepulveda Boulevard, Los Angeles, Calif. 90009
one of The Signal Companies

CIRCLE NO. 19

Secret of Good Circuit Packaging: MAKE IT PLANAR!

Planar is king. In printed circuits, in hybrid circuits and of course in monolithic ICs. The current push is to put whole electronic systems on one planar assembly. The reason is economics.

ROBERT H. CUSHMAN, New York Editor

Humans work best in two dimensions. They think best. They construct best. They repair best. And that is why, as our industry shifts from "cost-is-no-object" aerospace to "cost-is-*the* object" civilian markets, the packaging shift is away from the fancy 3-D of aerospace to the honest 2-D of the commercial world. **Fig. 1** shows what we mean. It compares the half-hearted planar that we have been accustomed to with the new all-planar ideal.

The interest in planar today is based on the ease with which a planar configuration can be produced by automatic machinery. The money in electronics is in making mass-produced, competitively-priced products—and to produce these in the U.S.A. you must use low-labor-content manufacturing. Many basic processes for automating the production of electronic products come from the printing and photographic and parts-handling arts developed by other industries. These other industries such as publishing, textiles and shoes, have production machines that handle parts in planar form. Even if the final product is in 3-D form, they try to keep its component parts in simple planar 2-D form (ideally in continuous-fed sheets) right up to the final assembly. Just visit their factories and you'll see.

We are going to examine four electronic products that have been put in sensible planar form—all were purposely chosen to represent quite different electronic end-product market areas. All, though, are nonmilitary. In each case we'll point out how planar packaging and manufacturing is being used to advantage. We'll also try to relate the market economics of the examples to the degree of tooling investment and manufacturing automation.

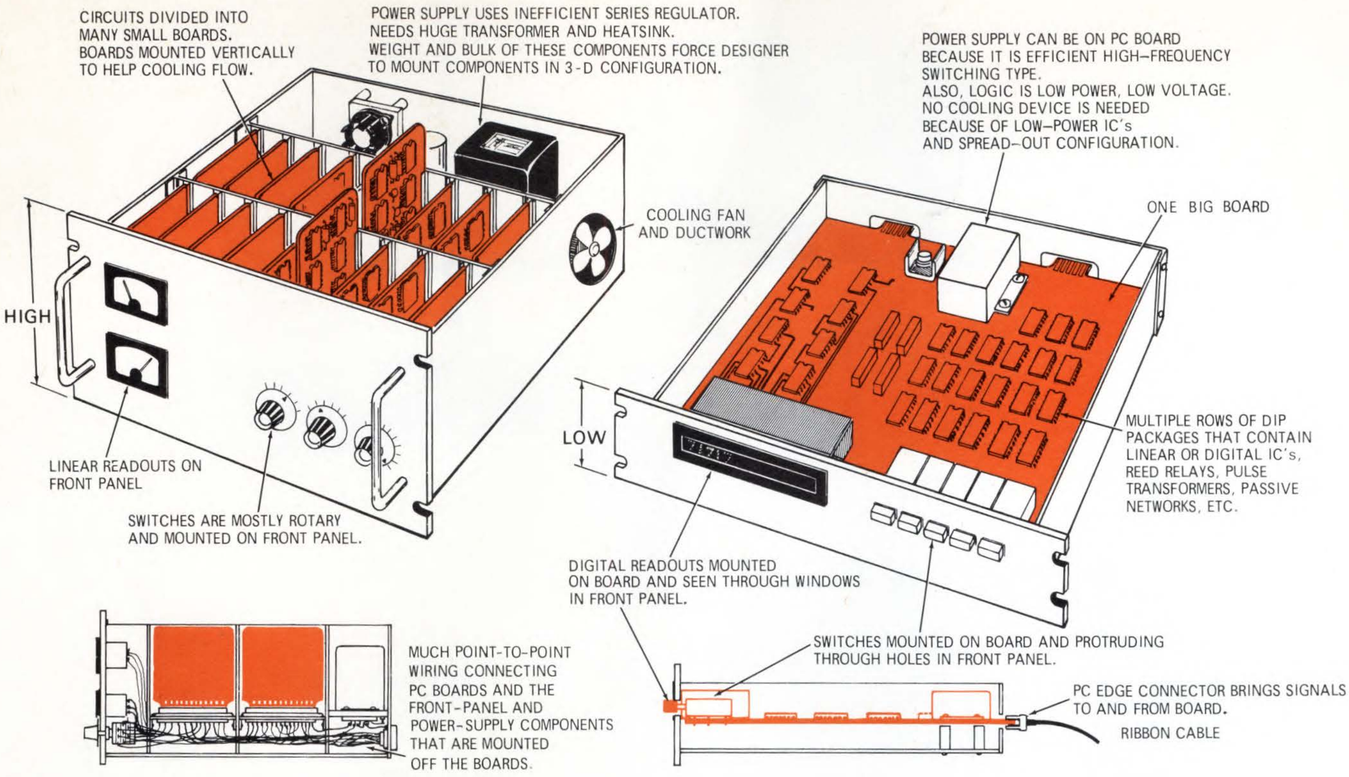
For each example, we'll comment on the investments made in engineering time and manufacturing tooling. We'll also try to show how these varied as the expected market sales for the products varied. The simple bench temperature controller of example-3 had much too low an expected volume—about 200 units a year—to warrant extensive tooling for automation, but it still has benefited from a planar approach. The company recently installed an automatic soldering machine (drag type), and now they can go to that first level of assembly automation.

On the other hand the automotive regulator of example-4, with its present volume of 2 million units a year and projected future volume of 10's of millions of units per year, has warranted massive tooling investment. As many as 100 engineers were put on its development during the 5 or so years it took to be put into manufacture. Here, though, the justification was that it was the pioneer product with which to develop the highly automated production technology for later use in all the company's automotive electronics.

The minicomputer of example-1 and the portable instrument of example-2 fall between the extremes. These products sell in volumes of about 1000 to 10,000 units per year. Partial automation is the answer for them, and planar has helped. A basic planar layout for the electronics makes it much easier for a manufacturer to work automation machines into his lines when his product sales grow and he can afford the capital outlay. As pointed out in example-1, it helps if designers get in the habit of laying out their planar configurations to suit the needs of automation machines that may be purchased in the future.

An element of the planar-automation story that we won't be able to cover fully is the standardizing of product subassemblies for manufacturing process. We see this coming, though. As more and more U.S. manufacturers invest in automation machines to combat cheap offshore labor, we foresee that more and more designers will find themselves restricted to configurations compatible with the machines on the factory floor. The exotic 3-D packages of the 1960's will not be much in evidence in the next few years. Has anybody seen any cordwood lately?

FOR A FREE REPRINT OF THIS ARTICLE, **CIRCLE NO. L61**



(a) **OLD**
SEMIPLANAR

(b) **NEW**
SUPER PLANAR

Fig. 1—**What we mean by planar.** From the viewpoint of this article a package is planar to the extent that it is on a single 2-D plane (right). Older approaches of the 1960's (left) where designers wanted modularity for finely-divided repairability have given way to big boards that carry whole major subsystems.

1—Making a Moderate-Volume Minicomputer Planar

Today, just about everybody in minicomputers has turned to "super-planar," or big-board, packaging. It was, among other things, through the use of big printed-circuit boards that Data General Corp. was able to move up so rapidly behind minileader, Digital Equipment Corp. (DEC).

Digital Computer Controls, Inc. (DCC) is a minicomputer company that was started in 1970 specifically to provide a second source to DEC's popular PDP-8 mini. Its planners said its product would be able to undersell and outperform the PDP-8 because it would use five large boards instead of DEC's 110 small boards.

We visited rapidly-growing minimaker, Interdata at Oceanport, N. J., to see how they were designing and producing their latest mini, the powerful Model-70 that uses big boards. Bert Sathmary, Interdata's package designer told us how important he believes this "super-planar" approach is:

"To remain in the running in the mini field, you've got to keep upgrading your product while you lower your price. The constantly-falling prices of ICs help you, but they help your competition too. So about the only way you can get an edge on the business from the manufacturing standpoint is to lower your packaging costs. You've got to cut down on the number of packaging parts you buy and the number of pieces you assemble. Big boards do both.

"We used to use fairly large 9-3/4- by 9-3/4-inch boards slid-in vertically in the old fashioned manner," Sathmary said (**Fig. 2**). "Now we've gone to the really big boards, 15 by 15 inches, which is about as big a board as will fit into the 19-inch relay-rack-sized cabinets used for minis, and we slide these boards in horizontally to keep the rack height of our equipment down. (Data General and DCC follow the same configuration). Just five of these big boards are needed to make up our $6800 computer. With modern MSI and LSI DIPs it is possible to put a whole computer subsystem—like a memory—on one of these boards, so they are much better for our system partitioning.'

"These four women you see here". . . . we were walking down Interdata's production line. . . ." will be able to turn out 40 boards a week even though they are putting most of the parts in by hand. We haven't gotten to the volume yet where we can justify automatic DIP insertion but we've planned for it. We use a computer-controlled PC artwork generator that puts all the 3500 or so holes on a big board on the precision tenth-inch grid that is needed for machine insertion. We do, however, put diodes in by machines."

His comments about looking ahead to the coming higher levels of automation have a bearing on our planar theme. When you go to planar, it is easier to take advantage of automatic machines such as those for numerically-controlled artwork generation and PC

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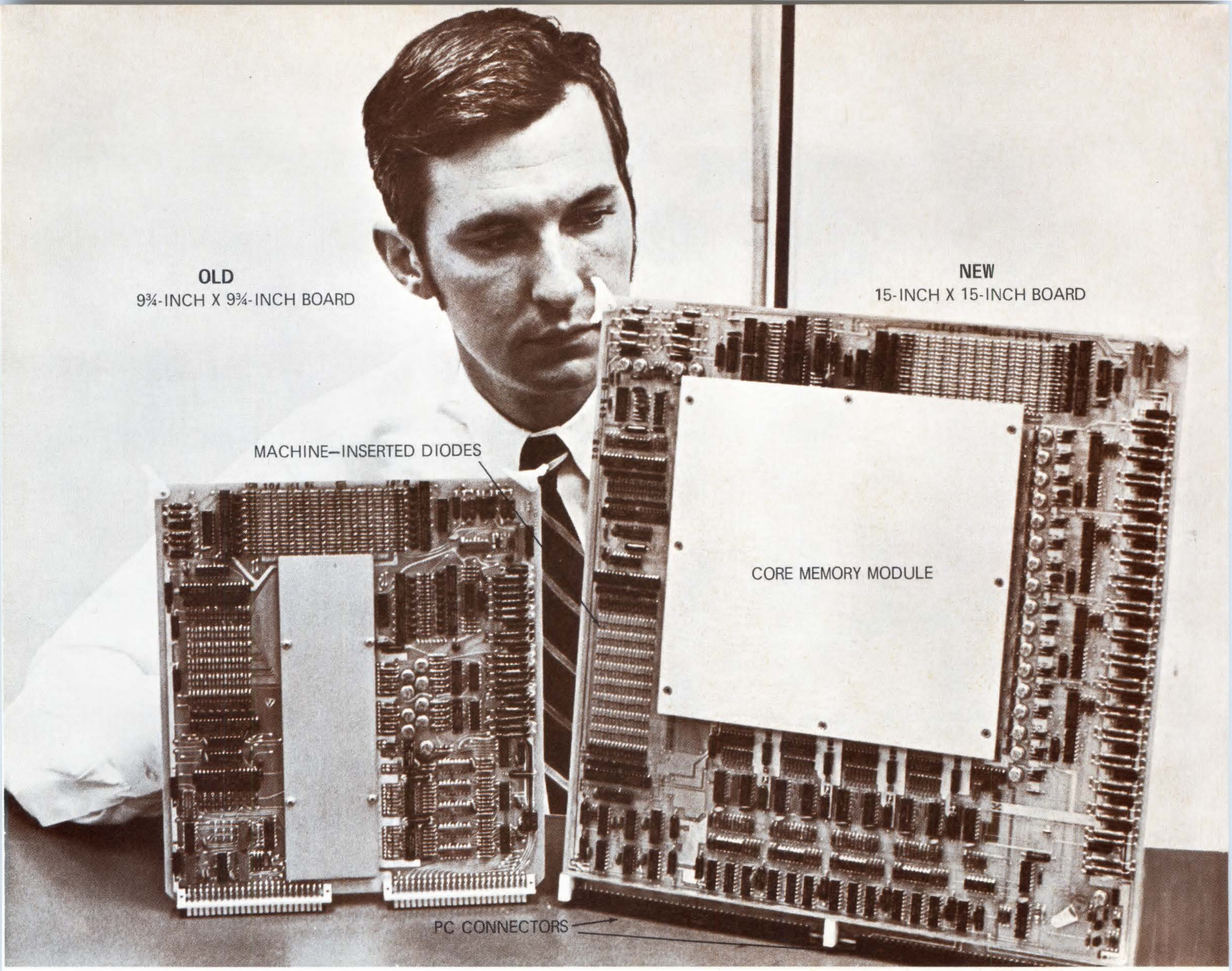
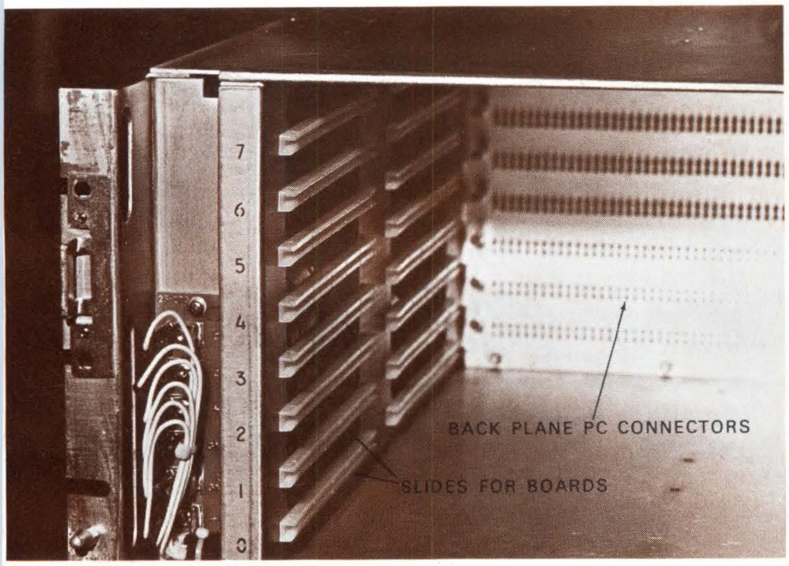
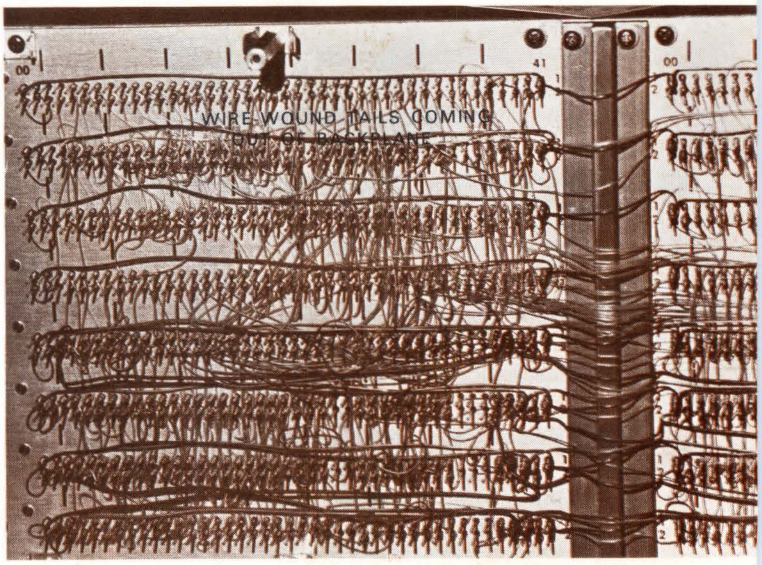


Fig. 2–**Minicomputer makers** have gone to larger boards to make their packages "more planar". The smaller 9-3/4- by 9-3/4-inch board that Interdata used on earlier computers has been replaced with a "full sized" 15- by 15-inch board on their newest computers. Pictured is a complete memory board–the large module in the middle is a magnetic core memory assembly and the circuitry around it is the addressing, driving and decoding.

Fig. 3–**Minicomputer cabinet** (viewed from front on left) accepts eight big boards slid in horizontally. Wirewrapped backplanes (cabinet viewed from rear at right) provide some freedom for system design changes.





Planar (Cont'd)

precision drilling (both of which Interdata does have).

But all this automation demands a significant capital investment in tooling, especially for the large boards. You need larger working areas for the drafting plotters, wider flow-soldering machines, larger swings for the drilling heads and automatic insertion machines, etc. Fortunately for Interdata, they now have the sales volume to justify the investment in production tooling, and the acceptance of their new powerful big-board machines encourages them to expect greater sales volumes in the future.

Right now they are making 600 machines a year, and at a minimum of five boards a machine this means at least 3000 boards a year. If they hold their own in the predicted three-times growth of the minimarket, by 1975 they should be making 2000 machines and 10,000 boards annually (assuming any increase in LSI will be offset by increased computer complexity).

We suspect that it isn't all gravy when you go to big boards. For instance, Interdata adds as many as three crosswise stiffening ribs to combat board warpage as it goes over the hot-flow solder connections afterwards. We noted on a recent visit to Federal Scientific Corp. (who has been using big boards in correlators) that it is sometimes necessary to add support posts in the middle of the boards to prevent vibration in later equipment use. Further, we've been told that the force to insert one of these big boards can be as great as 40 lbs, and that a board can be damaged if an impatient technician tries to jam it in.

Sathmary agreed that these big-board problems do exist. "You'll note we've gone to a two-piece PC connector instead of the usual one-piece connector. We use the AMP mod 4 connector because it has exceptionally low insertion force. We also put an aluminum support rib across the board just behind the connectors (see **Fig. 2**) to help hold the big board flat as it goes past the solder wave and to help prevent misalignment when the connectors are plugged into their mating halves in the chassis backplane. "Yet," said Sathmary, "what other form of package would permit you to put together and take apart a whole computer in well under an hour?"

One part of the system where everybody would like to use 2-D planar, and only some do, is in the backplane that interconnects the big boards into the system. The package designers we've talked to agree that printed-circuit backplanes—even if they must be multilayered—offer the least expensive approach. Sathmary also was of this opinion, but he said he would not take such a step until the engineering design changes stopped. Therefore, Interdata, as do many other systems makers, uses wire-wrapped backplane (**Fig. 3**). They do, however, have almost completely automatic wire-wrappers—workers need only feed wires to the wrapping heads and help the heads guide the wire between posts.

2—Making a High-Volume Portable Instrument Planar

Look at the small portable instrument in **Fig. 4**. It is a digital multimeter with 3-1/2-digit LED readout, 17 ranges and automatic polarity switching. As for the circuit, this is a full dual-slope instrument, and future versions may even have automatic ranging.

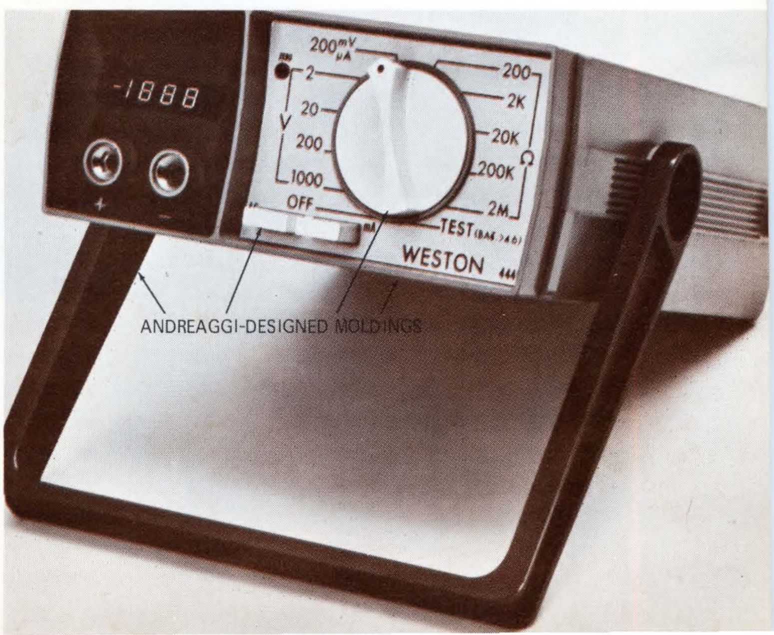
Now, try to visualize how you would incorporate economical 2-D planar electronic assemblies inside this compact, attractive 3-D case. How could you design the insides so you could make this instrument with U.S. labor and deliver it for $200 in OEM quantities!

Fig. 5 shows how Joseph Andreaggi, the Weston Instruments, Inc., mechanical engineer who designed the packaging, did it. He and Irwin Mundt, the electrical engineer, worked together as a close-coupled team to product the unit in a year (just the right design time investment for an instrument estimated to sell at the $2 million-per-year level). The electronic portion of this instrument has already been described in EDN/EEE (Sept. 15, pp. 49 and 50), yet that description only touched the top of the iceberg as far as the mechanical packaging design is concerned.

Andreaggi used two PC boards, one placed horizontally at the top of the case and the other horizontally at the bottom (**Fig. 6**). The bottom board was placed so it would line up with the input jacks and pushbutton switches on the front panel. Similarly, the top board was placed to line up with a small plug-in daughter-

(Continued)

Fig. 4—**A challenge to make planar.** How would you make this portable digital multimeter planar?



board (see **Fig. 5**) carrying the LED readout behind the display window.

The unavoidably-large rotary range switch had to line up with the middle of the front panel, so Andreaggi cleverly made this straddle the two boards. He used a standard seven-wafer CTS rotary with terminals designed for economical PC mounting. He also had CTS supply this switch as individual wafers instead of the usual bolted-together assembly. Then he put the first five wafers that switched input ranges on the bottom signal-conditioning board and the last two wafers that switched the A/D converter on the top digital board. It turned out to be possible to swing the last two wafers around 180 degrees to do this, even though CTS had never intended it. To make the rotary mechanically operable from the front panel, Andreaggi then designed a long plastic shaft, putting a keying ridge down its length so all the wafers would have to be lined up at the same rotation for assembly.

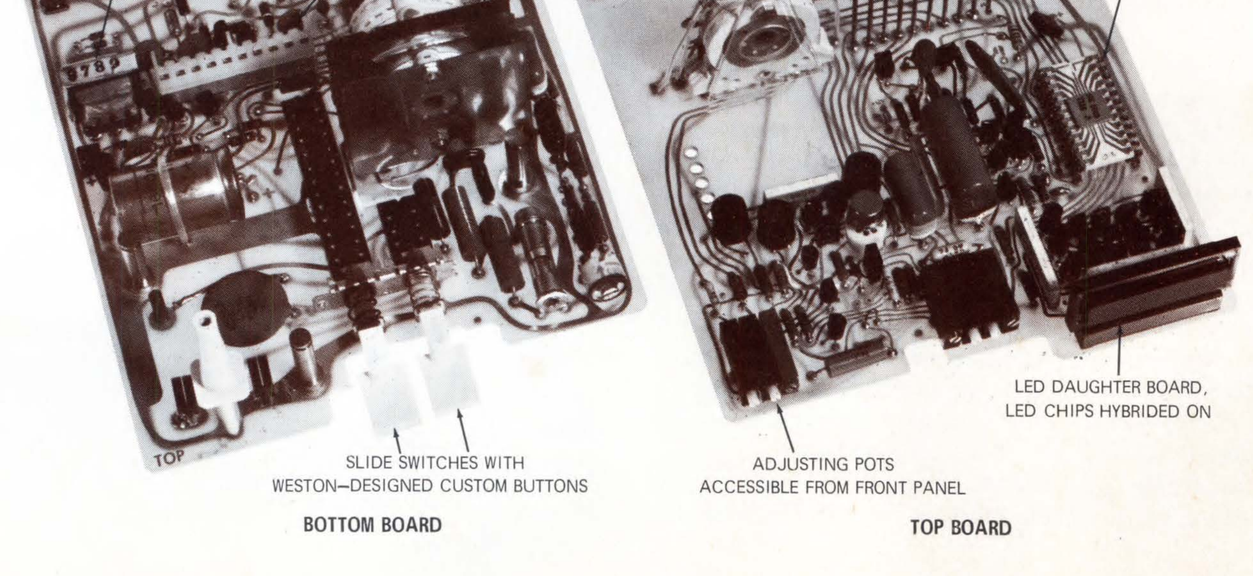
What a neat little 2-D planar thing Andreaggi made out of the electronic guts of this mini-instrument! By design, it is easy for Weston to make and assemble. By design, it is easy for a serviceman to disassemble, troubleshoot, repair, and reassemble. We watched Andreaggi take it apart. He pulled the two PCs out the back as a unit (**Fig. 6**), slipping the rotary switch out from its long shaft in the process. Next he pulled the two PC boards apart—at this point they were held mainly by the modified Molex board-to-board connector. Finally he laid the two boards out on the table, face up, put a jumper harness between the board-to-board connectors, and had a live, working circuit with everything visible and accessible for troubleshooting and repair. Beautiful planar simplicity!

This package illustrates how monolithic LSI complements PC planarity. All the switching for the A/D converter is contained inside one custom MOS chip, the 24-pin DIP that can be seen on the right side of the upper board. This DIP replaces 18 MSI TTL DIPs used in previous larger Weston digital meters. From our planar viewpoint, ICs are "microplanar" and LSI is "super-microplanar".

The projected market volume for this instrument (10,000 units per year) justified custom LSI, and the Mundt/Andreaggi design team took sensible advantage of it. They didn't lose their perspective just because they suddenly were able to put so much function in one small PC board area (the 18 TTL DIPs formerly used would have jammed up the whole upper board). Instead Andreaggi used the space-saving gained by the LSI to maintain a "human-finger" openness on the upper board. And, as can be seen, he did not hesitate to mix large electromechanical parts like the CTS switch wafers with the millions-of-times-more dense LSI right on the same board.

Another value of the LSI is that it is effectively a

Fig. 5—**The challenge answered.** Two boards, as large as the instrument's exterior permits, carry all the components.



complete "daughter board" that can readily be pulled from the main board and replaced for repair. Andreaggi used individually staked-in AMP sockets for the DIPs as a reliable low-cost way of achieving this pluggability.

Now the feasibility of an all-PC-mounted packaging system like Andreaggi's depends heavily upon being able to economically mount and position these 2-D elements into a final 3-D whole. Ordinarily this would take so many bits and pieces of metal, and so much assembly alignment, that it would be easy to lose everything that had been gained by the internal 2-D planarity. But here is where Andreaggi's skill in plastic molding paid off. He designed a one-piece injection-molded case that does it all (**Fig. 6**). His case has molded-in PC slides, front panel openings and many other built-in features.

This is not an ordinary plastic case, but a precision injection-molded structure of high-impact polycarbonate (Lexan is the G.E. trade name). Though Andreaggi says he is largely self-taught in plastic part design, the case is the work of an expert. The mold has six moving parts to allow undercuts. These are important for styling freedom and to permit extensive snap-fit assembly of parts such as the front-panel legend. There are five molded-in metal inserts including the input-jack bushings.

We asked Andreaggi if this plastic sophistication wasn't a design luxury, for we had rarely seen it in other products. "Management always asks me that," he answered. "Someone always says, 'just use metal stampings and we'll get the product out on the market faster with less expense'. But I've been able to show them that my way is actually less expensive and just as fast. It may take $50,000 worth of tooling for the eight molds I've designed for this product, but it costs a lot to go the usual hundreds-of-bits-and-pieces way, too.

"For example, each progressive punch and die to make a metal piece will cost from $1500 to $2000. Then what will really kill you is the labor of putting all the bits and pieces together. In my opinion it is often bad product design that forces companies to go offshore for cheap assembly labor."

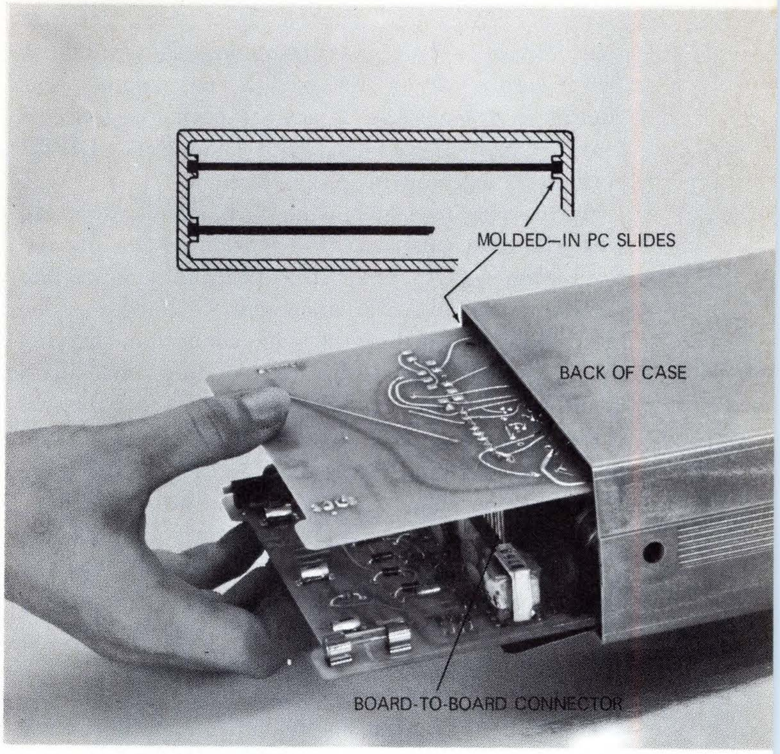


Fig. 6—**From 2-D to 3-D** is accomplished with just one multipurpose injection-molded plastic case. Molded-in PC slides accurately position the two boards. Similarly, molded-in openings in the front of the case allow controls and readouts on the boards to project to the outside world.

3—Making a Low-Volume Bench Instrument Planar

Planar takes on Spartan simplicity when applied to a low-volume industrial product. **Fig. 7** shows a precision laboratory temperature controller that embodies the "grass-roots" simplicity proper for a low-volume market. It's by the Yellow Springs Instrument Co., Yellow Springs, Ohio, a 145-employee, $2-1/2-million annual sales operation. The soundness of this instrument's design is attested by the fact that YSI designed it 8 years ago, and it has had steady, profitable sales ever since.

Sales volume of this controller has not been spectacular—it has averaged about 200 units a year—but that is the point: the package was, and is, suited to intermittent manufacturing. YSI makes up a batch of 25 each time it accumulates sufficient orders from the franchised laboratory supply houses that carry YSI products. It is relatively easy for YSI to pull out the sample "3-D" production instrument and tell the people on the small production line "Today we'll build 25 of these."

From the design man-power standpoint, you must have a simple package like this if you are producing a $345 instrument that will sell at the 200-units-per-year level. Using EDN/EEE's bogey of one man-year of design investment for each million dollars worth of expected annual sales, it figures out that a product like this should take no more than a month's design time. But it would be difficult to be precise about just how big a design-time investment YSI made, because a family resemblance is maintained between all their

(Continued)

instrument packages. Thus a bit of the effort that went into all past designs rubs off on each new project. The design effort on this product, for example, was done over 8 years ago. It set the packaging pattern that YSI has followed ever since (though now DIP IC packages are permitting size reductions).

Engineering manager, Charles Kimball, explained why YSI went this way: "We considered the alternatives. One was to break the electronics down into smaller modules. An arrangement we liked was one motherboard with three PC edge connectors carrying three smaller daughterboards. At the time, small modules were really in vogue and we, too, thought there might be some advantages in terms of field troubleshooting and repair and the ease of subassembly during manufacturing. But when we started costing out the multiple-board approach we quickly found out that the connectors alone would add $30 to $50 to the selling cost, and this was too much for our markets.

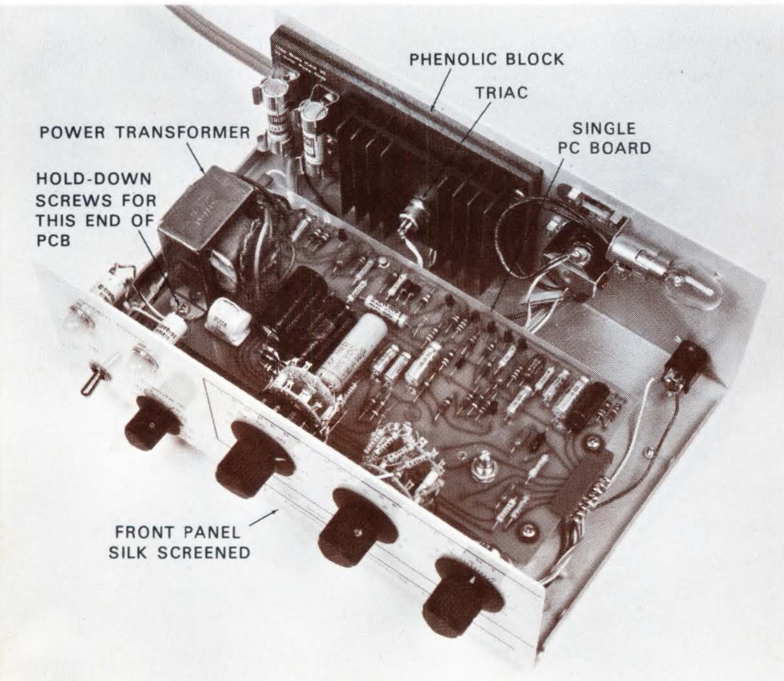
"So our basic reasoning back in 1963 for going to the larger board was, frankly, one of economics. But now that we've lived with the one-bit-board configuration, we see that it has decided advantages of its own. It really turns out to be easier to assemble than three smaller boards, and easier to troubleshoot. It is particularly easy to check in production because it carries its own power supply."

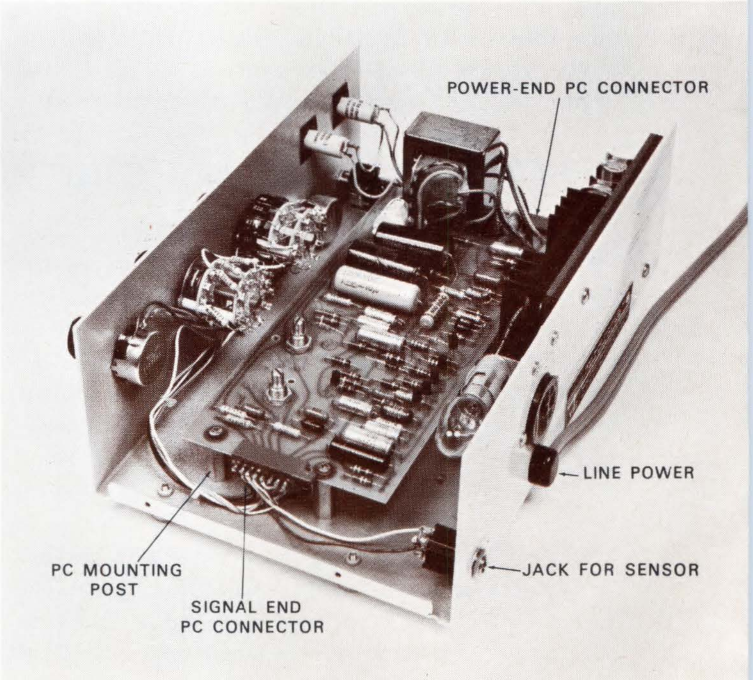
"You'll note that we preserve the same planar openness in the complete package. The chassis is just one big plane of heavy sheet metal bent up to form a front and back panel. In manufacturing, we silk screen the markings on the front panel and assemble that effectively as a unit. Then we treat the back panel, which carries the Triac power controller and its heat sink, as another unit."

"Even when all these three subsystems are together you can see that everything is still quite open and accessible. This saves everybody a lot of waste motion. We rarely have to disassemble instruments during test and calibration just to check if something is wrong. We can get at practically everything. In practice this is of great value in the final check on instruments before they are shipped. And it makes it easier for our customers to repair their own instruments. Among other things it lessens the danger that someone will cause a second fault while trying to fix a first.

"There are many little common-sense things about this design," Kimball said. "We did use PC edge connectors to bring the signal and power to and from the main board, but we did not try to force all the paths out one end. We tried that at first but it began to look like more of a stunt than it was worth. So we used two PC connectors, one at each end. Another bit of common sense was using a single thick Bakelite block to mount the Triac on the back panel. It may look crude but we found it more sturdy and less costly than the nylon posts we first used (the electrically-hot Triac heat sink demanded insulation)."

Fig. 7—**Grass-roots planar** in a low-volume temperature controller. This proven design has been selling for many years. Note how weight of the power transformer is carried by the support posts located under it at that end.





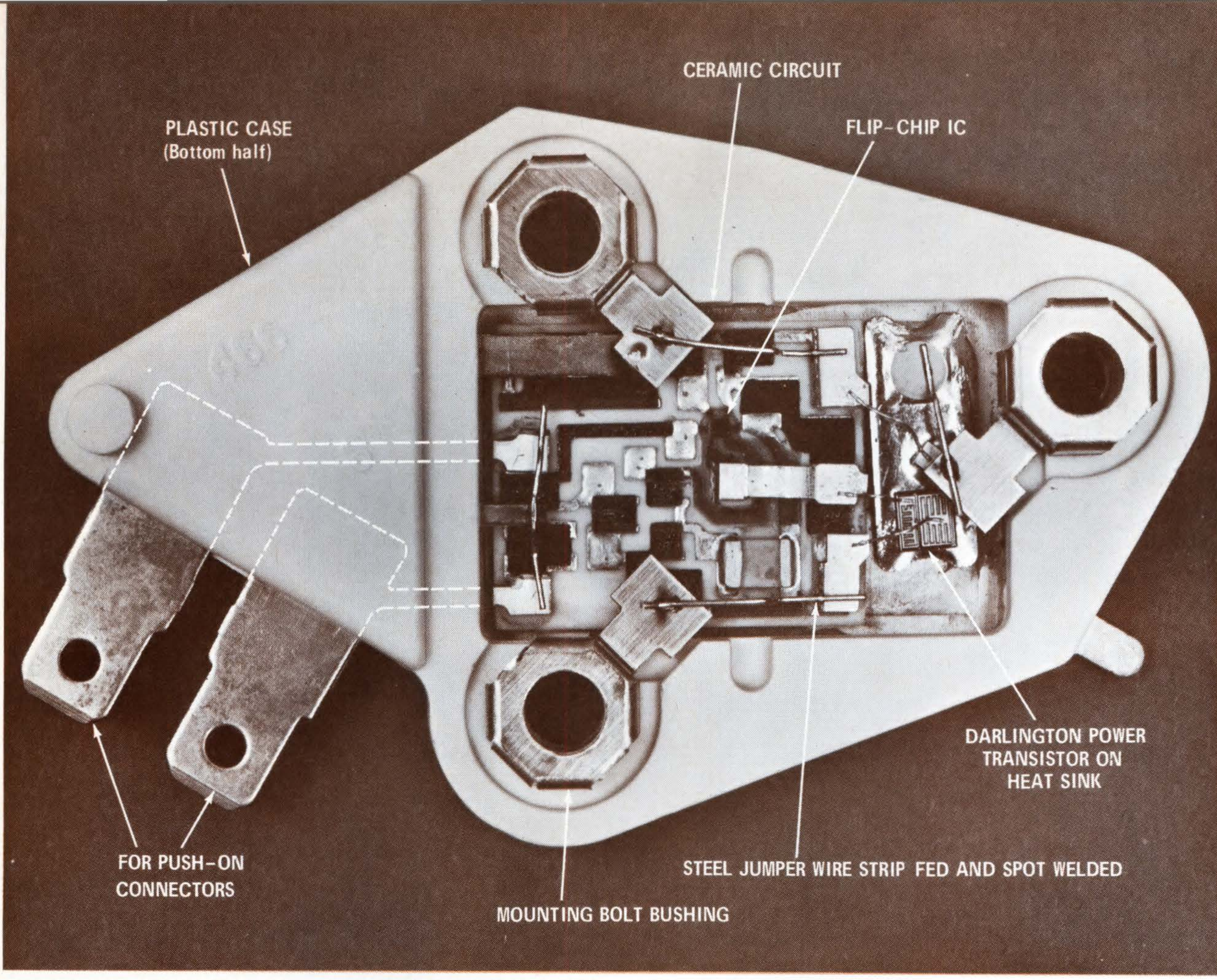


Fig. 8—**To survive** in the burly world of auto mechanics, this planar package must make a transformation from a delicate electronic structure to steel bolts. The connecting lengths welded of steel wire make this transformation. During manufacturing they are automatically cut at high speed from continuous reels of wire.

4—Making a Very-High-Volume Product Planar

Planar is taking on a mature form in high-volume-consumer products. Companies like Delco and RCA are following the lead pioneered by IBM in thick-film hybrid circuits and have developed automatic, continuous-belt production lines capable of turning out tens of millions of circuits per year at very low cost. To these companies, ceramic hybrids have all the virtues of printed-circuit planar plus the fact that they can be made as small, standard substrates ideally suited for automatic handling at high rates.

The high-volume ceramic hybrid circuit plants that we visited—Delco's at Kokomo, Ind., and RCA's at nearby Indianapolis—have the no-nonsense look of modern factories. They don't have the usual seas of workers at countless work stations, all doing bits of piecework. Instead they have long continuous conveyor belts that quickly and silently carry the modules from machine to machine. They are automatic screening machines, automatically-loaded and unloaded ovens, and high-speed, automatic resistor trimmers. Factories like these represent the only real answer our country has to dollar-a-day labor.

The circuits designed for these lines, therefore, bear close study. Delco's automotive voltage regulator (**Fig. 8**) took 5 years to design because it was developed in conjunction with the manufacturing process. RCA's color-TV kinescope drive (**Fig. 9**) took two man-years of production-engineering effort.

In each case the designers knew that the market was big enough to justify the effort. The Delco regulator was slated for production volume of about 5-million units a year; while the RCA driver was slated for around 3-million units a year. The payoff is that now Delco and RCA are able to produce these circuits for a few dollars apiece—something that would have been impossible with the high labor content of even the best of printed-circuit-level automation.

Certain standard practices can be seen emerging in these ceramic planars. The ICs are preferably flip chip, and are likely to be special units produced under the same roof (though the policy of both Delco and RCA is to have outside source backups). The resistor trimming is by laser. You can look through the monitoring optics, watch the tiny spot of light dance about as it is automatically directed from resistor to resistor, and sense how efficient this is. The mounting adhesives and conformal coatings are automatically applied by epoxy. Boards are of a few standard sizes and

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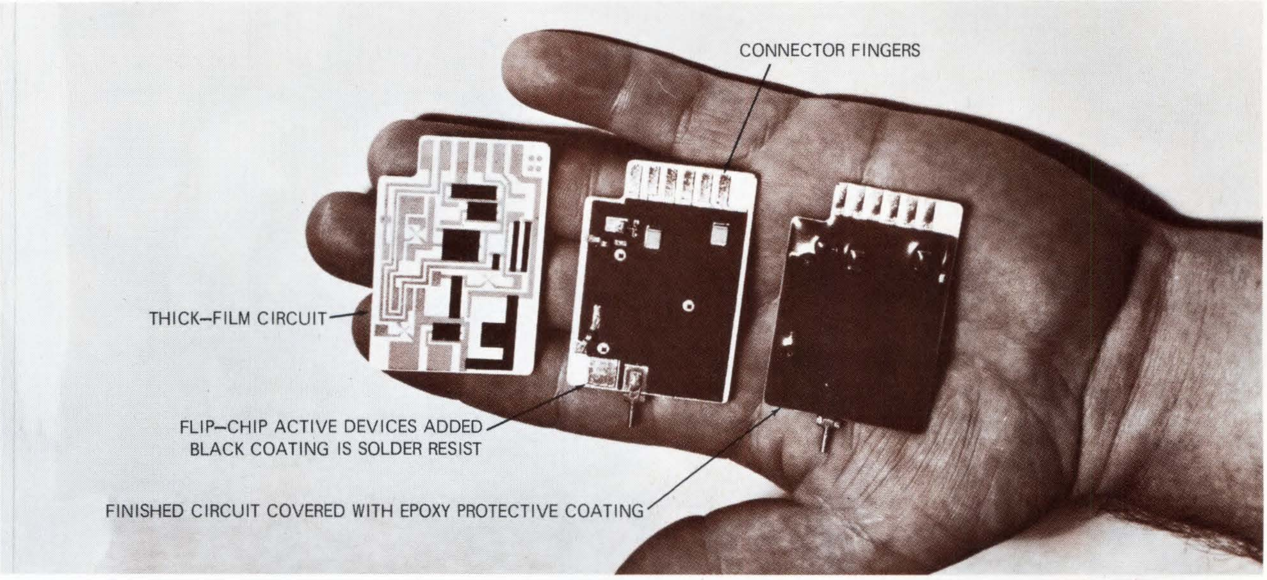

Fig. 9—**Planar, in thick-film-on-ceramic form,** is becoming popular for circuits produced in quantities of a million per year because its manufacture can be almost completely automated. The ceramic plug-in kinescope driver (top) may someday be made for less than a dollar—a price impossible with U.S. labor for conventional discrete-component drivers. Three steps in the manufacturing process are shown at the top, and the way the completed module plugs into printed-circuit edge connectors on the TV circuit motherboard is shown in bottom photo.

one-sided to reduce the complexity of the automatic handling machines.

In addition, you can see specialized packaging features that are related to the particular application. The Delco unit is mounted in a high-temperature alkyd plastic package that will be bolted right onto the alternator whose output it regulates. This is a demanding under-the-hood location, and Delco uses stainless steel tabs on the bolt-hole bushings with stiff steel jumper wires welded to these tabs and small steel tabs on the circuit itself to carry the current. Note also the rugged tab connectors coming out of the left end of the regulator. These offer quite a contrast to the delicate-looking ICs inside the package, but they are the sort of connectors that can survive the abusive thumbs of auto mechanics.

The RCA module, on the other hand, plugs into an RCA-designed PC socket on a phenolic motherboard in the TV set. The ceramic wafer has enough strength for this, but RCA adds a flexible epoxy conformal coating to help protect the circuit against both moisture and the service-man's fingers. RCA apparently has developed a low-cost tin-lead-silver alloy that possesses sufficient oxidation resistance to permit reliable connections when it is used for the contact fingers on the module. ▭

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CIRCLE NO. 20

SHED SOME LIGHT
ON YOUR OPTICAL FILTER PROBLEMS

Optical-filters are becoming increasingly important to electronic designers. But common problems and misconceptions exist that hinder the designer in dealing with these devices.

MARTIN L. BAKER, Heliotek Div. of Textron, Inc.

There are similarities and analogies between optics and electronics. Therefore, the transition to circuit/system design involving optical components is relatively simple. Perhaps deceptively so, however, because there are a number of special problems and characteristics that must be understood and observed. The following discussion points out some key misconceptions or misunderstandings that designers harbor in their work with optics.

What to Specify

Traditionally, center wavelength, peak transmittance, bandwidth at half-power points and blocking outside of the passband are characteristics that define an optical filter. But, specifying these items for a filter in a laser system may actually fail to get a usable component.

For laser systems, specifying the center wavelength or the peak transmittance is not important. Significant parameters are transmittance at the laser bandwidth, maximum bandwidth (consistent with angle shift problems), and the rejection outside the band to eliminate noise. With these specifications, it is up to the manufacturer to assure that when the temperature and angle shifts take place, the filter will not drop below the required transmittance.

This reasoning applies to lasers because the spectral line is highly stable—wavelength is precisely known. Therefore, it also applies to any other highly stable sources, but not to such devices as light-emitting diodes (LED) where temperature affects wavelength. For LEDs and other sources subject to wavelength drift, the traditional parameters such as center wavelength, peak transmittance and a broad passband are

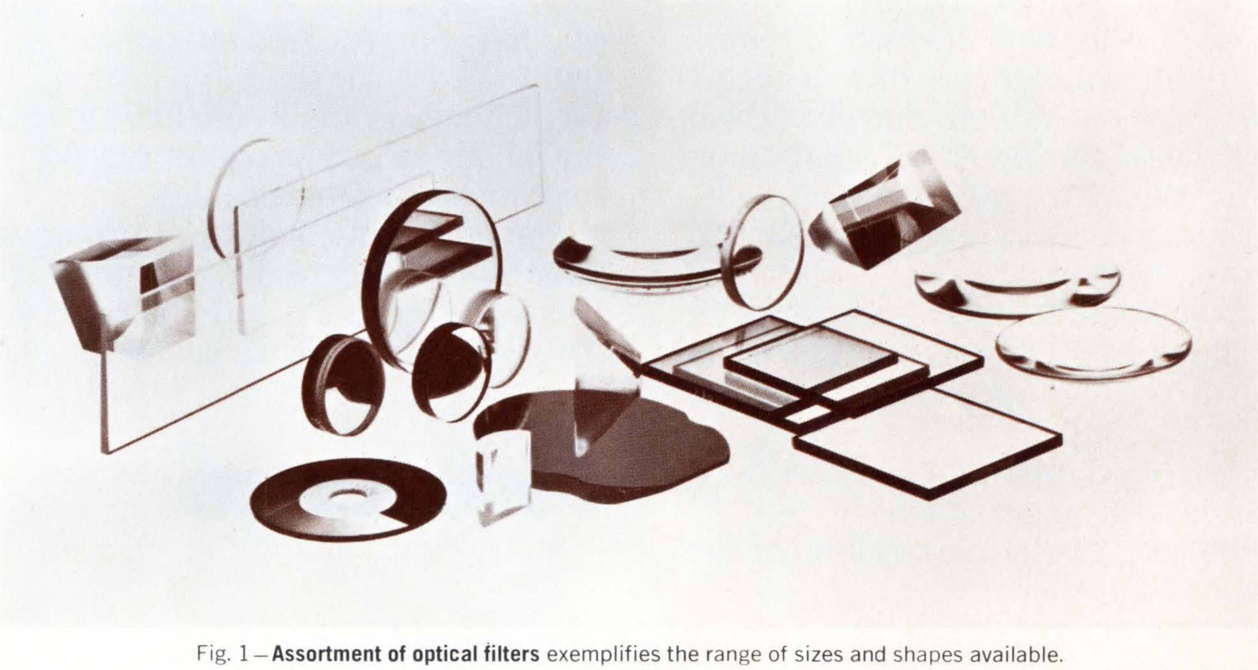

Fig. 1—**Assortment of optical filters** exemplifies the range of sizes and shapes available.

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appropriate.

If the optical filter manufacturer enters the design at an early stage (a highly recommended procedure), he should be told the spectral response of the system detector. Any unusual stray signals other than sunlight should also be brought to the manufacturer's attention.

Angle of Incidence

Not all light strikes the filter straight on, of course, and it needs to be recognized that the transmittance wavelength of the filter shifts lower as the angle increases. This is illustrated in the plots of **Fig. 2**. Note that the total area under each curve, representing the total energy, essentially remains the same. If the light incident on the filter from all angles were to be summed, the result would be a wavelength vs transmittance plot that was lower and wider than the curve for straight-on light only.

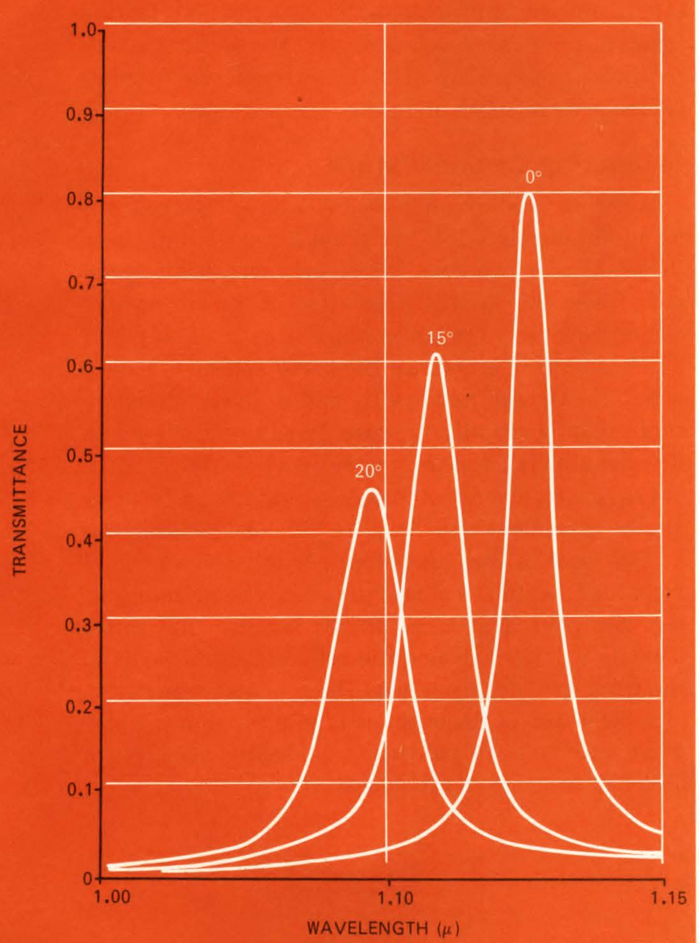

Fig. 2—**The effect of a shift of incident angle** on the transmittance wavelength is shown for three angles.

For dichroic mirrors, a beam is split into two distinct wavelength regions—normally involving fairly high angles of incidence. For such applications, the user often fails to recognize that it is impossible to achieve a steep cut-off at high angles of incidence unless the system is restricted to one plane of polarization. The reason for this is that the filter exhibits a different effective index of refraction for each plane of polarization—index of refraction controls the optical thickness which, in turn, controls the filter location in wavelength. Instead of having the edges of the wavelength vs transmittance curves superimposed, they shift as indicated in **Fig. 3**. This means that it is impossible to have a steep rising curve if both planes of polarization are present. The problem can be easily side-stepped by polarizing the incident light and advising the filter manufacturer on the plane of polarization that he will be working with. In the case of the laser systems, this is readily achieved.

Temperature

Temperature increase causes the center of the wavelength of an optical filter to increase. A number of factors determine the amount of shift, but generally a filter designed for room temperature shifts upward in wavelength by about 0.5 to 1.5% at 150°C and down by about 0.5 to 2% at −150°C. Essentially, the curves are linear on each side of the design temperature.

As previously indicated, the total energy under the curves of **Fig. 2** remains about the same. Note, however, that an extreme high temperature shift could cause the coating material to absorb energy and would change the energy under the curve. Temperature extremes can also cause a mismatch between the two materials used in the coating and this would alter the area of the curve.

For narrow bandpass filters, temperatures in the vicinity of 200° or more should be avoided because this approaches the limits of the filter. For soft filters, the limit is about 180 to 190°F. Interestingly, the filter degrades much more for a swing to the high side than to the low.

(Continued)

Blocking

Blocking refers to the rejection outside of the passband. In an electronic circuit, a typical specification is the number of decibels down at the half-power point, or at some other point off the center frequency. By contrast, for optical filters specifying the transmittance outside of the passband describes blocking. In other words, the percentage of light permitted through the filter.

A common tendency in specifying blocking is to call out the maximum permitted transmittance. This seems to be a natural enough approach, and it certainly suffices in the sense that the filters provided will perform without surprises. But it also may be a costly way to specify blocking—in terms of the selling price for the filter. In fact, it may be so unduly restrictive that it causes lengthy and unnecessary delivery delays—or may even define a filter that cannot be built.

In actuality, a sensible approach is to identify blocking as the source detector filter response to the unwanted energy compared to the inbound energy. Expressed another way, the user should take specific wavelength limits below the passband and determine that, integrated between these limits, a certain value of average transmittance can be withstood—average, not maximum.

Obviously, this puts a burden of effort on the designer. It is far more trouble to determine the average integrated transmittance than to pick an arbitrary, but safe, maximum transmittance value. However, the rewards are great in terms of achieving substantially lower cost, and the increased assurance of having a filter that can be manufactured readily and reliably.

As a final consideration, blocking of the filter should not be specified outside of the detector response unless there is so much incident energy that heating becomes a problem. Since the filter will not see light outside of the detector's range of operation, it may seem unnecessary to point this out. Unfortunately, many filter manufacturers advertise extreme ranges of filter response—the "X-ray or radio waves" variety of spec. This tends to be misleading to those who specify a unit with those characteristics even when their detector is, say, a phototube.

Center Wavelength Specifications

For bandpass filters, it is customary to assign tight tolerances to the center wavelength as compared to the half-power bandwidth. Even with a filter 100Å wide, for example, the center wavelength is often specified to within ±1Å—an unnecessary and unrealistic call-out.

A safe rule of thumb for the incoherent light situation is that the center wavelength tolerance should be about 20% of the half-power bandwidth. Thus for a 100Å filter, ±20Å is a reasonable limit. Manufacturers can meet tighter requirements, but these should not be called for unless there is a definite need.

As previously mentioned, it is more appropriate to talk about transmittance at the spectral line for the coherent light case, such as lasers. For systems where continuous spectra are involved, it is suitable to specify center wavelength and peak transmittance.

Measuring Optical Filters

Knowing what you get once you have received it is an admirable objective, but is not always as simple as its seems. For example, to properly measure a bandpass filter, the spectral resolution of the instrument should be five to ten times as good as the half-power bandwidth. If it is not, the filter will appear to have a wider half-power bandwidth and a lower transmittance than is actually the case. In addition, the center wavelength may appear to be shifted downward.

The measurement of filters at significantly large angles of incident light is quite difficult, and requires a great deal of care and attention in order to obtain meaningful data. As a case in point, a polarization effect is produced at large angles because the instrument is polarized, hence the reflected components of the filter are also polarized. There is also translation (displacement) of the beam as it goes through the part being measured. In addition, the effective focal length of the optical system is changed.

Martin L. Baker is division manager for the optics and thin-film division of Heliotek, Div. of Textron, Inc., Sylmar Calif. Mr. Baker has a B.S. and M.S. in Physics. He has been granted three patents and is a member of the Optical Society of America.

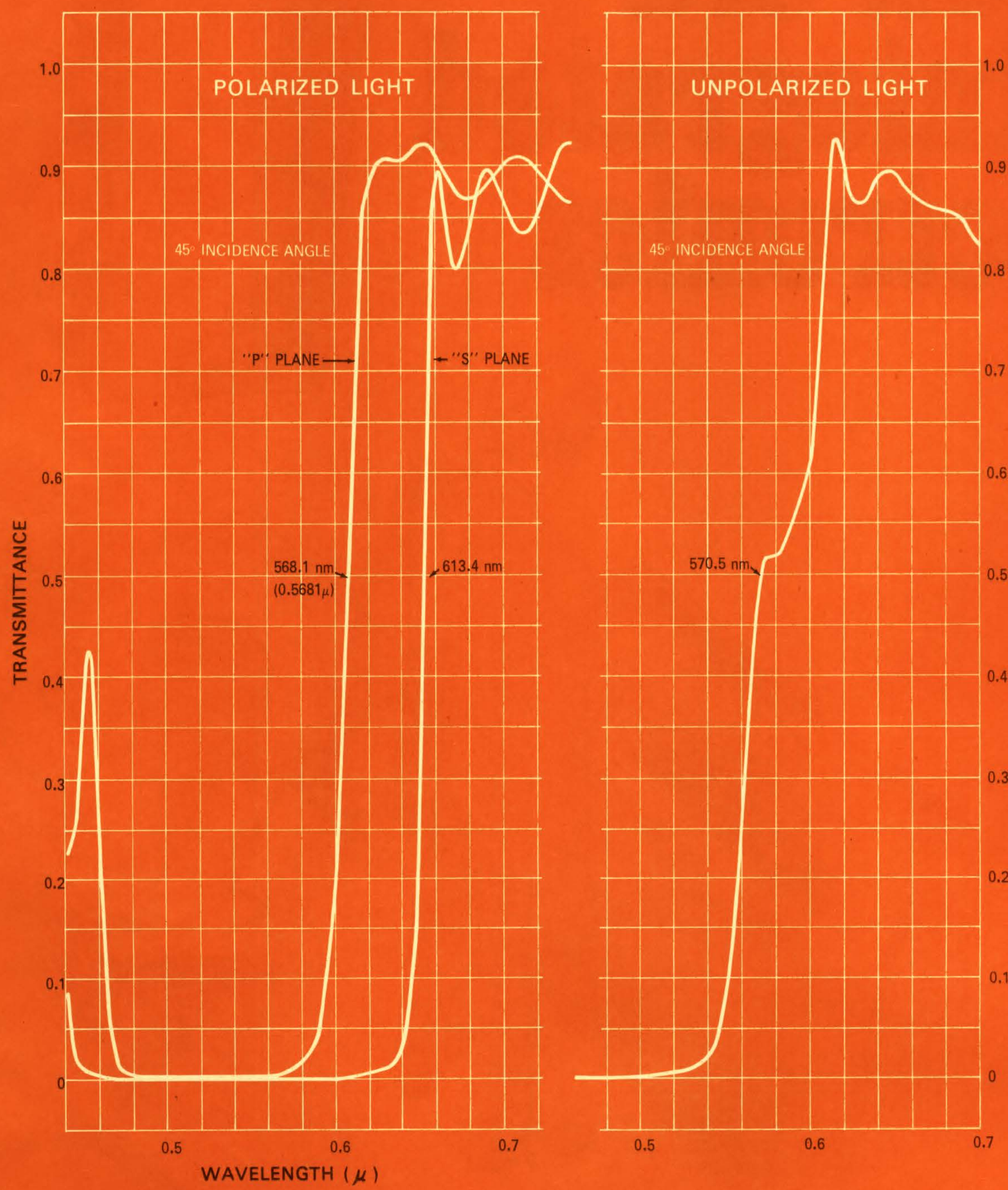

Fig. 3—**The effects of polarization** are shown for a 45° angle of incidence.

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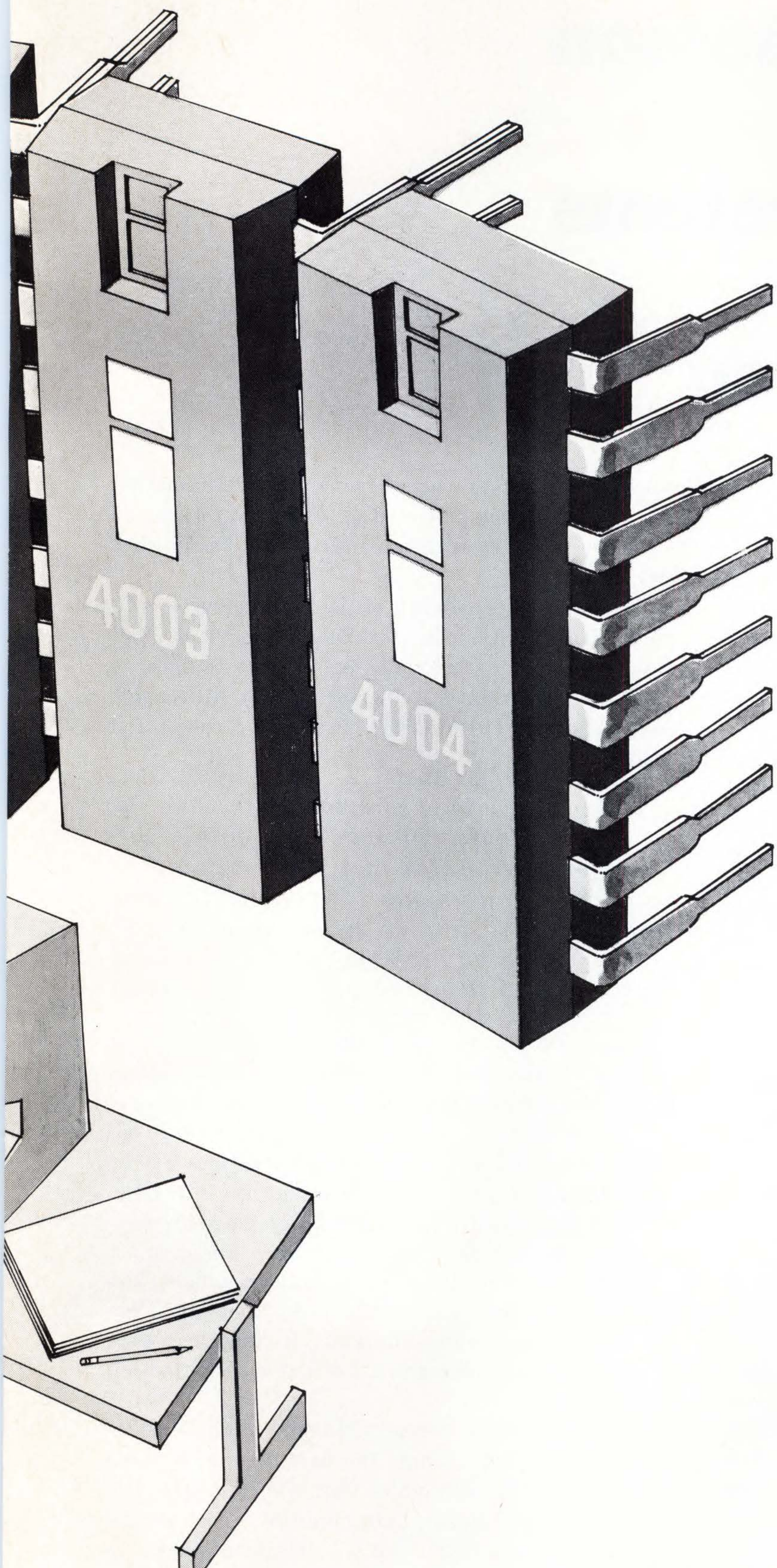

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CIRCLE NO. 21

Robert P. Henderson Of Honeywell Information Systems Speaks Out on Privacy Pollution

Privacy is one of our most precious human rights, and in today's crowded environment, it may be one of the hardest to maintain. The computer does not in itself create any invasion of privacy, for its role is no more active in this respect than the old-fashioned filing cabinet, and the threat to privacy posed by surveillance and record-keeping has been a fact of life for centuries. The new element introduced into this picture by the computer is its fantastic efficiency.

Professor Robert Fano of MIT has said, "You can never stop these things. It is like trying to prevent a river from flowing to the sea. What you have to do is to build dams, to build waterworks, to control the flow". It is toward building those dams and controlling that flow of information that I direct myself, and I feel very deeply that computer manufacturers and systems designers are among those who must assume heavy responsibility in the matter.

We have too many examples around us today of how technology failed to look ahead at problems which it might accelerate even if it did not create them. Pollution of our environment is one, and now we must reckon with the human consequences of pollution of privacy.

The burden of answering questions from all sides is growing for the average man. All of us are leaving a longer and longer trail of information behind us. If we cannot stop this relentless flow of information about ourselves into central files, we can do as Professor Fano suggests—build a dam here, a filtering system there to control it. A time limit on *all* personal data might be a good idea—so that a youthful indiscretion wouldn't haunt a man's records for the rest of his life.

The words "privacy" and "security" are often used interchangeably. Actually there is a great difference between the two, and different parties must be responsible for each.

Privacy is—or should be—the inherent and legal right of individuals, groups or institutions to determine for themselves when, how and what information about them is communicated to others. In relation to computers, security is the means taken to ensure that privacy.

The prime responsibility of the manufacturer is in the field of security. It is a technical rather than philosophical question; thus his chief responsibility is to provide the hardware and software that will enable the user to achieve the degree of security he needs and desires.

As practiced by users today, we have a superficial degree of security against the casual browser. But in fact, the computer industry now can provide a sophisticated and broad array of devices, both hardware and software, that go far beyond the superficial degree of security practiced by most users.

In hardware there are two basic classifications of security devices: encoding and personal identification. Devices for scrambling or encryption of data transmission to and from a remote computer terminal are becoming available so that intercepted messages will be unintelligible unless the interceptor has the code. Data in mass storage devices, such as magnetic tape or discs, also can be in encrypted form. The greatest array of devices, however, are designed to prevent the unauthorized user from getting even that far. They are the systems designed to positively identify a user as one authorized access to a file and the information in question.

The real problem comes with time sharing or remote entry systems, where the user may be working from a terminal many miles from the computer. The simplest security device here might be a lock on the terminal; or one might have a special sequence in which the keys are punched before the terminal will operate. More elaborate personal identification devices like voice prints, fingerprint scanners or picture phones are under study. Their feasibility and economics have yet to be positively determined.

At Honeywell we are working on still another method of personal identification utilizing hardware.

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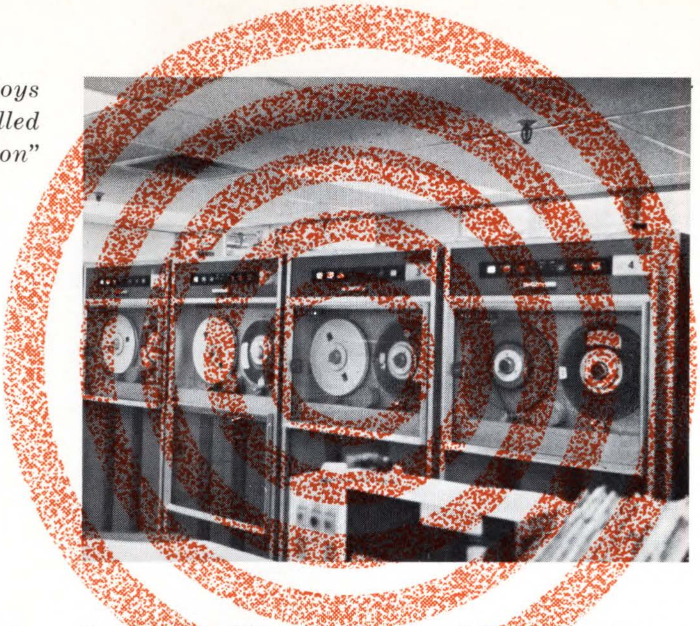
Another system employs what are called "rings of protection"



Think of the data base of a computer's memory as a tree with data leaves on its various branches. Our system would make security checks on the user at each junction of the branches. As he passes through the hierarchy of memory, the computer will run an automatic check on the user's security clearance.

For instance, user XYZ may have access to only a certain portion of the memory. As he comes to each new junction or branch, the computer will check to see if user XYZ is authorized to proceed into that area of the memory. If he is not, he won't be allowed to proceed. Or, at the junction, the user will be asked a question to determine his identity and clearance more positively, such as his mother-in-law's maiden name. If he does not answer correctly, he won't be allowed to pass. This system would allow the user to position his security checks at various junctions as he desires.

Another system devised by Honeywell and the Massachusetts Institute of Technology employs what are called "rings of protection." In addition to the tree or pyramid structure of conventional data bases, the ring structure is built like concentric circles. Thus segments of the memory containing sensitive information, can be placed in a privileged ring together with programs which process, update and extract this information in a carefully prescribed and controlled fashion. A subscriber is allowed to enter a ring only at a carefully defined point, and once he enters the ring, his activity is completely controlled. The way the information is processed and handled is completely beyond his control, and the user is prevented from moving elsewhere, even within that ring.

Another hardware feature designed to maintain the security of files (and it is available today) is an audit/monitor. This records the identity of the person who requested access to information, as well as when and for how long. The audit/monitor system can record abnormal patterns or frequencies of any given file being accessed or changed; and it can record attempts to gain access to a file that were foiled by other security systems.

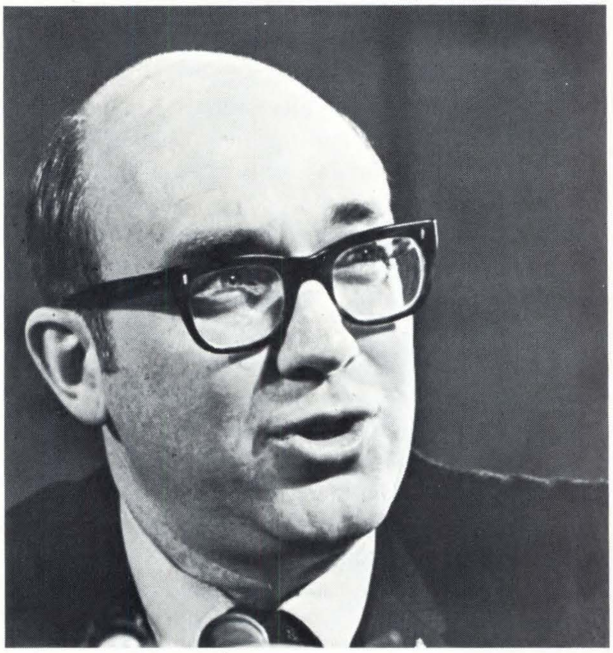
We now come to software, which in most instances is more economical than hardware, but just about as effective as a security measure. Software becomes impractical when it gets so complex that the computer spends more program time running security checks than it does on the processing job it is supposed to do for the user.

The most common software security again deals with passwords to identify a given user. A password program can be as simple as an entry code name which can be checked and verified against the computer's files, or as complicated as a long series of personal

(Continued)

questions which only an authorized user can answer—about birthdays, pets' names, or it could require several persons to be present, each possessing separate parts of a code. It could have intelligence built in to detect any unusual pattern of access request—hesitation, for example, and it could record each request so as to pinpoint blame later if information is misused.

Through software, we can limit not only who has access to a file, but also who can alter a file. Parenthetically, it can also be done through hardware by offering a limited number of file spaces; thus we can limit what kinds of information can be stored on an individual. For instance, a government agency or a credit bureau may be allowed to store information pertaining to age, marital status, income, etc.,—but not political affiliations, reading habits or the like.



Security is not the real problem. The real problem lies in enforcing the security in order to protect privacy of the files. Thus I think that some new legislation is needed to protect the rights of privacy.

Legislation should give the right to privacy the same status as the rights to life, liberty and property—rights guaranteed by the various amendments to the Constitution. I think the best way to accomplish this now is to make some provision that would allow everyone to examine his own file, wherever it may be kept, and to challenge its contents if he feels the file is inaccurate (as he now can do with his credit rating). Some concerned individuals have urged strict controls on the "technology of data banks"; however, I think that such action, at this time, would not be in our best interests. Even we in the industry would like to know much more than we do about the "technology of data banks".

Because new developments occur every day, any legislation controlling today's technology would quickly be outdated by tomorrow's breakthroughs. Thus I believe that any legislation that would seek to control the data bank itself would be premature and I am against such federal regulation.

Perhaps most important, concern for the problem should be built into the system from the very beginning, for it is much more effective, and economical, than adding devices or altering the system after it has been installed.

Finally, I feel that public education is imperative. Ralph Nader has said, "The problem of doing something constructive is that there aren't enough people who care." The first step to the solution of any problem is recognition that the problem exists. If concerned individuals, systems designers, business men and officials do not act soon, it may be too late.

Control of information is power, and absolute control of information is technically just around the corner.

Very simply, there are two directions in which computerized and centralized information systems can take us. One would lead us to a rigid, automated bureaucracy with great knowledge and power but little regard for the human consequences of its program. The other would enlist the power of computers into the service of individuals; enabling them to cope more successfully with the complexities of modern life and increasing the opportunities for successful fulfillment of their talents.

If the time ever comes when the misuse of computerized record-keeping leads man to fear being curious, daring, and willing to deviate from the norm in order to experiment, it would not be a case of the machine triumphing over man, as some people fear; it would be a case of man *becoming* the machine. □

Robert P. Henderson is vice president and associate general manager, North American Operations, Honeywell Information Systems, responsible for all North American marketing activities. Since October 1969 he has served as vice president and general manager of Honeywell's Electronic Data Processing Div. Prior to that Henderson was vice president of marketing for the division.

He graduated from Dartmouth College with a B.A. in English in 1935 and received a Master's degree in Business Administration from the college's Amos Tuck Graduate School in 1957.

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Switching time	0.25μs	1.0μs
Power dissipation	5 mW.	130 mW.
DTL/TTL compatible address		
16-pin DIP		
Operational range	−55°C to +125°C	

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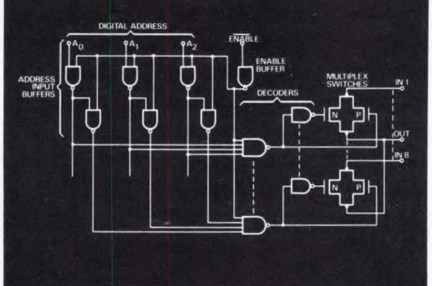
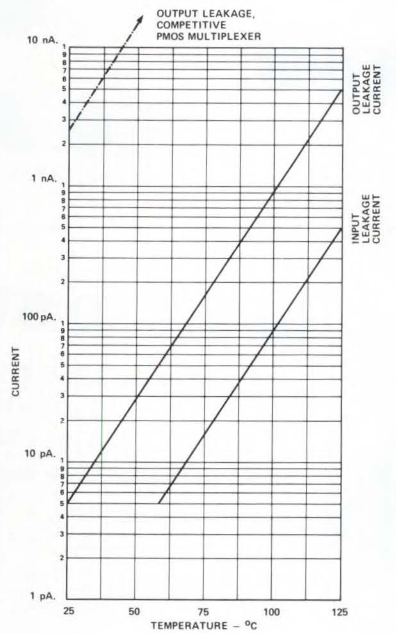
BLOCK DIAGRAM HI-1818

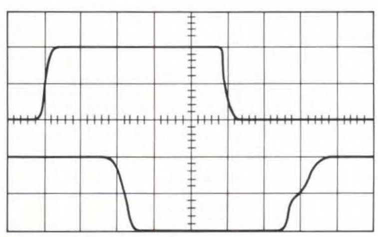


OFF leakage current



TYPICAL LEAKAGE CURRENT VS. TEMPERATURE

Access time



UPPER TRACE: A_0 INPUT; 2V/DIV.
LOWER TRACE: OUTPUT; 5V/DIV.
HORIZONTAL SCALE: 100 NANOSECONDS/DIV.

ON resistance

A new feature of these devices is that the analog switching element consists of an n-channel and a p-channel MOS in parallel. As a result of this arrangement, a level of almost constant resistance is maintained despite constant variations in the analog voltages.

OFF leakage current

This figure shows typical input and output leakage currents versus temperature. In comparison with conventional P/MOS multiplexers, the HI-1818 has three orders of magnitude lower leakage currents at high temperature.

Access time

Typical waveforms for the digital input and analog output are shown here. Access time is about 250 ns, or four times faster than conventional P/MOS multiplexers.

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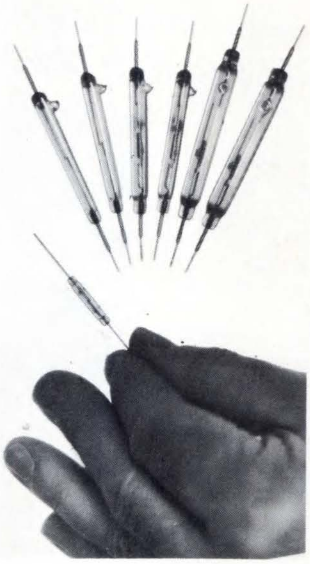

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Dial Any Angle to 0.088° Accuracy

DC outputs of this generator are proportional to sine and cosine functions of any angle set by panel switches. A range of 0 to 360° is provided in steps of 0.088°.

RICHARD W. WILKENS, Electronic Communications, Inc., Subsidiary of NCR

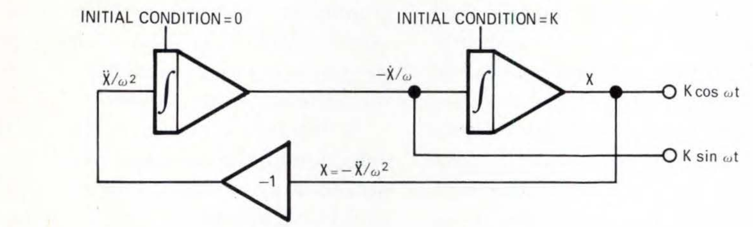


Fig. 1—**Analog elements** solve the differential equation $\ddot{x} + \omega^2 x = 0$.

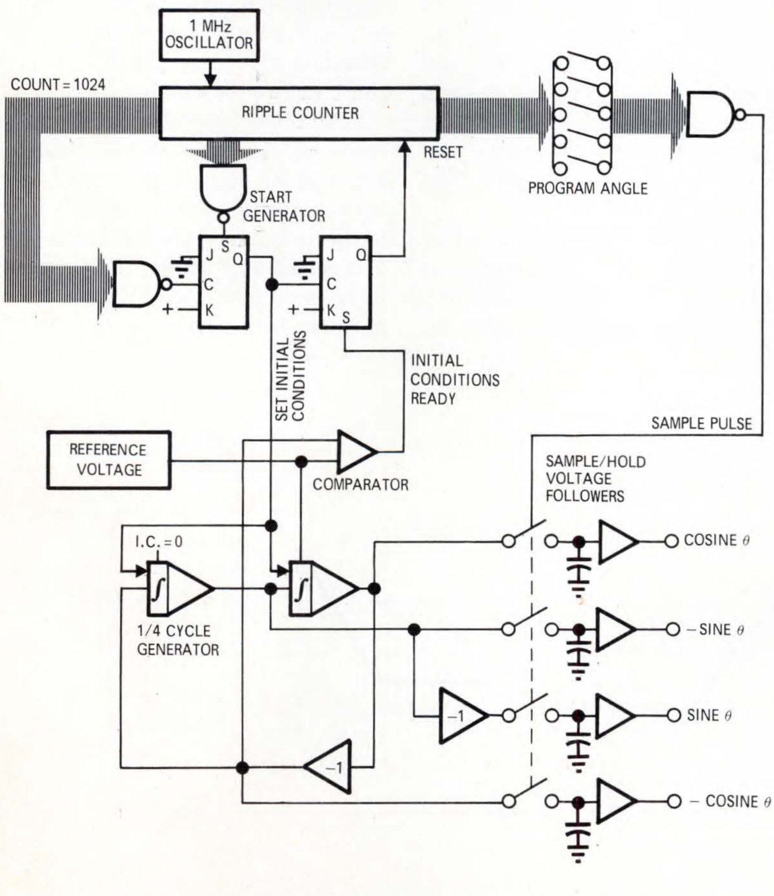


Fig. 2—**Control loop** repetitively generates one-fourth of a cycle.

A practical circuit for generating two voltages to represent any angle from 0 to 360° in 0.088° increments utilizes low-cost ICs. The outputs are dc with one voltage equal to $K\sin\theta$ and the second equal to $K\cos\theta$. K is the value of an input voltage derived from a calibrated source or generated internally.

This technique has been used in a resolver simulator designed to test resolver-to-digital converters. Since the converter was designed to sample the peak voltages of the two outputs of a resolver, dc voltage inputs were a satisfactory substitute for the resolver signals.

The system provides long-term stability and requires a minimum of alignment.

Generating the Angle

Fig. 1 illustrates a configuration of analog computing elements that solves the differential equation:

$$\ddot{x} + \omega^2 x = 0$$

where

$$x = K\cos\omega t$$
$$\dot{x} = K\sin\omega t$$

K is the amplitude of the initial conditions at $t = 0$. This equation is recognized as the function equation for the damped or undamped spring:

$$\ddot{x} + 2d\omega\dot{x} + \omega^2 x = f(t)$$

where the damping term d equals zero.

However, as anyone who has attempted to generate this solution knows, the damping term can never truly be zero. The circuit output usually either decays to zero or builds up until the amplifiers saturate. Adjusting the loop to perfection is impossible. Without perfection, the outputs are never true sine or cosine waves because of the changing amplitude.

(Continued)

Using these outputs as true sine or cosine waves, involves a consideration of just how much imperfection one can tolerate. For example, if the system is permitted to oscillate for one cycle, the amplitude variation of similar angles in the four quadrants is a direct function of the damping factor. With careful adjustment, these errors could be tolerated if the first cycle was made to repeat by instantaneously resetting the system to the initial conditions at the end of the first cycle and before the start of the second.

Now, if we reset the system to overcome the damping factor, then it becomes advantageous to reset it at one-fourth of a cycle (the end of the first quadrant) and simply switch the output polarities to simulate the remaining three quadrants. Errors are less significant now because it is the deviation from the normal waveform in the first quadrant only that we must be concerned about, and similar angles (45°, 135°, etc.) look alike.

Fig. 2 illustrates a control loop to generate repetitively one-fourth of a cycle. Here, two functions operate independently and collectively. The quarter-cycle generator tells the ripple counter that its initial conditions are set and ready, and the ripple counter tells the quarter-cycle generator that it has run for one quadrant and it is time to reset. In the meantime, the ripple counter has created time slots in which specific samples of the quarter-cycle generator may be taken to read out the sine and cosine amplitudes of discrete angles (**Fig. 3**).

Hardware Requirements

Fig. 4 is a diagram of the system. A1, A2 and A3 amplifiers make up the generator loop with A4 serving simply as a phase inverter ($G = -1$). Calculating the component values for the integrators was done as follows: First, a sample period was determined both intuitively and by experimentation using a FET switch and a voltage follower in a sample-and-hold circuit, as shown in the figure. Here, a balance between the sampling capacitor charging speed and the minimum capacitor value that could reliably be employed had to be studied. The minimum capacitor value was determined by the voltage follower leak-off input current and the gate-to-channel capacitance of the FET. The capacitor maximum was determined by the length of time an operator could wait without being inconvenienced when programming a new angle.

With 0.01 μF there was no severe voltage offset caused by the gate-to-channel capacitance of the FET, and charging took less than a second when a large change in angle (such as from plus to minus 7V) was programmed. The sampling period that resulted was 16 μsec.

This provides a time base for calculating the integrator components. A total of 1024 time slots, corresponding to 0.088° increments for each slot, comprises the 90° quadrant. Then: 1024 bits $\times$ 32 μsec/bit $\times$ 4 quadrants = 131,072 μsec period for 1 cycle. And, $\omega = 2\pi/T = 47.9367$ radians where $\omega = 1/RC$ in the equation for the integrator:

$$E(out) = -1/RC \int E(in)dt$$

$$K\cos\omega t = -1/RC\ (-1/\omega\ K\sin\omega t)$$

$$\omega = 1/RC$$

Then, if we let C = 1 μF, R = 20.84K. R will necessarily have to be adjustable to compensate for tolerances in the capacitors. The capacitors need not be selected at 1 μF, but they should at least be matched rather closely. Metallized Mylar serves well as a low-leakage capacitor to minimize the integrator errors.

A designer's choice exists in the selection of the op amps. What is required is a low input current. A 709 could be employed if a FET front-end was configured either as a source-follower or with gain. Alternatively, a quality amplifier could be used that has an input Darlington configuration. Compensation requirements are as required and the nulls should be trimmed with the amplifiers in a gain configuration of 4 or 5.

When the initial conditions are being set, A1 has a gain of essentially zero and A2 has a gain of 1. The feedback capacitor across A2 will charge to the reference voltage. This voltage is inverted by A3 and compared to the reference by the comparator. A comparator "low" indicates that the ini-

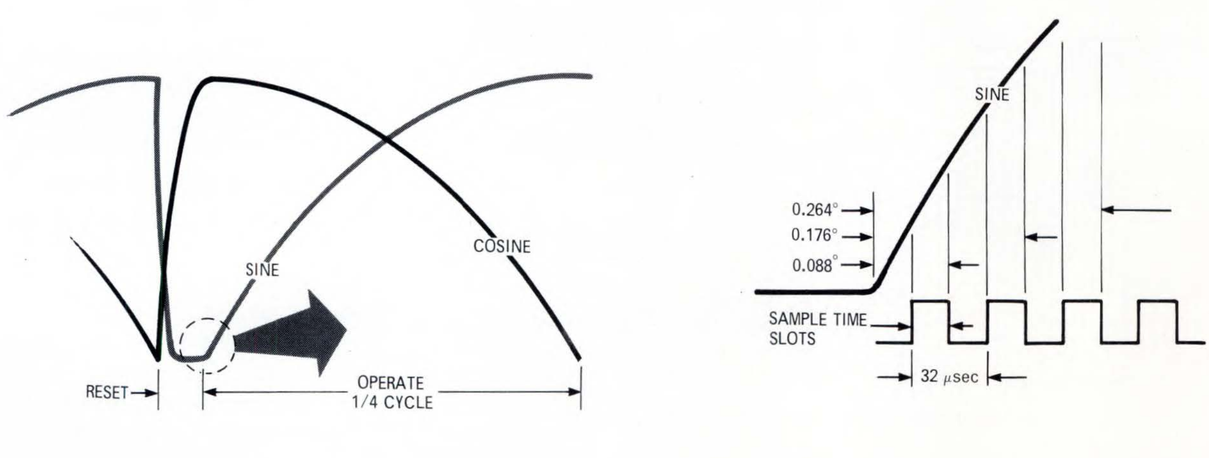


Fig. 3—**Sine and cosine** values of any selected angle is read during time slots created by the ripple counter.

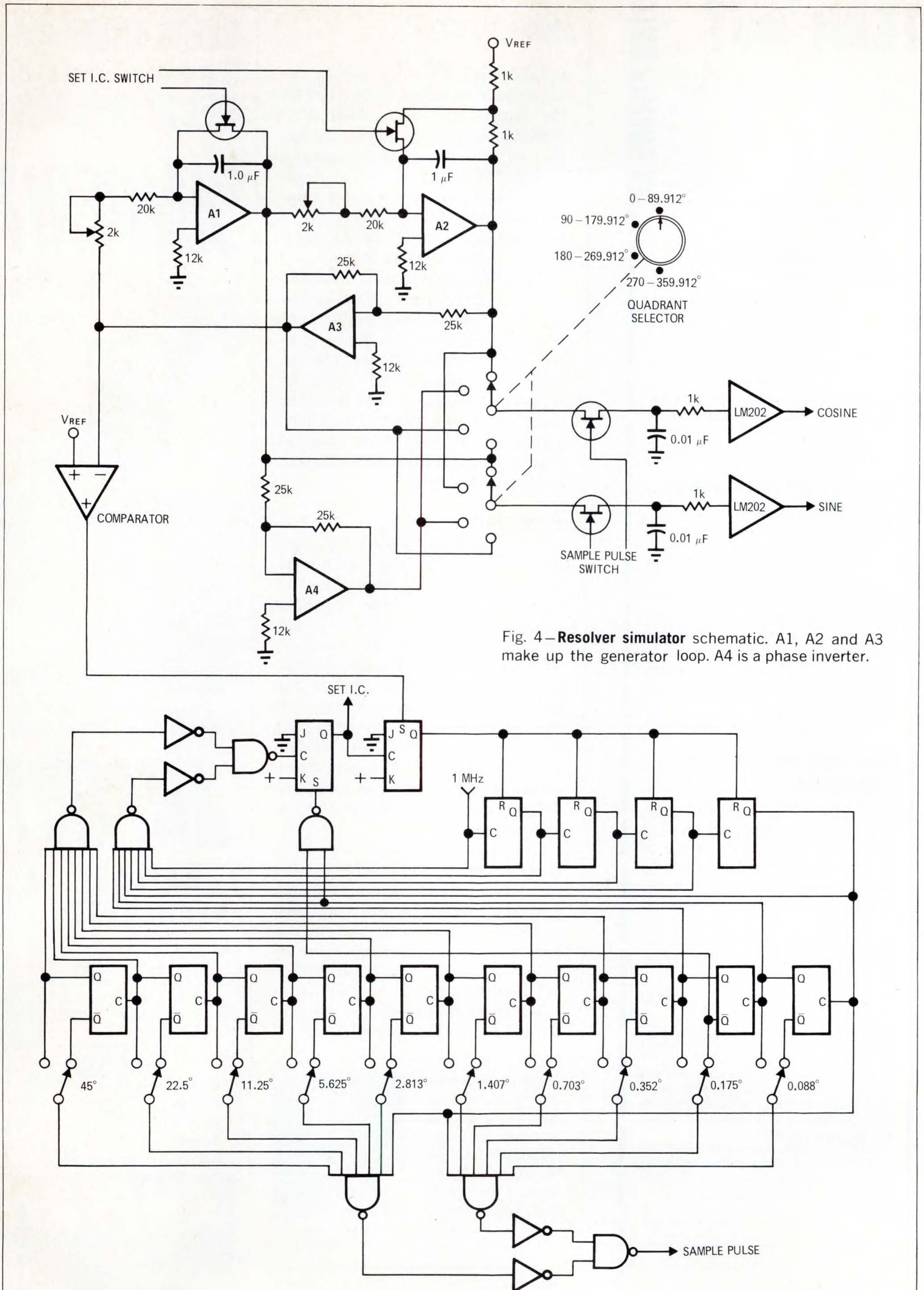


Fig. 4—**Resolver simulator** schematic. A1, A2 and A3 make up the generator loop. A4 is a phase inverter.

(Continued)

Angle (Cont'd)

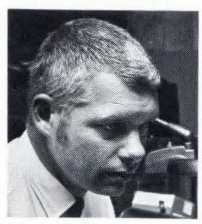
tial conditions are ready, and the ripple counter is turned loose to create the sample time slots. After 1023 sample slots are counted (one bit less than 90°), the quarter-cycle generator is made to set in the initial conditions. The sample pulse is generated by comparing the digital angle from the switches to the digital angle counted in the ripple counter.

The frequency source for the counter is a one-megacycle crystal oscillator. This provides good stability, and when divided down, the 16 μsec sample slots are quite accurate. The stability of the quarter-cycle generator is purely a function of the resistor and capacitor values. And at room temperature, the stability is excellent with a demonstrated drift of about one bit per 3 months.

Alignment

The angles of 0.088°, 45° and 89.912° (one bit less than 90°) are the three points of alignment. The two trimming resistors of the integrator inputs are adjusted to obtain the correct sample outputs. For example, with a $5\sqrt{2}$ V (7.0711) reference voltage, the sine output at 0.088° is 10.8 mV with no detectable change from the reference at the cosine output. At 45°, both the sine and cosine outputs are 5V. And at 89.912° the cosine output is 10.8 mV with no detectable difference from the reference at the sine output.

The proof in this collective pudding is in a step-by-step comparison of the programmed angle increments against a computer printout of Ksin θ and Kcos θ. And as it turned out, not one angle deviated from the norm by more than 4 mV (less than 1/2 bit). Much of this error was attributed to collective null conditions of the amplifiers and voltage followers. ☐



Richard Wilkens is a senior engineer with Electronic Communications, Inc., subsidiary of NCR, St. Petersburg, Fla. He is presently project engineer on the actuator digital interface unit and the APS digital interface unit development program for space shuttle control systems. Wilkens has been with ECI for 10 years and has a B.S.E.E. from the University of Florida.

Linear Circuit Multiplies Pulse Width

Pulse stretchers are more than just a convenient way to measure fast pulses on a scope. Stretched pulses can enhance the accuracy of many signal processing circuits by providing a "longer look" at pulse widths.

FRANK TARICO, Motorola Semiconductor Products Inc.

Many signal processing problems can be solved by pulse width multiplication techniques. In such circuits, the output pulse width represents the input pulse width multiplied by a constant factor. One application in which pulse multiplication works well is in the digitization of the signal from a digital phase detector. By increasing the total signal energy available to the A/D converter, the multiplier minimizes resolution and offset errors.

The circuit shown in **Fig. 1** provides an output pulse width equal to:

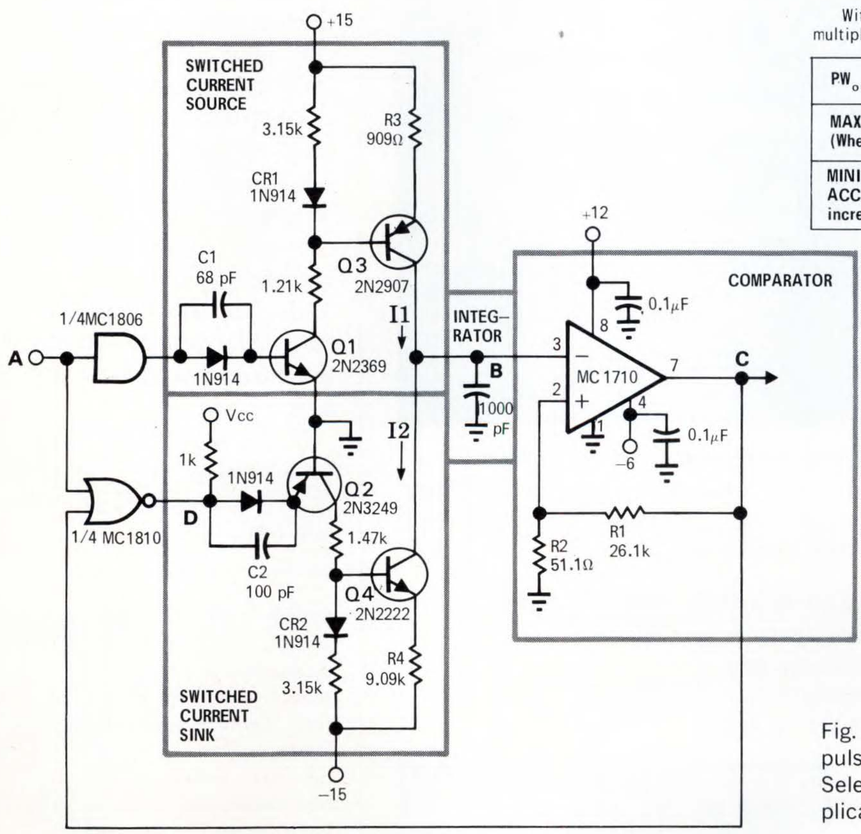
$$PW_{out} = PW_{in}\left(1 + \frac{I1}{I2}\right)$$

$$= PW_{in}\left(1 + \frac{R4}{R3}\right)$$

The circuit consists of a switched current source, a switched current sink, an integrating capacitor and a comparator. Source and sink currents are determined by the values of R3 and R4 respectively, and the pulses are TTL- or DTL-compatible.

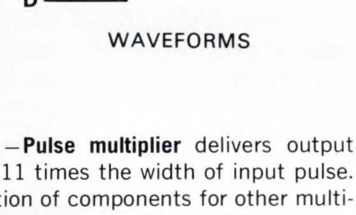
When a positive-going pulse, shown by waveform A, is applied to the input, the current source is turned on. This charges the integrating capacitor. When the input pulse

(Continued)



With the given component values the multiplier circuit performs as follows:

PW_{out} / PW_{in}	11
MAXIMUM INPUT PULSE WIDTH (Where T = pulse repetition rate)	T/11
MINIMUM INPUT PULSE WIDTH FOR 1% ACCURACY (accuracy improves with increasing pulse width)	70 nsec



WAVEFORMS

Fig. 1—**Pulse multiplier** delivers output pulse 11 times the width of input pulse. Selection of components for other multiplication factors is discussed in text.

(Continued)

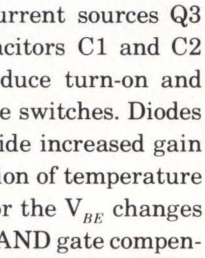
Circuit (Cont'd)

goes low, the current source is turned off and the current sink is turned on. Because the same quantity of charge must be supplied to—and withdrawn from—the capacitor, the ratio of charge to discharge time equals the ratio of sink to source current. When the capacitor is discharged to the level that trips the comparator, the current sink is shut off and the circuit is ready to accept another input pulse.

Resistors R1 and R2 are used to provide positive feedback in the comparator to enhance switching speed and to reduce the width of the transition region. For the values shown, this introduces a hysteresis of about 10 mV. It is necessary to choose the value of I1 and the size of the integrating capacitor so that the capacitor will charge to a minimum voltage that is much greater than the hysteresis voltage.

Transistors Q1 and Q2 act as switches for the current sources Q3 and Q4 while capacitors C1 and C2 are provided to reduce turn-on and turn-off times of the switches. Diodes CR1 and CR2 provide increased gain stability as a function of temperature by compensating for the V_{BE} changes in Q3 and Q4. The AND gate compensates for the propagation delay in the NOR gate. This insures that the current sink is switched on by the trailing edge of the input pulse. If the AND gate was omitted there would be a delay of about 30 nsec between the current source turn-off and the sink turn-on.

If the output pulse must be of the same polarity as the input, an inverter may be added to provide a $\overline{C}$ output. □



Frank Tarico is a project engineer in measurement systems design at Motorola Semiconductor Products Div., Phoenix, Ariz., where he has been employed for 10 years.

He received a B.S.E.E. from Purdue University, holds one patent with another pending and is an IEEE member.

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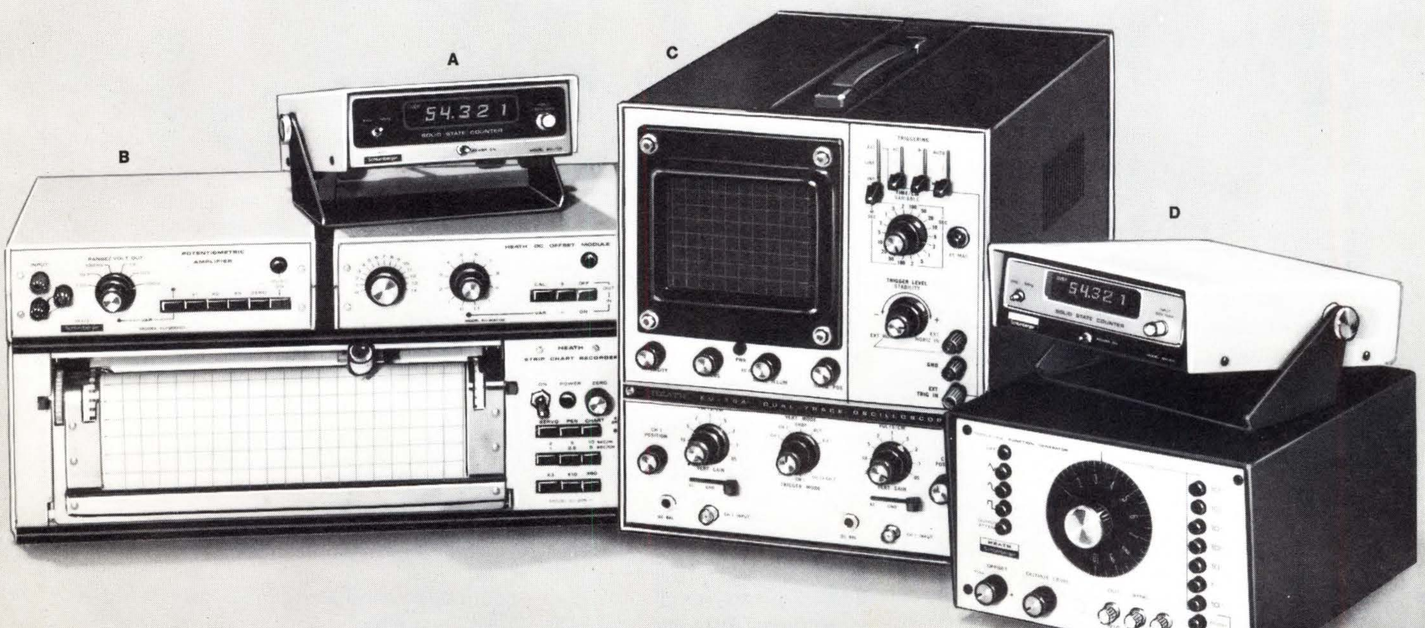

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Readers have voted Russell Kincaid winner of the August 15 Savings Bond Award. His winning circuit was called "Squaring circuit makes efficient frequency doubler". Mr. Kincaid is with Sanders Associates, Nashua, N. H.

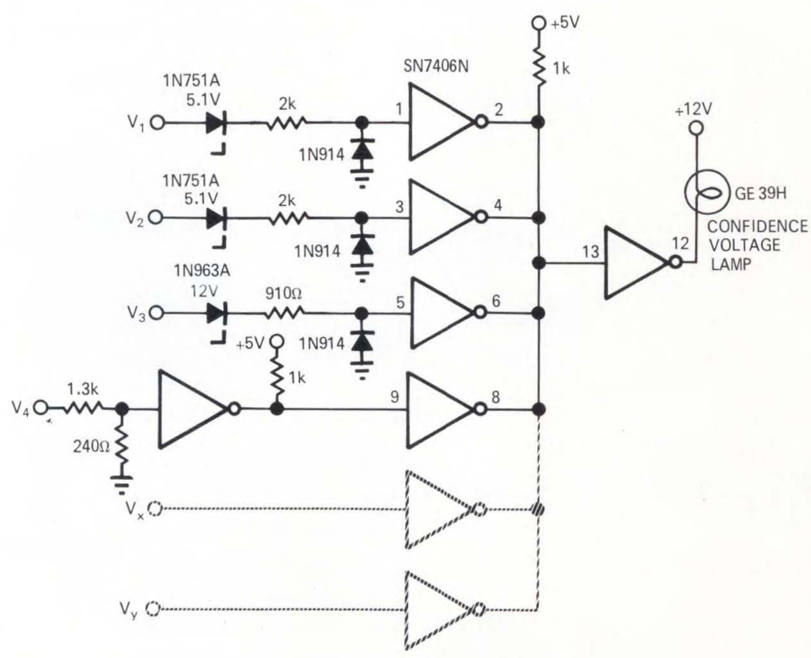
Under-voltage sensing circuit

To Vote For This Circuit
Circle 151

by Richard J. Buonocore
Dynell Electronics
Melville, N.Y.

Using a hex inverter IC, it is possible to build a circuit that monitors levels of several different input voltages. The basic circuit technique is quite flexible and can easily be modified for different input voltages (either positive or negative) and expanded to accept additional inputs. Circuit operation is as follows:

First consider what happens with a negative input voltage. Whenever one of these input levels falls below the breakdown voltage of the associated series zener diode, a high impedance is presented to the input of the respective inverter. This means that a logic 0 appears at the inverter's



Simple indicator circuit provides a continuous confidence indication provided none of the input voltages falls below a predetermined level. Circuit can be easily expanded to accept additional inputs.

output (i.e. at the WIRED-OR connection). Because the lamp-driving output inverter has a logic 0 at its input, it no longer sinks current from the lamp and hence the lamp is extinguished, thus providing a "no-go" signal. (Note that the circuit is "fail safe" in the event of a lamp failure.)

If a positive input voltage (for example, V_4 on the schematic) falls below a predetermined value set by the associated resistive voltage divider, a logic 0 will again be presented to the output converter, causing a "no-go" signal as in the first example.

Thus, by suitable modifications to the input circuits, it can be arranged that the lamp will be extinguished whenever one (or more) of the inputs is below a specified critical level. With the components specified, and without special trimming, an accuracy of ±30% or better can be expected. Refinements could be incorporated to improve this figure.

The SN7406N is an open-collector hex inverter capable of sinking 40 mA. This device can handle standoff voltages up to 30V. ▭

OPERATING LEVELS

INPUT	NOMINAL VOLTAGE	CONFIDENCE–VOLTAGE LAMP: TURNS OFF AT:	TURNS ON AT:
V_1	-5V	-4.8V	-4.9V
V_2	-5V	-4.3V	-4.4V
V_3	-12V	-11.3V	-11.5V
V_4	+8V	+6.6V	+6.7V
V_X	OPTIONAL ADDED INPUT		
V_Y	OPTIONAL ADDED INPUT		

Variable delay blanking-pulse generator

To Vote For This Circuit
Circle 152

by Donald E. Norris
SCI Electronics
Huntsville, Ala.

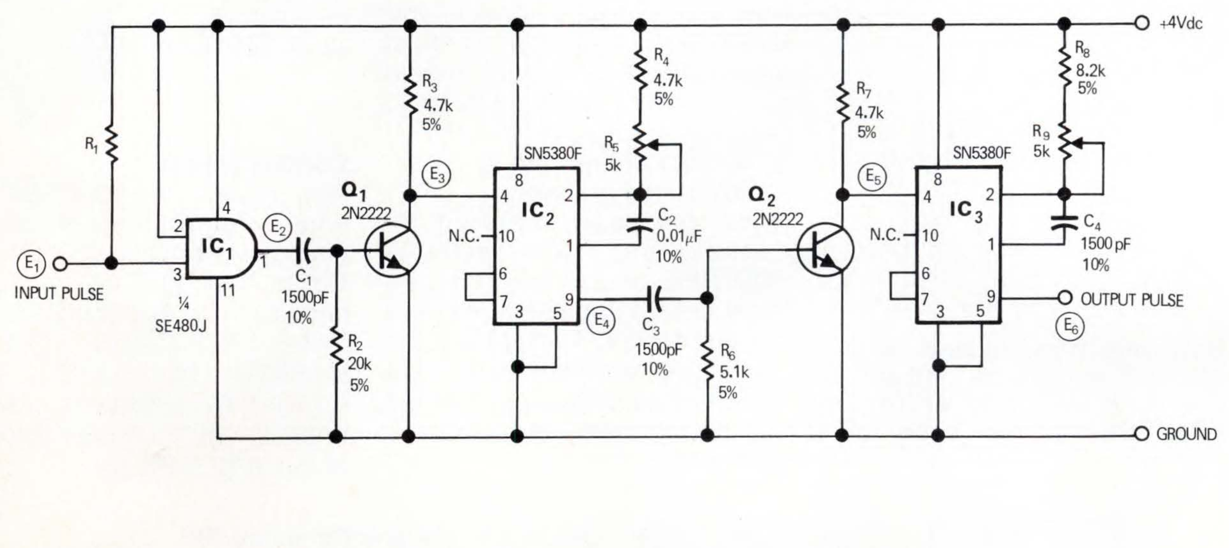
This circuit produces a variable width blanking pulse at the end of a selectable delay time after being initially triggered by an input pulse.

With the component values shown in the schematic, the circuit can produce output pulses having widths ranging from 8 μsec to 12 μsec. The delay period is adjustable from 26 to 36 μsec.

The circuit can easily be modified to provide different ranges of output pulse width and delay. Components C_2 and R_4 control delay time while C_4 and R_8 control the width of the blanking pulse.

When a logic 0 is applied at E_1, output E_2 from the input gate goes to logic 1. This turns on Q_1 and triggers the first "one-shot," IC_2, which generates a delayed pulse at point E_4. The trailing edge of the pulse from IC_2 then triggers Q_2 which, in turn, triggers the output "one-shot," IC_3.

The first "one-shot" controls delay time, and R_5 allows fine adjustment of delay. The second "one-shot" controls the width of the output pulse, and R_9 allows continuous adjustment of pulse width. ▭



Pulse-generator circuit allows independent adjustment of pulse delay and pulse width using controls R_5 and R_9, respectively.

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How unique and original is your idea? Does it perform a much needed function? Is it a source of fun! Will other designers get a real charge out of it?

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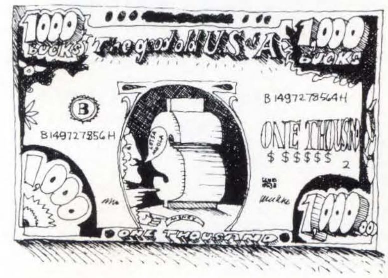
Have you really studied the January 1st 1972 issue of EDN/EEE. Have you imaginatively used components throughout the design? Include a list of advertised products with your entry—or just tear out the ads describing them and staple to your entry.

Here are the prizes



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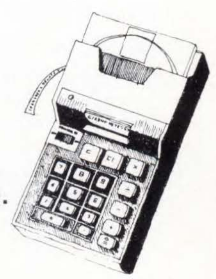
$1,000 cash money



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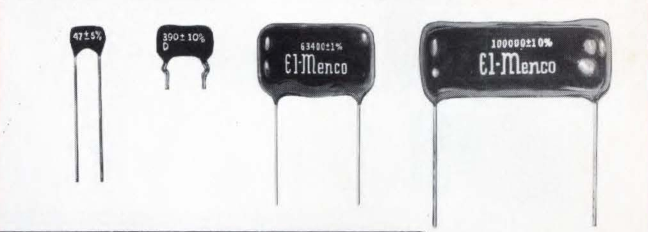
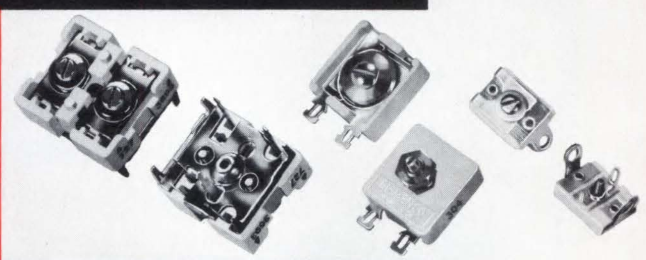
- Exceed all electrical requirements of military specification MIL-C-5A.



EL-MENCO TRIMMERS & PADDERS

Design Versatility!

- Available in 350 VDC and 500 VDC as well as other test voltages.
- All bases are of low-loss steatite.
- Special lugs are obtainable for printed circuitry.
- Miniature units are available.
- Solder Lugs can be bent in any position without affecting the capacity setting due to the rigid construction.
- Various types of mounting brackets are available for all trimmers.
- Units can be constructed for special applications.

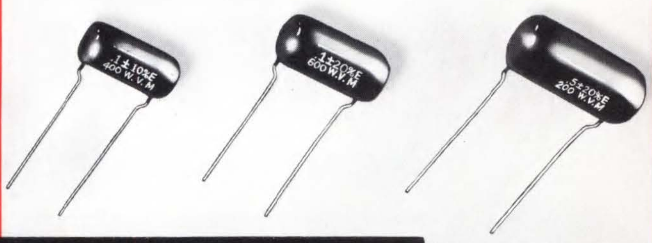


EL-MENCO *MYLAR-PAPER DIPPED CAPACITORS

Only 1 Failure in 7,168,000 Unit-Hours!

- Life tests at 100°C with rated voltage applied have yielding only 1 FAILURE PER 716,800 UNIT-HOURS for 1 MFD. Since the number of unit-hours of these capacitors is inversely proportional to the capacitance, 0.1 MFD Mylar-Paper Dipped capacitors will yield only 1 FAILURE PER 7,168,000 UNIT-HOURS!
- Working volts DC: 200, 400, 600, 1000 and 1600.
- Durez phenolic resin impregnated.
- Tolerances: ± 10% and ±20% (closer tolerances available).
- Dielectric strength: 2 or 2½ times rated voltage, depending upon working voltage.
- Exceed all electrical requirements of E.I.A. specification RS-164 and military specifications MIL-C-91A and MIL-C-25A.

*Registered Trademark of DuPont Co.

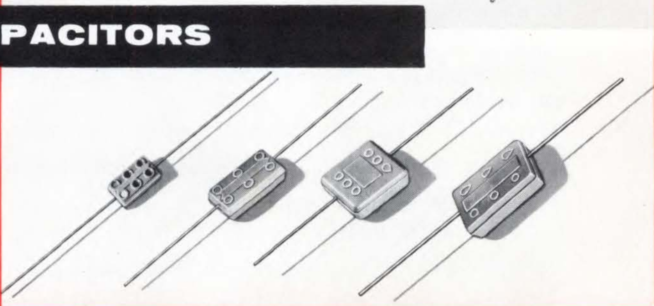


EL-MENCO MOLDED MICA CAPACITORS

Superior Performance!

- Unmatched for excellent stability, dielectric strength, high insulation resistance, extremely high "Q" and correspondingly low power factor.
- Units can be subjected to a short "debugging" life test at elevated voltage and temperature for removal of early life failures and for improved reliability.

Write for Free Samples and Booklets on Any of The Above Capacitors



THE ELECTRO MOTIVE MFG. CO., INC.

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Dipped Mica • Molded Mica • Silvered Mica Films • Mica Trimmers & Padders
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West Coast Manufacturers contact: **COLLINS & HYDE CO.,** 900 N. San Antonio Rd., Los Altos, California 94022
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CIRCLE NO. 30

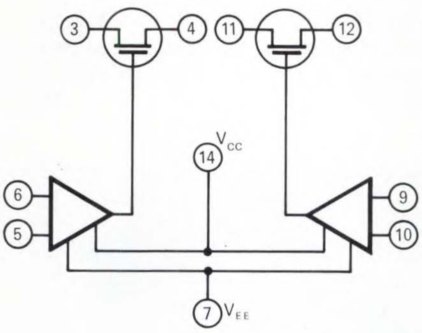
Progress in Products

FET Analog Gate Switches AC

PROGRESS IN CIRCUITS

FET analog gates themselves are not new to the industry and are available from many sources. What makes this one different from the rest of the pack, including Teledyne Crystalonics' own CAG13, is that it can switch ac signals as well as dc. Not only that, you have to pay only half the previous price, thanks to the use of a dual monolithic driver. The FETs have a low ON resistance (50 Ω max), and the new CAG45 can switch ±10V at currents up to 10 mA.

The CAG45 is made up of two separate analog switch circuits that can operate separately as dual spst switches or as one spdt switch. The latter is possible because turn-off time (0.5 μs max) is faster than turn-on time (1.0 μs max). This "break-before-make" switching also makes the CAG45 ideal for multiplexing applications because it prevents cross-talk. In addition, when the FETs are off, their gates are ac-grounded, thereby lowering the high frequency feedthrough (≈30 MHz) by at least 10 dB over conventional analog gates.

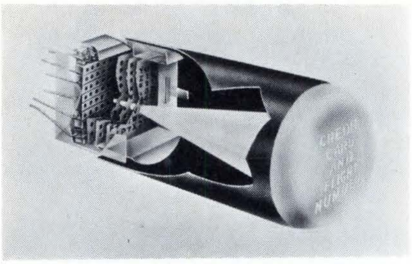


Separate logic grounds allow more than ±10V noise immunity with respect to signal or supply grounds, thus if any noise is picked up, the input amplifiers will float on it. This ground isolation from the supply means that the logic input can go as high as +15V while logic ground can be as low as V_{EE} plus 1V. Toggling is strictly a function of the voltage difference between logic input and logic ground terminals.

This input circuit arrangement also allows the dual gates to operate directly from bipolar or MOS logic, and to switch outputs ON from either logic '0' or '1' as shown in the table.

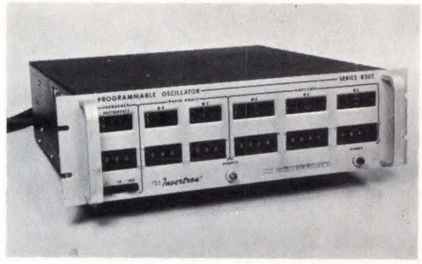
Teledyne Crystalonics, 147 Sherman St., Cambridge, MA 02140 **150**

FUNCTION	PIN CONNECTIONS
Indep. SPST - (+) logic - ON fm logic '0'	6/9 = logic input ('0' - ON, '1' - OFF) 5/10 = ground
Indep. SPST - (+) logic - ON fm logic '1'	6/9 = logic supply (+3V) 5/10 = logic input ('1' - ON, '0' - OFF)
Indep. SPST - (-) MOS logic - ON fm logic '0'	6/9 = ground 5/10 = logic input ('0' - ON, '1' - OFF)
Indep. SPST - (-) MOS logic - ON fm logic '1'	6/9 = neg. logic supply 5/10 = logic input ('1' - ON, '0' - OFF)
SPDT - (+) logic - (connect 4/11 or 3/12 as common) ('0' ON at pins 3 & 4, '1' ON at pins 11 & 12)	6/10 = logic input 5 = ground 7 = logic supply (+3V)
SPDT - (–) MOS logic - (connect 4/11 or 3/12 as common) ('0' ON at pins 11 & 12, '1' ON at pins 3 & 4)	6/10 = logic input 5 = neg. logic supply 9 = ground

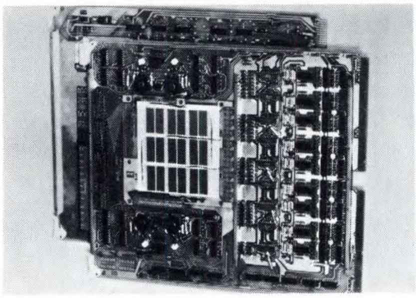


Vacuum tube readout, Series 6500, displays complete EBCDIC/ASCII code combinations on a 0.63 by 0.63 display area. Dubbed "nimo 64", the 1.5-inch CRT projects characters ranging in height from 0.125 to 0.562 inches and five line messages. Price, including tube, mounting hardware, driver/decoder and anode power supply is <$100. Industrial Electronic Engineers, Inc., 7720-40 Lemona Ave., Van Nuys, CA 91405. **151**

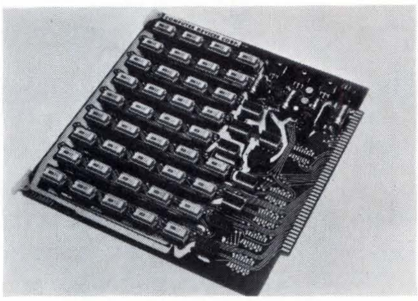
Portable TermiCette, Model 330, is plug-to-plug compatible with any RS-232 modem, terminal or similar equipment. Operational speeds are 110, 150 and 300 baud. It is compatible with either half- or full-duplex systems and performs unlimited back and forward spacing. The 7- by 17- by 10.5-inch unit weighs 18 ozs. Prices start at $1650. International Computer Products, Inc., Box 34484, Dallas, TX 75234. **154**



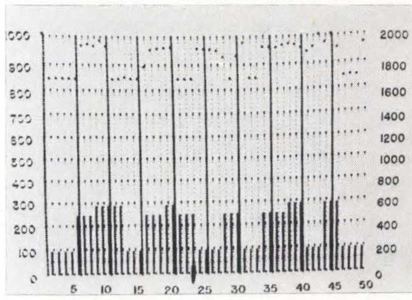
Programmable oscillator 830T generates up to six functions: system frequency, phase B angle, phase C angle and three independent amplitudes may be simultaneously or individually programmed. Control is by 1248 BCD logic levels or optional front-panel switches. Front panel readouts are available to indicate the BCD function value. Base price is $750. California Instruments, 5150 Convoy St., San Diego, CA 92111. **157**



Magnetic core memory system CB-65 uses 18-mil cores in a 3-wire, 3D organization to attain 650 nsec cycle time. A continuously strung planar stack fits 4096, 18-bit words on to a 3.5- by 4-inch frame. All sense and drive circuits are on the same board. The system is expandable in 4k increments to 65k words. Lockheed Electronics Co., Inc., Data Products Div., 6201 E. Randolph St., Los Angeles, CA 90040. **152**

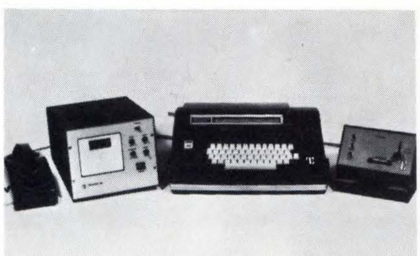


Random access memory, RAMS 4001-4, offers arrays from 256 words of 1-bit to 1024 words of 10-bits. Using type 1101 chips, standard access times are 1 or 1.5 μsec in commercial or Mil Spec temperature ranges. Power regulators are on the board, permitting operation with 5 and −16V dc unregulated. Small-quantity price for a typical 256 × 6 memory is under $250. Computer Devices Corp., 63 Austin Blvd., Commack, NY 11725. **155**



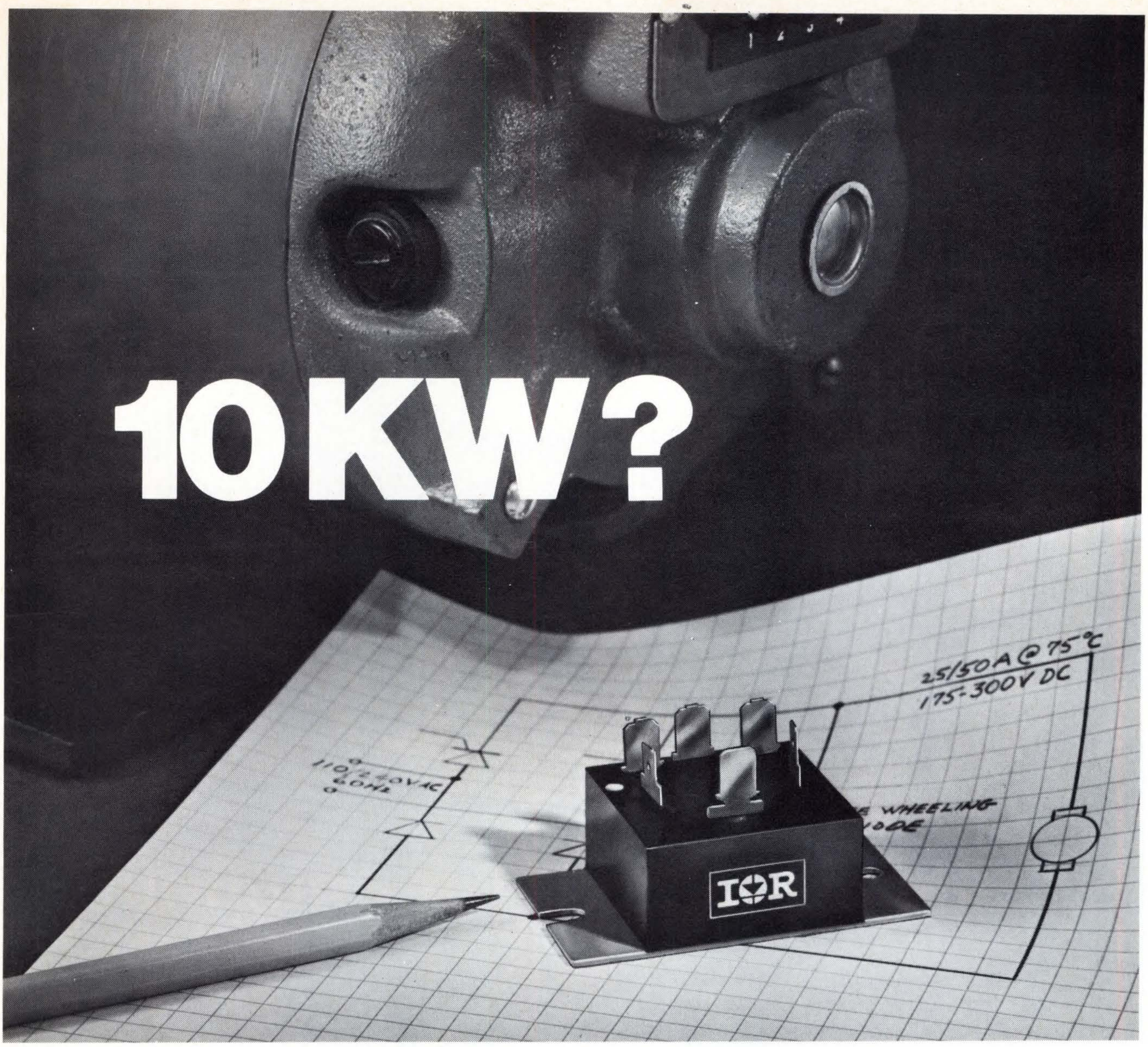
Bargraph display, Metrascope MS20D-M, receives digital numerical data in bit-parallel or bit-serial form, stores it in memory and displays it on a 20-inch CRT. Up to 80 channels may be displayed against an electronically-generated, no-parallax grid. External data rate should be <2000 words/sec and the maximum capability is 16-bits/word, 80 words/frame. Metra Instruments, Inc., 1340 Space Park Way, Mountain View, CA 94040. **158**

Solid-state motor control Model 2017A provides power to a teleprinter as long as data are being received. If data are not received for a period of time (adjustable from 30 sec to 10 min), the unit automatically turns off the power to the teleprinter. When new data arrives, power is instantly switched on. Consequently, equipment life increases. Single unit price is $54. Logic Systems Corp., 1567 Cypress Dr., Jupiter, FL 33458. **153**



Magnetic-tape cassette terminal CT-300 Series (four standard models), enables the user to tailor his data entry equipment to his needs. Orginate models transmit 11-bit ASCII at 10 cps, with transmission characteristics similar to an ASR 33 Teletype. Polled versions transmit 10, 15 or 30 cps, switch-selectable. Prices range from $1825 to $2970. Transcom Div. of Hi-G, Inc., 12 Tobey Rd., Bloomfield, CT 06002. **156**

Calculator, Wang 600, offers 16 registers and 312 program steps for $2600. Memory may be increased by as many as three increments of 512-byte RAM at $300/ increment. A full system will have 1848 steps or 247 registers. Available options include a Cassette Program peripheral that enables the user to overlap program blocks and extend the capacity to 16,000 steps. Wang Laboratories, Inc., 836 N. St., Tewksbury, MA 01876. **159**



Handle just that, or more, with IR's new PACE/pak™ Passivated Assembled Circuit Elements... first to operate directly from 110-to-240 VAC lines!

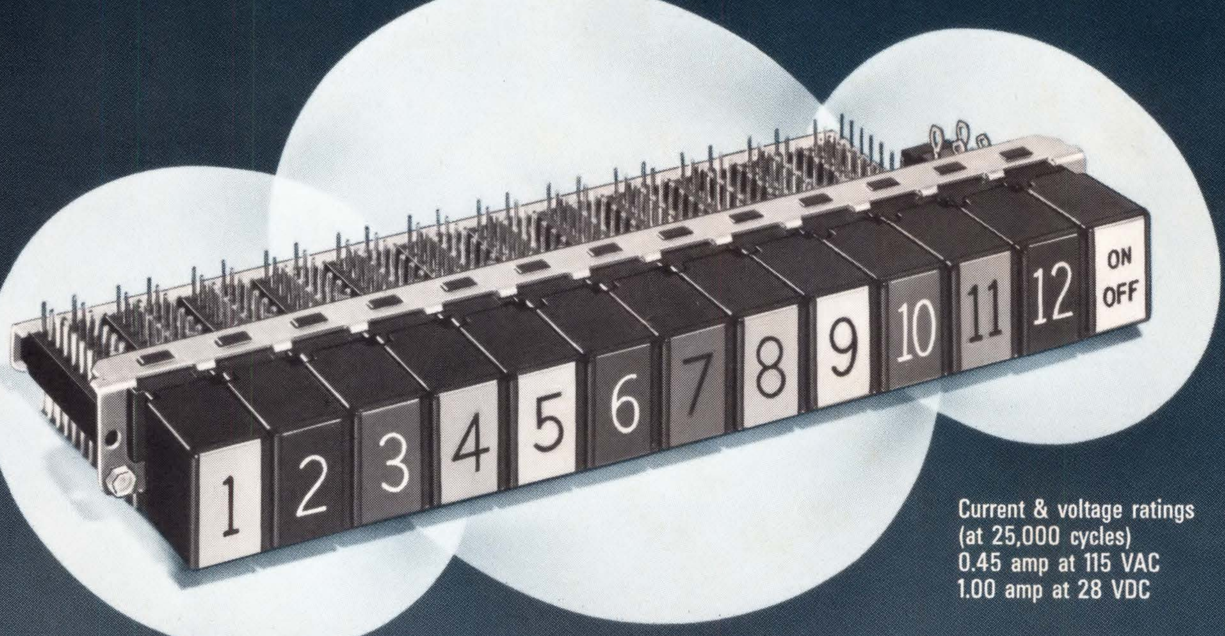
Combining long-term know-how in fabricating power semiconductor devices, with advanced passivation methods and the use of proprietary thick-film techniques, IR now introduces a unique series of solid-state encapsulated power circuits. The first such units available, PACE/paks offer a host of benefits for power applications such as: DC motor drives, solid-state circuit breakers, power supplies, generator exciters, welding controls, inverters, chopper drives and heating controls. ■ They provide a number of advantages over conventional power circuits. For example, the savings in assembly and heat-sink costs alone can amount to 50% or more, not to mention as much as a 7-to-1 reduction in piece-part inventories! And, as fewer interconnections are required, their reliability is greatly extended. In addition, their high thermal efficiencies, electrical isolation and compact, convenient packaging make them ideal for any power design requirement where peak-power-performance, low cost, small size and high reliability are prime requisites. ■ They operate directly from 110-130 or 210-240 VAC and can easily handle current loads in the 50-100 Amp range. IR anticipates fabricating PACE/paks with outputs of up to 800 Amps for 440 Volt line application, in single or three-phase configurations. ■ Contact your local IR representative or write to us now . . . and find out how to optimize your own power equipment!

INTERNATIONAL RECTIFIER IOR

Semiconductor Division, 233 Kansas Street, El Segundo, California 90245, Phone (213) 678-6281

CIRCLE NO. 31

Centralab push button switches brighten your design...



...for as low as $1[25] per module

When it comes to economy and performance the spotlight is on Centralab. Our push button switches* (lighted or plain), which provide convenience and efficiency through modular design, are a bright example. In the first place, it's worth repeating that you can buy Centralab domestically manufactured lighted push button switches for as low as $1.25 per module in production quantities. Plain modules are as low as 21 cents each. What's more, with our new RSD (Rapid Switch Delivery) program, we can deliver in four weeks, sooner in emergencies. On prototype orders, we'll deliver in two weeks.

Then there's the plain module itself, which contains only four parts to give longer, more reliable life. Two, four, six or eight pole, double-throw designs are available for printed circuit or panel mounting. As many as 29 modules can be ganged on a common mounting bracket in the PB-10 Series, 15 modules in PB-15 and PB-20 Series. And standard functions include momentary, interlocking, push-push and push pull.

In lighted modules, interchangeable lenses and filters provide maximum color utility and aesthetic appeal. Front bulb replacement is another convenience feature.

For consumer and industrial applications, Centralab push button switches are lighting the way to new economy, performance and efficiency. For complete specifications, write Switch Sales Manager, Centralab Electronics Division, Globe-Union Inc.

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Electronics Division
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MILWAUKEE, WISCONSIN 53201

M-7102

CIRCLE NO. 32

Computer Products

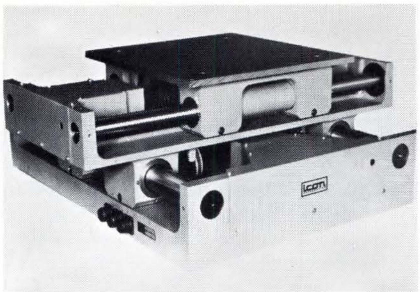
Mark sense option grants every model of card reader the ability to read all 80-column cards whether the data is punched, pencil marked or an inter-mixed combination of both. This feature is available as an option for the OM 200 (300 cpm), OM 600C (600 cpm), OM 1000C (1000 cpm) and the OM 1200 (1200 cpm). Delivery time is 60 days from the date of request. Documation Inc., 841 E. New Haven Ave., Melbourne, FL 32901. **160**

A 120-element phototransistor array TIL137 measures 1.3 by 0.9 inches and is arranged as 10 rows on 0.063-inch centers by 12 columns on 0.087-inch centers. It can be connected as a 5 × 24 or a 10 × 12 matrix. Price in 1000 piece quantities is $120 each. Texas Instruments Incorporated, Box 5012, Dallas, TX 75222. **161**

Trillion-bit laser mass memory UNICON 690 occupies only 60 square ft of floor space and has an average access time of approximately 150 msec. The laser vaporizes or burns minute holes in a metallic surface on a recording strip called "Data Strip". Each strip, approximately 31 inches long and 5 inches wide, is capable of recording and storing over 11,000 tracks of information at the rate of 6k bps. An on-line file consists of 450 strips. Precision Instrument Co., 3170 Porter Dr., Palo Alto, CA 94304. **162**

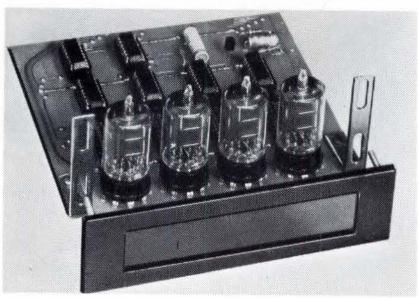
Teleprinter called TotalTerm prints asynchronously up to 30 cps on edge-sprocketed multi-part forms and is fully adjustable to 132 columns. Unit incorporates an unusual incremental printing mechanism, solid-state circuitry and controls. Applications include time-sharing, information retrieval, point-to-point data exchange and repetitive printing of documentation. Syner-Data, 133 Brimbal Ave., Beverly, MA 01915. **163**

Fast Fourier Transform Processor MOD 2030, operates with computers such as IBM, Varian, Univac, DEC and others. Unit performs both fourier transform or inverse fourier transform on arrays stored in user's computer and it operates internally using 20-bits with a 16- or 18-bit direct memory access channel. Arrays up to 32,768 complex variables may be processed. The processor permits real-time analysis to 50 kHz (up to 25 MHz with input buffer). UniComp, Inc., 18219 Parthenia St., Northridge, CA 91324. **164**

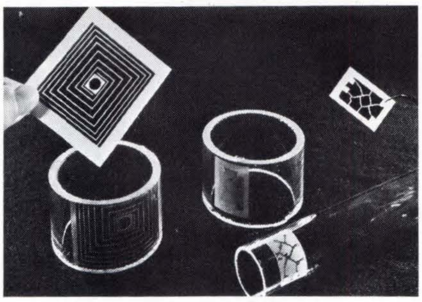


X-Y positioning table has 15 by 20-inch travel. The Model XYD-1520 is driven by high-speed step-motors at speeds up to 360 inches/min with an accuracy of ±0.001 inch over full travel. The table is designed for use with numerical controllers or control by real-time computer. Icon Corp., 156 Sixth St., Cambridge, MA 02142. **165**

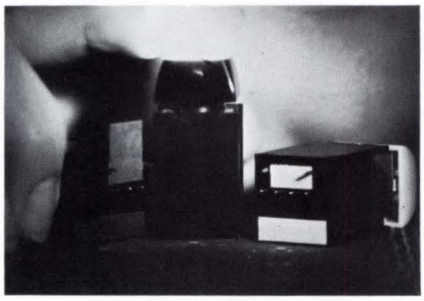
Digital-panel-meter counters feature five-digit displays, BCD output, remote programming and integral power supplies. Model CPM-603 ($295) displays frequency and will totalize. TPM-600 ($250) totalizes only. CPM-601 ($595) displays normalized frequency rates. CPM-600 ($425) measures frequency, period, ratio and totalizes. Delivery 4 weeks ARO. Anadex Instruments Inc., 7833 Haskell Ave., Van Nuys, CA 91406. **166**



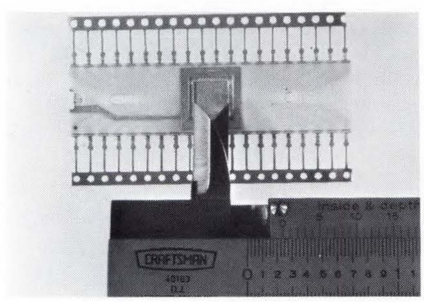
Seven-segment display module, TR-510, incorporates variable intensity, memory and high frequency anti-blur circuits. Operating from a 5V source, the modules are available with 3 to 6 digits complete with TTL-compatible latches, driver/decoders, decimal points at each position and optional front mounting assembly with bezel and colored filter. Tronix, Inc., Box 349, Phillipsburg, N J 08865. **167**



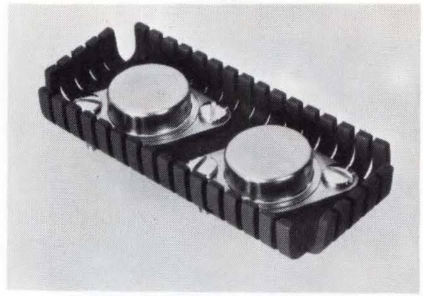
Thick-film circuits and patterns can now be deposited on inside surfaces of various substrates such as ceramic, glass and metal. This newly developed method permits custom deposition of circuits up to 4 inches long. The patterns are deposited to precision tolerances with lines and spacings as small as 3 mils. Vitta Corp., Wilton, CT 06897. **168**



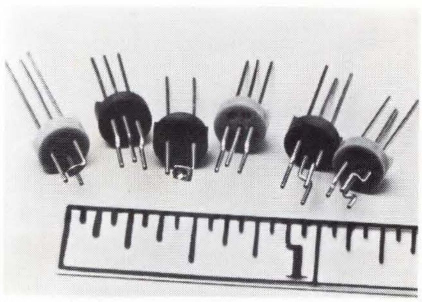
Lighted, solid-state pushbutton switches, Type 201SN, exhibit a maximum output risetime of 1.5 μsec. The Hall-effect device requires a supply voltage of 5V dc and draws 15 mA at standby. Switching capability is 2.8V dc at 10 mA to each of two isolated outputs. Adhesive tapes affixed to the base assist in positioning the switch during assembly. Honeywell, Micro Switch Div., 11 W. Spring St., Freeport, IL 61032. **169**



Composite MOS packages provide a wide cavity to accept larger chips. Both 28- and 40-lead A1SiPak packages are available with 0.240 inch^2 cavities. Cavities are 0.040 inch deep with a 0.050-inch-wide gold-plated seal ring, identical to the standard packages. Substrate material is A1SiMag No. 771, a 94% pure aluminum oxide. American Lava Corp., Chattanooga, TN 37405. **170**



Compact heat dissipator for TO-3 pairs permits operation at twice rated power with no increase in case temperature rise. The dissipator, Model UP10-TO3-2U, measures 3-3/8 by 1-13/32 by 7/16 inches. Price starts at $0.25 each for unplated versions in OEM quantities. International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, CA 91504. **171**



Plastic platform headers with twisted or formed leads meet many special production requirements. Available in a wide variety of shapes, with lead wires of copper, Dumet, steel or nickel and with gold, silver or nickel plate. Headers accommodate special circuitry and are compatible with automatic-assembly equipment. General Electric Co., Lamp Metals & Components Dept., 21800 Tungsten Rd., Cleveland, OH 44117. **172**

Microsoldering system (PDS II) provides precise control of solder, flux, rise time, temperature and total heat output for soldering miniature components. The system utilizes interchangeable microtips, and provides manual or automatic timing of the heating-pulse length. This pulse may be varied from 0.10 sec to 10.0 secs. Circon Corp., Santa Barbara Airport, Goleta, CA 93017. **173**

Take the price you'd normally pay to measure one nanosecond and 550 MHz.

Now divide by two.

Now for less than half the price of alternative solutions you can measure frequencies up to 550 MHz and time intervals from 0.15 nanoseconds to 10^9 seconds. You get the best resolution too, <50 picoseconds. Only HP's unique type of time interval averaging permits these measurements with such economy.

And you get all the other functions you expect in universal timer/counters. Features such as totalizing, period, ratio and conventional time interval measurements. They're the most programmable counters of their type as well.

This series also includes the only counters with built-in digital voltmeters. So you can set trigger levels digitally and better than an oscilloscope can for accurate time interval measurements. Use the DVM to check out dc voltages too, or add an HP 11096 probe for ac.

For more accurate measurements you can option for a high stability time base of 5 parts in 10^{10}/day. Or to measure low level signals, we can offer input sensitivities as high as 25 mV.

The HP 5327 Series is ideal for testing logic timing, cable delays, low-power circuits, and crystal oscillators—as well as calibrating frequency and pulse generators. Prices of the three models in the HP 5327 Series range from only $1495 to $2150. Or, if a 50 MHz will do your job, there's the companion 5326 Series from just $950 to $1595.

Sound too good to be true? Ask your local HP field engineer about these outstanding counter values. Or for more information, write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

02117

HEWLETT PACKARD

ELECTRONIC COUNTERS

CIRCLE NO. 34

EDN/EEE CARAVAN ROUTING

November 22 - December 13, 1971

DATE/DAY/TIME	AREA	SITE
Monday, November 22		
9:00 - 12:00 noon	Phoenix, Ariz.	Honeywell Information Systems Inc.
1:30 - 4:30 p.m.	Scottsdale, Ariz.	Motorola
Tuesday, November 23		
1:30 - 4:30 p.m.	San Diego, Calif.	Stromberg Datagraphix Inc.
Wednesday, November 24		
9:00 - 12:00 noon	La Jolla, Calif.	Control Data Corp.
1:30 - 4:30 p.m.	San Diego, Calif.	NCR
Monday, November 29		
9:00 - 12:00 noon	Concord, Calif.	Systron Donner
1:30 - 4:30 p.m.	San Leandro, Calif.	Friden
Tuesday, November 30		
9:00 - 12:00 noon	Mountain View, Calif.	Sylvania
2:00 - 4:30 p.m.	Walnut Creek, Calif.	Varian Associates
Wednesday, December 1		
9:00 - 12:30 p.m.	Santa Clara, Calif.	Memorex
1:30 - 4:30 p.m.	Santa Clara, Calif.	Hewlett-Packard
Thursday, December 2		
9:00 - 1:00 p.m.	Palo Alto, Calif.	Philco-Ford
2:00 - 4:30 p.m.	Palo Alto, Calif.	H-P Microwave Div.
Friday, December 3		
9:00 - 12:00 noon	Sunnyvale, Calif.	Singer-Link
1:30 - 4:30 p.m.	San Jose, Calif.	IBM/Systems Development
Monday, December 6		
9:00 - 12:00 noon	Westlake Village, Calif.	Burroughs Corp.
1:30 - 4:30 p.m.	Woodland Hills, Calif.	Litton Systems
Tuesday, December 7		
9:00 - 12:00 noon	Van Nuys, Calif.	Litton Data
1:30 - 4:30 p.m.	Van Nuys, Calif.	RCA.
Wednesday, December 8		
9:00 - 11:30 a.m.	Woodland Hills, Calif.	Data Products
2:00 - 4:30 p.m.	City of Industry, Calif.	Burroughs Corp.
Thursday, December 9		
9:00 - 12:00 noon	Culver City, Calif.	Hughes Aircraft
1:30 - 4:30 p.m.	Torrance, Calif.	TRW Data Systems
Friday, December 10		
9:00 - 12:00 noon	El Segundo, Calif.	Xerox Data Systems
1:30 - 4:30 p.m.	Hawthorne, Calif.	NCR
Monday, December 13		
9:00 - 12:00 noon	Anaheim, Calif.	Calif. Computer Products Inc.
1:30 - 4:30 p.m.	Anaheim, Calif.	Century Data Sys.

Components/Materials

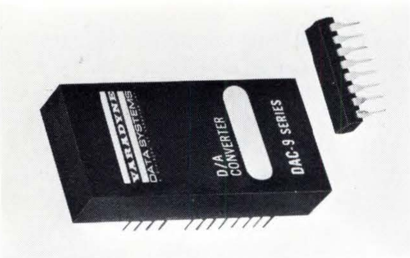
Alumina ceramic edge-mount IC packages meet MIL-STD-883. The "InCert" family consists of a 64-lead double-sided package (32 contacts per side) with chip cavity measuring 0.430 inch on each side; a 40-lead double-sided package measuring 1.0 by 0.75 inches, and a 40-lead single-sided package. The 40-lead packages have a chip cavity that measures 0.360 inch on each side. Metalized Ceramics Corp., West River Industrial Park, Providence, RI 02904. **174**

Flexible cable-like microwave TEM-line called "Wireline" can be used to fabricate hybrids, couplers and power dividers. Couplers can be constructed to any desired value. A nomograph, supplied with the material, eliminates design calculations and gives the required dimensions for the desired characteristics. Wireline is available from stock in bulk form at $12/ft, 10 ft minimum. Sage Labs., 3 Huron Dr., Natick, MA 01760. **175**

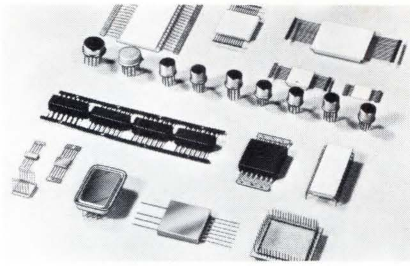
Matrix program boards with switching crosspoints on a 0.130 inch grid, the Series 1000, have horizontal and vertical contact buses and provide input/output switching by inserting shorting pins at the desired crosspoints. Matrices of 10×10 to 100×100 are available in standard or special arrangements with up to 8 levels of contacts. Price is $0.10 to $0.20 per crosspoint, and delivery is 3-5 weeks. Info-Lite Corp., 2337 Lemoine Ave., Fort Lee, N J 07024. **176**

Dry-film lubricant, Synthetic Dri-Slide, provides film strength in excess of 100,000 PSI, contains no solids and is non-staining. The clear spray cleans, penetrates, displaces moisture and inhibits rust. It requires no agitation and is applicable through most automatic systems. The lubricant is available in 8 oz aerosol cans or in bulk. Dri-Slide, Inc., Industrial Park, Fremont, MI 49412. **177**

Solder cream, Flowsolder "SSP," is a mixture of finely-powdered solder and resin-based flux formulated for screen process printing. When heated above the fusion point of the solder, the cream provides a tinned coating on solderable substrates, or a soldered joint between substrate and component leads. A wide range of tin-lead, tin-silver or tin-lead-silver alloys is available. Fry's Metals Ltd., Tandem Works, Merton Abbey, London, SW19 2PD, England. **178**

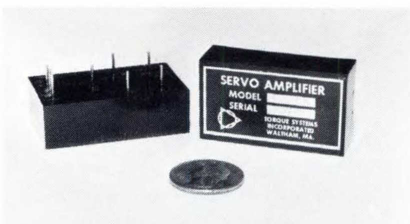


D/A converter Model DAC-9-8B has 8-bit resolution and sells for $9.95. Full-scale output is 2.6 mA with maximum voltage compliance of 1.2V. Output settling time to ±0.4% is 1 μsec. Units are compatible with standard TTL/DTL levels and pin locations are DIP-compatible. Each module contains input buffer logic, electronic switches, precision ladder network, reference circuit and output current source. Varadyne Systems, 1020 Turnpike St., Canton, MA 02021. **179**

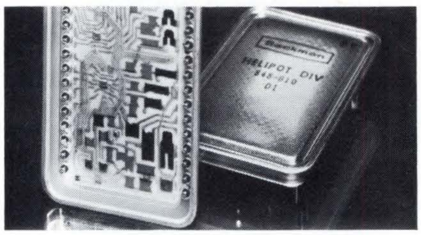


High density hybrid microcircuits with thick and thin film can be designed to meet user's requirements. Controlled-thickness tantalum nitride and nichrome network films and precision etching provide TCR tracking of ±10 to ±50 ppm/°C for thin films and ±50 to ±250 ppm/°C for thick films. Available resistor trim tolerances are ±0.01 to 2% for thin films and ±1% for thick films. Package designs include DIP, TO and flat packs. Aerovox Corp., New Bedford, MA 02741. **182**

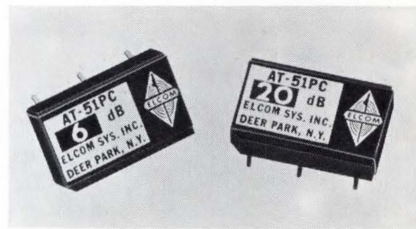
Photo-electronic control device EPX28 features both high sensitivity and great angle of opening. This unit contains a silicon photo element, and npn transistor and two silicon diodes, suitable for direct relay drive. Other characteristics include 45V collector-emitter voltage, 325 mW total power dissipation and 3.5 μsec rise time. Price is $5.77 each (100 quantity). European Electronic Products Corp., 10150 W. Jefferson Blvd., Culver City, CA 90230. **185**



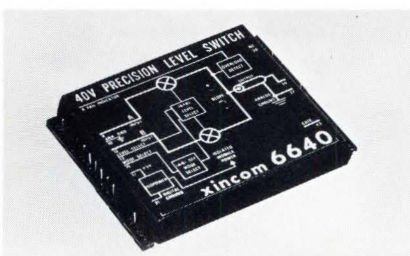
20W Class B op-amp, PA-011, comes in the standard "L" pack for PC card mounting and is designed to drive permanent-magnet dc instrument motors. Features include up to ±24V, ±1A output, 20,000 V/V minimum open loop gain and 5000 Hz full-power bandwidth. The epoxy molded package measures 1.12 by 2 by 0.6 inches and weighs <2 oz. Price for 1-9 is $49 each. Torque Systems Inc., Box 167, 225 Crescent St., Waltham, MA 02154. **180**



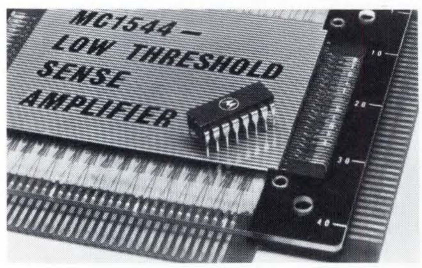
D/A converter, Model 848, features 11-bit resolution and 4V/μsec minimum slewing rate. The module contains a current summing ladder network, analog switching, a precision voltage reference, output op-amp and preset scaling and offset adjustment resistors. Four standard output voltage ranges are available. Unit meets MIL-STD-883 specifications. Helipot Div., Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, CA 92634. **183**



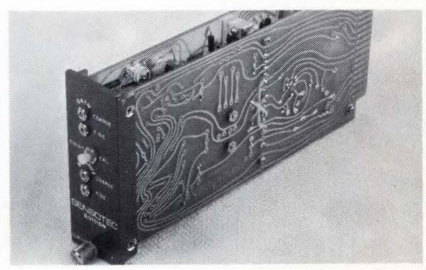
14-pin DIP attenuator occupies only 0.08 cubic inch, and operates within the dc to 500 MHz frequency range. Available in 1 to 20 dB values, these devices exhibit a VSWR (50Ω system) of 1.2:1 nominal and attenuation accuracy of 0.5 dB to 100 MHz and 1 dB to 500 MHz. Handling capabilities are 250 mW, CW (100W peak) at 70°C. Price is $9.50 each. Elcom Systems Inc., 151-24 W. Industry Ct., Deer Park, NY 11729. **186**



Precision level switch Model 6640 can drive unterminated coaxial cable with 1V/nsec 40V pulses, with minimal aberrations. For MSI/LSI MOS devices requiring a pin to both drive and receive information, a DTL/TTL disable command will generate an open-circuit output. The unit is designed to operate up to 5 MHz, 40V p-p—with 10 MHz achievable at reduced amplitude. Prices range from $305 to $350 each. Xincom Corp., Box 648, 20931 Nordhoff St., Chatsworth, CA 91311. **181**



Capacitive-coupled sense amplifier MC-1544 is ideal for use with plated-wire or thin-film memories. This device employs internal coupling capacitors, Schottky clamped output transistors to achieve an 18 nsec propagation delay and an unusual dc level restore circuit to eliminate repetition rate problems. A typical ±3 mV signal can be detected. The device sells for $9.00 in 100-up quantities. Motorola Inc., Semiconductor Products Div., Box 20924, Phoenix, AZ 85036. **184**



Dual-board signal conditioner, Series 4, will interface with all types of strain gage and resistance transducers. This dual board concept permits the standard SCA-4 signal conditioner to be fitted with 10 channel, 19 inch multi-channel case. The function boards permit the user to select function options such as digital active filtering with cut-off frequencies from 0.1 to 10 Hz. Sensotec, Inc., 1400 Holly Ave., Columbus, OH 43212. **187**

D/A converters, DAC 372 Series, exhibit linearities conforming to 8 to 12 bits (all units have 12-bit resolution capability). Standard drift is 30 ppm/°C, and these 2- by 2- by 0.4-inch units have DIP pin spacing. Price starts at $39 for 1-9 quantities. Hybrid Systems Corp., 95 Terrace Hall Ave., Burlington, MA 01803. **188**

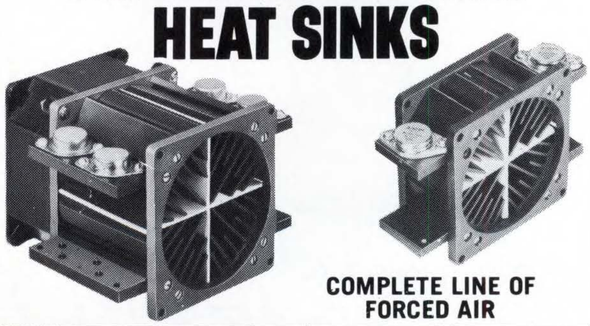
Vibration monitor the single- or dual-channel Vibragard, spans the vibration ranges of 0 to 0.003 or 0 to 0.01 inch. Other ranges are available on request. A front panel connector provides output for continuous recording. Helm Instrument Co., 4216 W. Alexis Rd., Toledo, OH 43623. **189**

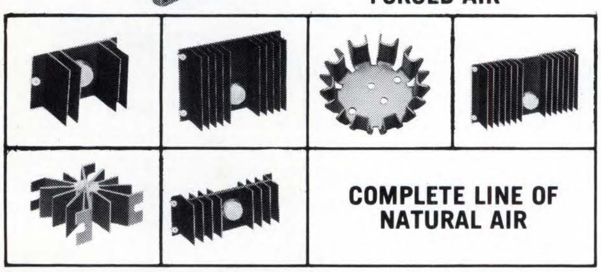
Threshold extension unit, Model 60, lowers wideband FM system thresholds by 4 to 5 dB. It is available with switchable capacities from 12 to 600 channels. Dimensions for a typical plug-in unit are 4 by 2 by 6 inches. Hekimian Laboratories, Inc., 322 N. Stonestreet Ave., Rockville, MD 20850. **190**

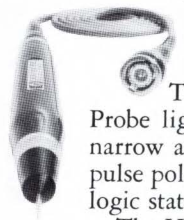
Solid-state synchro interface converters are 13-bit synchro-to-digital (S/D) and digital-to-synchro (D/S) devices. Options include resolver interface, BCD interface, self-contained power supplies, up to 10-kHz operation and input levels to 100V rms. Digital Device Development Corp., 12 Wilmington Rd., Burlington, MA 01803. **191**

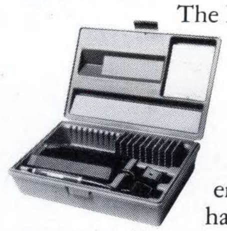
Phase-lock oscillator Model 4327 spans the 1030 to 1090 MHz range, with similar models available for the 960 to 1540 MHz range. Units have 80 mW power output, ±0.001% accuracy, 0.003% stability and −60 dB spurious response. Zeta Laboratories Inc., 616 National Ave., Mountain View, CA 94040. **192**

Differential FET operational amplifiers Models 161 A/B have 400V/μsec typical slew rate, 45 MHz gain bandwidth product, 6 MHz full-power response and will settle to 0.01% within 300 nsec. Prices (1-9 quantity) are $49 (161 A) and $55 (161 B). Dynamic Measurements Corp., 6 Lowell Ave., Winchester, MA 01890. **193**









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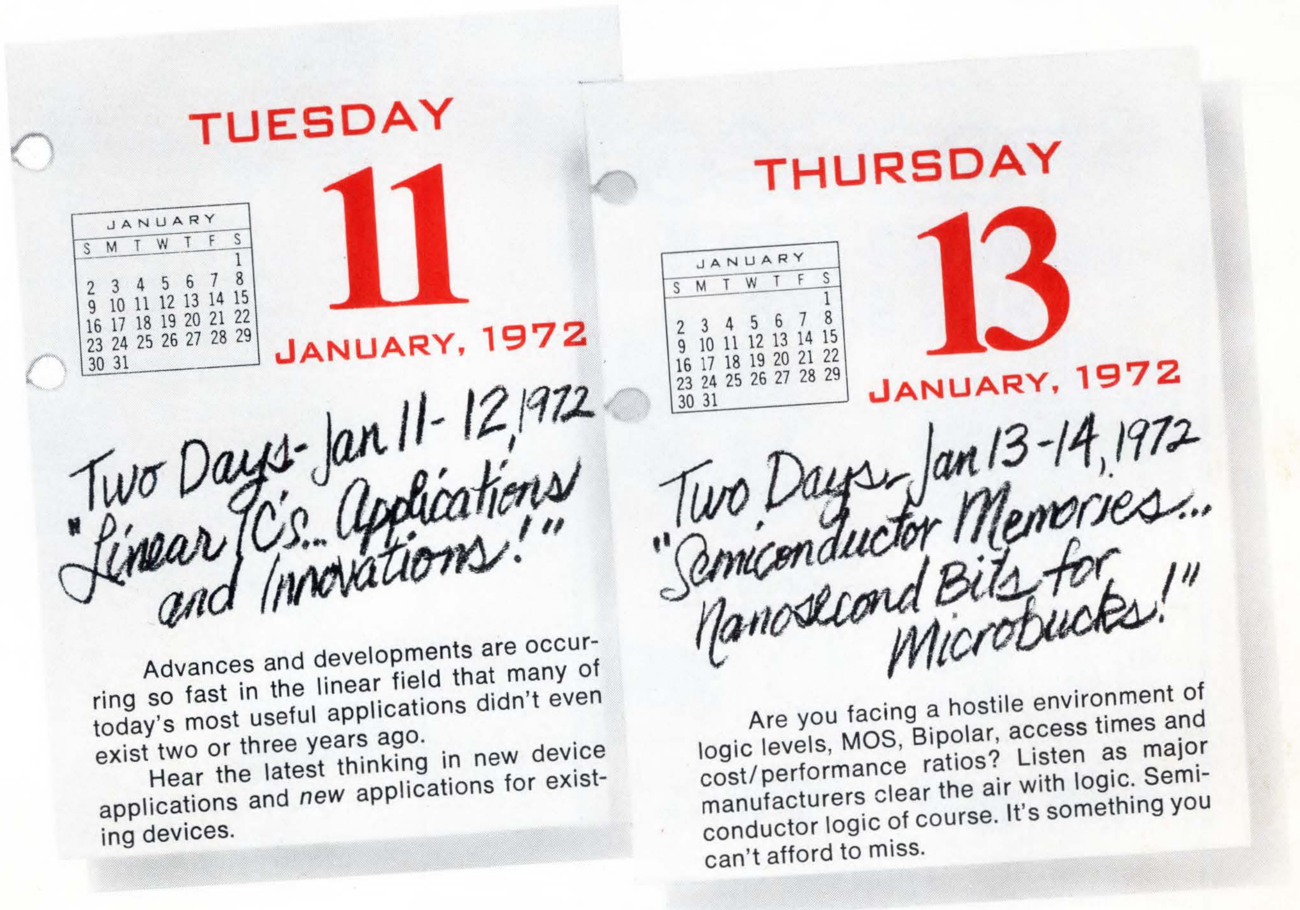

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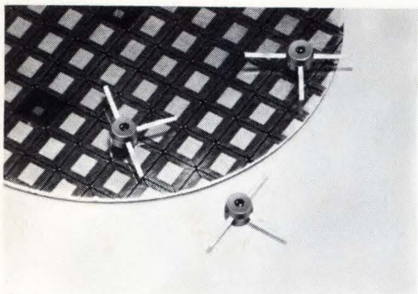
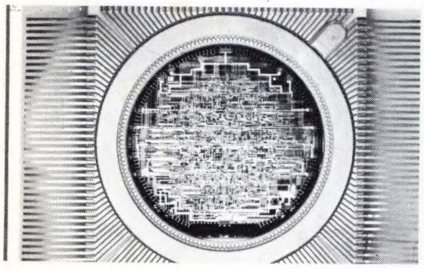
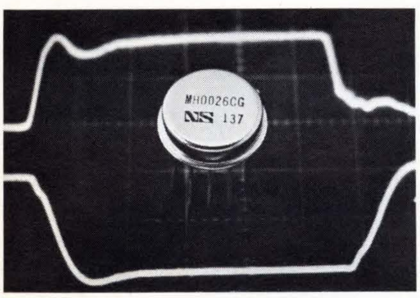


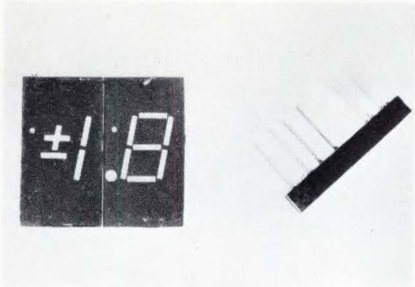
Miniature plastic SCRs, the Micro-T MCR051 through MCR054, are less than 1/10-inch in body diameter. These devices are available with PRV ratings from 15 to 100V and gate trigger currents of 200 μA max. Peak forward surge current is 6A. Available from stock, they are priced at $3.40 to $4.95 each in unit quantity. Motorola Semiconductor Products Inc., Box 20912, Phoenix, AZ 85036. **194**



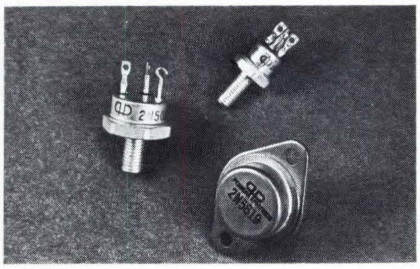
8-bit plus sign multiplier, designated H1002MC, is comprised of 52 full adders and 96 gates for an equivalent of 616 gates integrated on a single 1-1/2-inch silicon wafer. The bipolar LSI device is TTL-compatible and has typical operational speed of 10 nsec per gate and will perform 8 million multiplications of two 8-bit words plus sign per second. Hughes Aircraft Co., Box 90515, Los Angeles, CA 90009. **195**



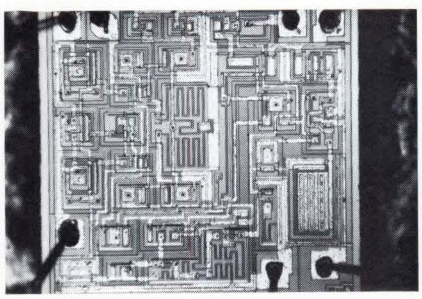
Monolithic MOS clock drivers, Type MH0026/MH0026C, have typical pulse rates of 5 MHz with rise and fall times of less than 20 nsec when driving a 1,200 pF load. Maximum voltage swing is 20V. All types are available from stock, and prices range from $7.75 to $39.50 in single quantities. National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, CA 95051. **196**



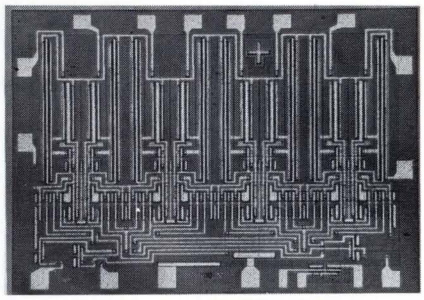
Solid-state indicator, Type SLA-2, displays numeral "one" with plus and minus signs. The red-light emitting display is packaged in a standard 14-pin DIP configuration for direct mounting. The gallium phosphide diodes provide a 0.33 inch high character with brightness of 300 fL when operated at 15 mA and 2.1V. OPCOA, Inc., 330 Talmadge Rd., Edison, N J 08817. **197**



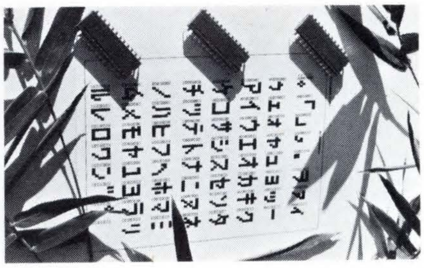
PNP silicon planar power transistors, Types 2N4999, 5001, 5003, 5005, 5009, 5625 and 5627, are direct complements to the manufacturers NPN devices. Delivery time is 2 weeks since the unmounted transistor chips are inventoried in a "die bank" ready for mounting in the customers specified package. Prices are from $15 to $60 each in 100 piece quantities. Power Physics Corp., Box 626, Eatontown, N J 07724. **198**



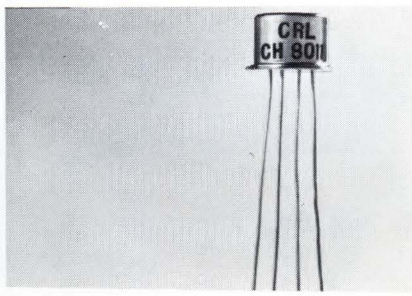
Linear IC op amps SN52108A/72308A and SN52108/72308 feature slew rates of 0.25V per μsec at unity gain. Typical input offset voltages for the 52108A and 52108 are 0.3 and 0.7 mV, and for the 72308A and 72308 are 0.3 and 2.0 mV. Prices range from $8.10 to $75.79 each in 100 piece lots; delivery is 3 weeks ARO. Texas Instruments Inc., Box 5012, Dallas, TX 75222. **199**



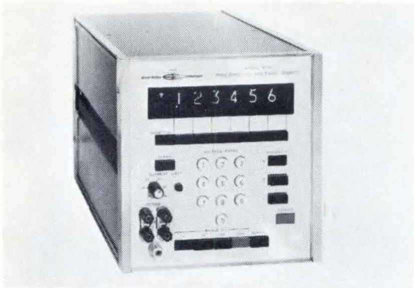
Monolithic 8-channel analog multiplexer features full 3-bit decoding and chip-select incorporated in the array. The MS-504 is a C/MOS device with a ±8V input signal range and power dissipation of 50 nA at 15V. Switching speed is less than 50 nsec. Availability is from stock in 16-lead flat packs or DIPs at $38.50 each. Ragen Semiconductor, Inc., 53 S. Jefferson Rd., Whippany, N J 07981. **200**



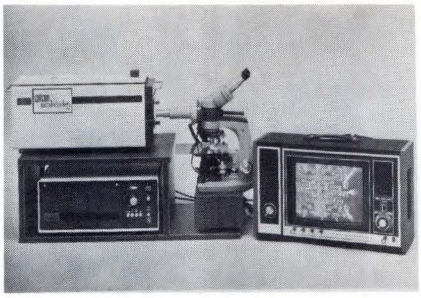
MOS ROM generates characters of Japanese Katakana alphabet. The 2560-bit static ROM can be used in row-output raster scan CRT displays, printers, etc. The 2513NX/CM2143 is encoded for a 5 × 7 dot matrix version of Katakana, and the 2513NX/CM2170 is encoded with ASCII Roman alphabet including a symbol for Yen currency. Both are $18.10 each in orders of 25-99 pieces. Signetics Corp., 811 E. Arques Ave., Sunnyvale, CA 94086. **201**



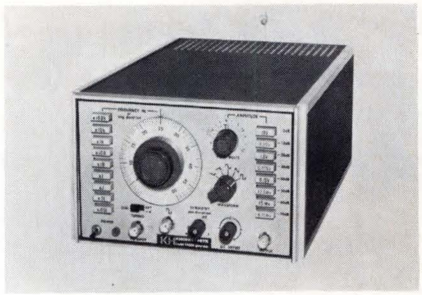
Reference amplifiers CH2001-CH2004 consist of matched NPN transistor/reference diode chip combination in a TO-12 package. The devices are available in reference voltages of 6.5 to 6.9V with four temperature coefficients: ±10, ±25, ±50 or ±100 PPM/°C. Prices start at $4.25 each in 1000 quantities. Centralab Semiconductor, 4501 N. Arden Dr., El Monte, CA 91734. **202**



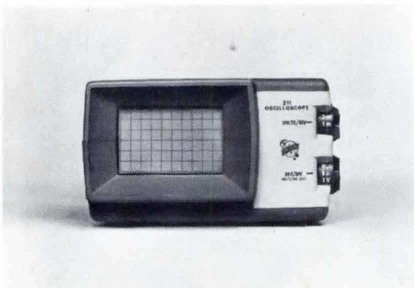
Programmable voltage source supplies 0 to 1000V dc in four ranges with 6-digit resolution and readout. All functions are push-button controlled or are programmable by parallel or series DTL/TTL input. BCD output is available. Price each, in either bench or rack version, is $1750 with delivery 60 days ARO. Alpha Scientific, Box 2044, Oakland, CA 94606. **203**



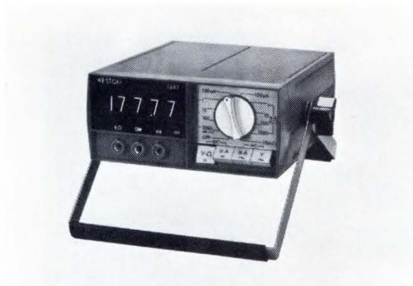
Color TV-microscope system permits microscopic examination at up to 1000 power magnification. Model MV 9700 includes color camera, control unit, color monitor, high-intensity light source and a modified quality binocular microscope. Price of the system complete is $12,000. Circon Corp., Santa Barbara Airport, Goleta, CA 93017. **206**



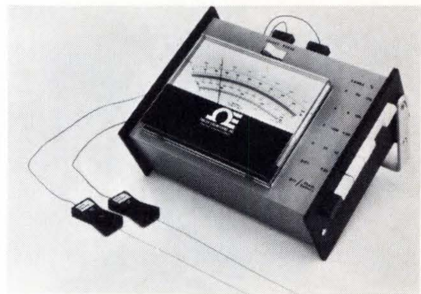
Function generator, Model 5400A, incorporates a symmetry control that allows pulse rep rate to be set independently of pulse width. Frequency coverage is 0.002 Hz to 5 MHz with output in sine, square, triangle, ramp, pulse and sawtooth waveforms. Maximum output is 30V pk-pk. Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge, MA 02139. **209**



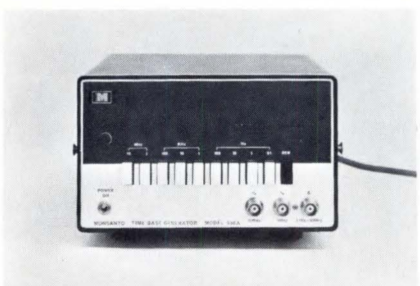
Miniature laboratory oscilloscope with 500 kHz bandwidth has an integral 1 MΩ probe and is designed for severe environments. The Model 211 operates from ac line, or up to 5 hrs on internal batteries. Deflection factors are 1 mV/div to 50V/div with sweep rates extending to 1 μsec/div. Measuring only 3 by 5-1/4 by 9 inches, the "miniscope" is priced at $545 complete with batteries. Tektronix, Inc., Box 500, Beaverton, OR 97005. **204**



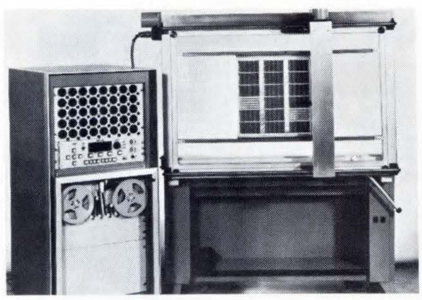
Portable Bipolar DMM with display of 19999 provides 25 ranges that include ac and dc voltage and current and resistance—yet is small enough to fit in an attache case. The 4-1/2 digit Model 1242 features weight of only 4-1/2 lbs, overload protection, rated accuracy to 0.05% of reading ±1 digit and a price tag of $595. Weston Instruments Div., Weston Instruments, Inc., 614 Frelinghuysen Ave., Newark, N J 07114. **207**



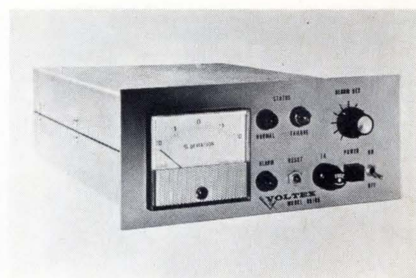
Thermocouple readout meter that uses thermocouples as small as 0.001 inch in dia contains a built-in amplifier and is available in biomedical, cryogenic and general purpose models. Meter ranges are available from −200 to +400°C, each with a μV differential range equivalent to about ±20°C. Response time is only 2 sec and the meters can use any Type T thermocouple. Omega Engineering Inc., Box 4047 Stamford, CT 06907. **210**



Programmable Time-base generator, Model 590A, has three outputs: two sine-wave outputs at 1 and 10 MHz and a square-wave output that can be varied in nine decade steps from 0.1 Hz to 10 MHz. Output frequencies are derived from a 1 MHz oven-stabilized crystal. Price is $700 each. Monsanto Commercial Products Co., Electronic Instruments, 620 Passaic Ave., West Caldwell, N J 07006. **205**



N/C wiring machine, Model WWM-300, is designed to provide in-house wiring capability in the range of 100,000 wires or more. The system price of $10,000 includes the positioning table, controller console, display readout, tape spoolers and wire bin. Production rates range up to 600 terminations or 300 wires/hr. Standard Logic Inc., 1630 S. Lyon St., Santa Ana, CA 92705. **208**



Voltage monitor measures, about a given set-point, the deviation in percent of the variable around the pre-set value. Useful as an expanded scale meter, a dual-set-point meter relay, a status and alarm indicator or a drive system for an expanded-scale recorder Model 85105 is priced at $170 complete with internal power supplies. Voltex Co., Inc., 115 Marine St., Farmingdale, NY 11735. **211**

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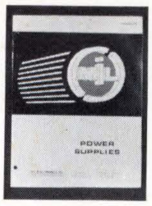


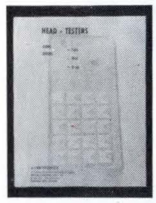
DC-to-dc power supplies with single, dual, triple and quadruple outputs up to 20W are described in Catalog No. 716. It contains 27 pages, including a selector index that aids in locating a standard model for a particular application. Performance curves and dimensional information are provided. MIL Electronics Inc., 176 Walker St., Lowell, MA 01854. **250**

Thermocouple recorder that provides 32-channel automatic data acquisition when combined with a DVM is described in a four-page brochure that includes features, specifications and accessory descriptions. Kaye Instruments, Inc., 737 Concord Ave., Cambridge, MA 02138. **251**

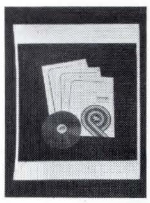
DC motors are described in short-form Catalog HF 971 with a table showing motor ratings, motor constants and dimensions for 10 models. Characteristics are also provided for encoded motors and motor/tachometers. Sequential Information Systems, Inc., 249 N. Saw Mill River Rd., Elmsford, NY 10523. **252**

Relays are featured in a 28-page catalog that gives descriptions of solid-state, optoelectronic, reed, time-delay, time-interval and frequency-sensitive relays. Solid State Electronics Corp., 15321 Rayen St., Sepulveda, CA 91343. **253**

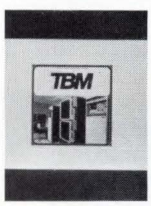
"NBS Frequency and Time Satellite Experiment" is a 12-page brochure that describes the experimental geostationary satellite program for broadcasting time and frequency signals. Information provided includes operational requirements for reception of the satellite signals. National Bureau of Standards, Time & Frequency Div. (273.01), Boulder, CO 80302. **254**



Head-testers for audio and digital tape, disc and drum are described in a six-page brochure that provides specifications and prices. A 20-channel audio-head alignment tester is also described. Aventronics, Div. of Schmidt Tool & Die Co., Culver City, CA 90230. **255**

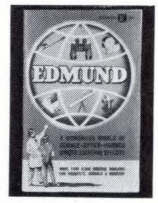


Polyester film of capacitor grade is described in a technical bulletin that provides physical, electrical, chemical and thermal properties and capacitor life test data. Specification and price folders are also included. 3M Co., Box 3686, Dept. Fil-18, 3M Center, St. Paul, MN 55101. **256**



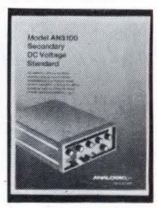
Terabit memory system uses videotape recording methods to store from 90 billion to 3 trillion data bits (400 billion bytes) on-line for random access. It is described in Brochure G414. Ampex Corp., 401 Broadway, Redwood City, CA 94063. **257**

Solder preform selector is a 16-page brochure that provides information on the physical properties of elements used in preforms, standard alloy listings, metal combinations and impurities to avoid, a temperature conversion table and other information on solder preforms. Indium Corporation of America, Box 269, Utica, NY 13503. **258**



Edmund Scientific catalog contains a variety of optical and scientific equipment for industry, research labs, design engineers, experimenters and hobbyists. Catalog # 721 features over 4000 items with prices. Edmund Scientific Co., 380 Edscorp Bldg., Barrington, N J 08007. **259**

Fast fourier transform system is described in a brochure that graphically illustrates the flow of information from various input sources to outputs. A complete description is provided for the equipment that is shown. UniComp, Inc., 18219 Parthenia St., Northridge, CA 91324. **260**



DC secondary voltage standard, Model AN3100 is described in a six-page brochure that provides the theory of operation of the unit and includes application data. Analogic, Audubon Rd., Wakefield, MA 01880. **261**

Advertiser's Index

Index to Ads, Products and Literature

Application Notes

"TRU-ROta Encoder Logic Interfacing" is an eight-page note that gives suggestions on proper loading of encoder output channels with respect to the various control input configurations most generally used. Schematics are provided for interfacing encoders with TTL, RTL, DTL circuits and a high input-impedance amplifier. Trump-Ross Industrial Controls, Inc., 265 Boston Road, North Billerica, MA 01862. **262**

"Ideafile" is a series of application notes dealing with design problems in the areas of circuit protection and switching. Note number one offers a solution to the problem of circuit protection during startup of high-reactance equipment. Number two discusses the applications for a breaker that doesn't turn off mechanically. Additional issues will be published. The Heinemann Electric Co., 127 Magnetic Dr., Trenton, N J 08602. **264**

"Analog Dialog", Vol. 5, No. 4, is a 16-page application bulletin with articles on fast-slewing IC op amp design; sample-hold circuits with specifications and applications; fast-recovery ac coupling for ECGs; multiple scale factors using thin-film ladder networks and digital sweep generation. Many circuit diagrams and graphs are used. Product information is also included. Analog Devices, Inc. Rte. 1 Industrial Park, Box 280, Norwood, MA 02062. **266**

Double-balanced modulator applications bulletin contains 28 pages. It presents the operating principle, circuit description and circuit characteristics of the LM325 IC in modulator and multiplier operation, and discusses applications. Circuit diagrams and performance curves are included. European Electronic Products Corp., 10150 W. Jefferson Blvd., Culver City, CA 90230. **263**

Fractional-horsepower brushless dc motors is the subject of an applications bibliography that lists 25 articles, technical papers, brochures and books by U.S. and foreign authors. Subjects covered include principles of operation and applications for the use of motors with and without Hall effect devices. Siemens Corp., 186 Wood Ave. So., Iselin, N J 08830. **265**

Digital Application Note No. 1 is a six-page note on the subject of high-noise-immunity logic. It discusses industrial applications of HNIL to replace switches, relays, latching relays, stepping relays and mechanical counters in high-noise environments. Circuit diagrams are also included. Teledyne Semiconductor, 1300 Terra Bella, Mountain View, CA 94040. **267**

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853	X		−21 to −32		
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805	X		+3 to +9		±0.1%
806		X	"		"
855	X		−3 to −9		"
856		X	"	Up to 0.5 amp	"
807		X	+30 to +60	0.150 amp	±0.05% at −20° to +125°C +0.1% at −55° to −20°C
808		X	+60 to +120	"	"
809	X		+5 to +28	0.75 amp	0.003%/mA
859	X		−5 to −28	"	"
828A		X	+5 to +30	500 mA	Line: ±0.01%/V Load: ±0.01%
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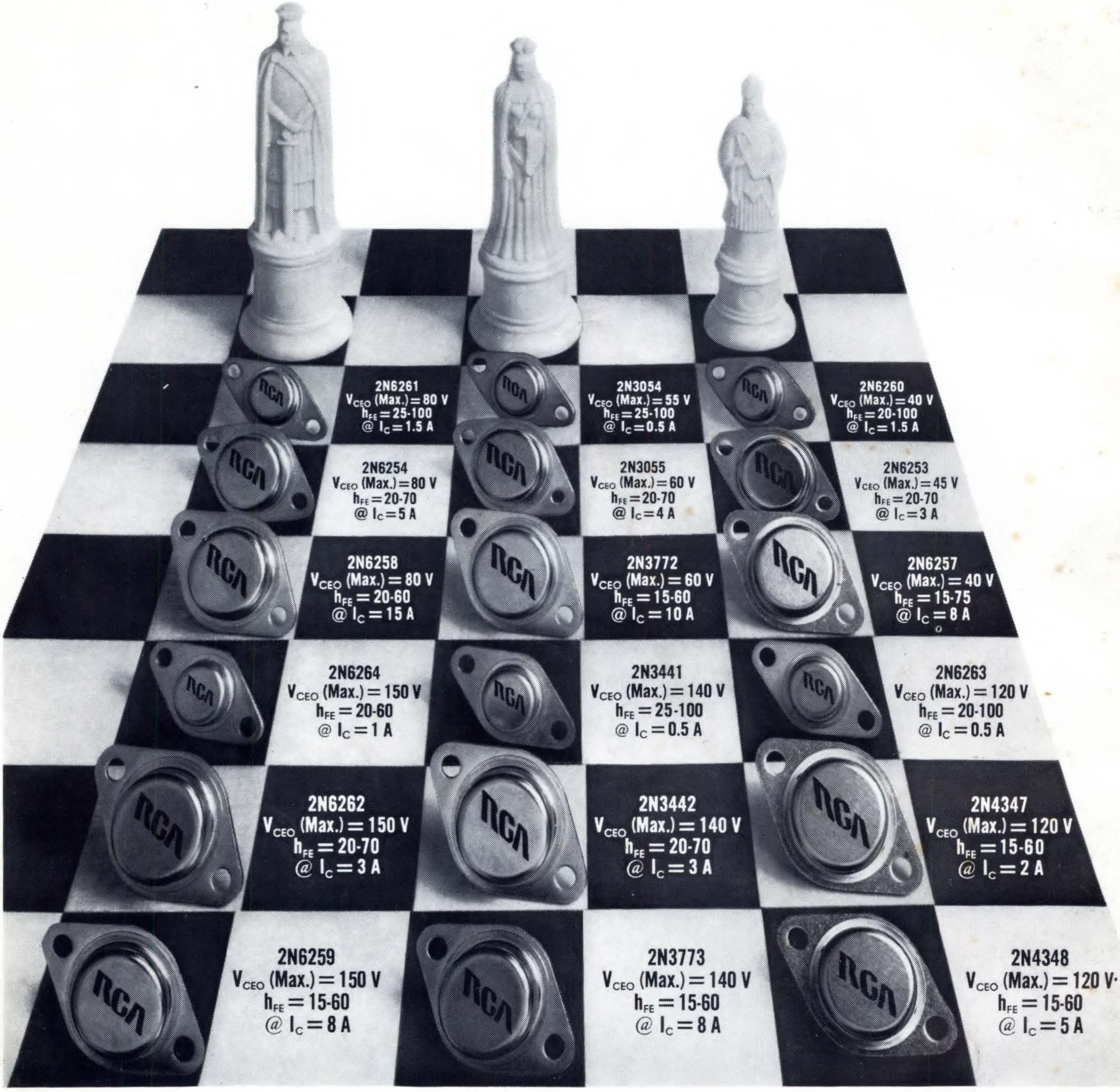

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