VOL. 20 NO.

Electronic Design 20

FOR ENGINEERS AND ENGINEERING MANAGERS

SEPT. 28, 1972

Tiniest 4-1/2-digit DMM costs less than any other and, in fact, less than most 3-1/2-digit units. Rechargeable batteries provide six-hour operation and freedom from power-line interference. But even line operation offers better than 100 dB of common-mode rejection at 60 Hz. For a look at this small meter, see p. 87.

Do you face
a make or buy decision
on power supplies?

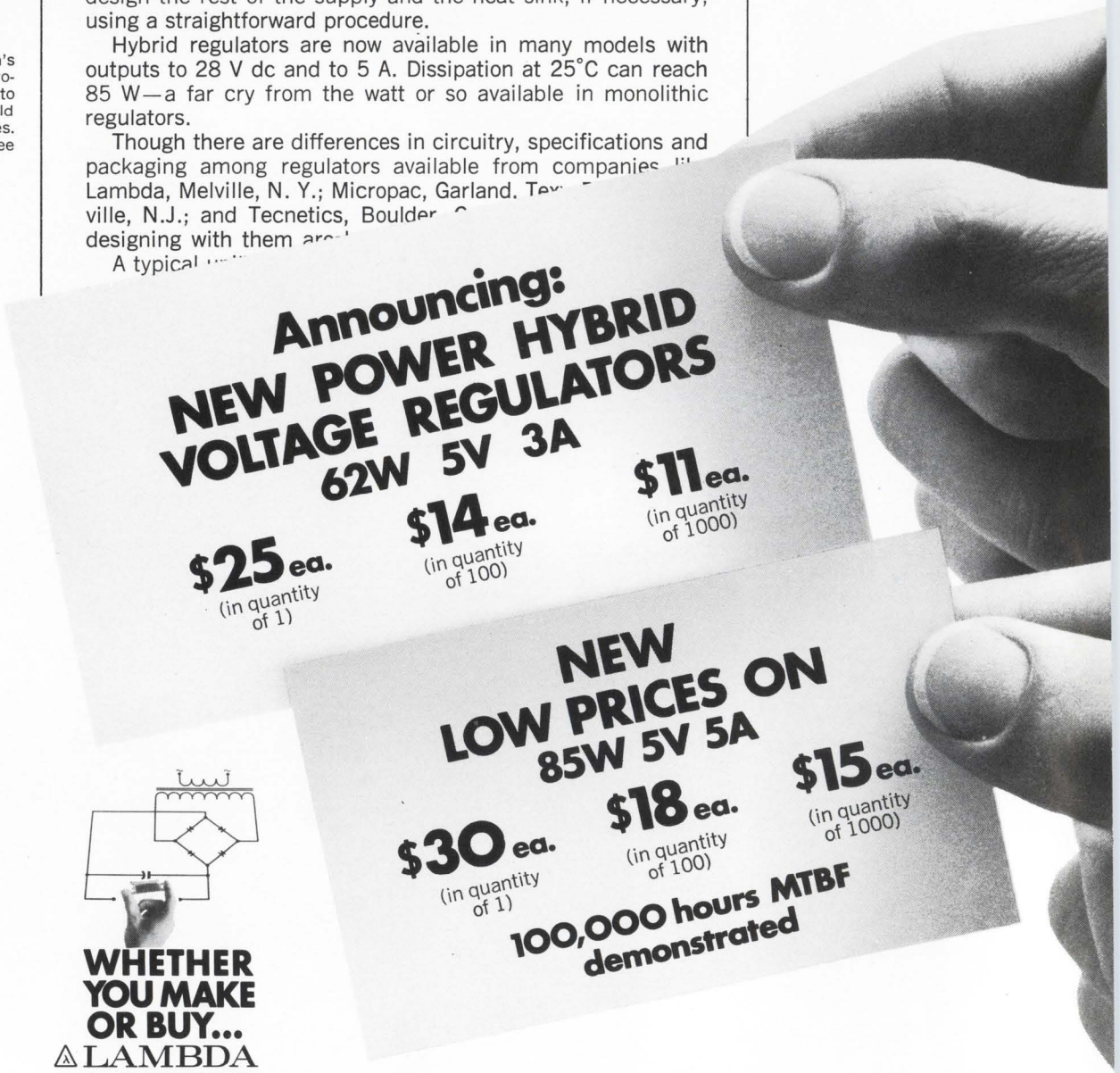
How to use power hybrid voltage regulators to build your own power supplies.

This article in Lambda's new hybrid regulator brochure tells you how to use these devices to build your own power supplies. . . . Send for your free copy.

There's another choice now in power-supply design. You're no longer restricted to a supply designed by others, nor to one you have to design from scratch. You can buy the heart of the supply —the voltage regulator—in a hybrid form that offers much more power output than monolithic regulators. Then you can design the rest of the supply and the heat sink, if necessary, using a straightforward procedure.

Hybrid regulators are now available in many models with outputs to 28 V dc and to 5 A. Dissipation at 25°C can reach 85 W—a far cry from the watt or so available in monolithic regulators.

Though there are differences in circuitry, specifications and packaging among regulators available from companies li
Lambda, Melville, N. Y.; Micropac, Garland. Tex
ville, N.J.; and Tecnetics, Boulder
designing with them are
A typical



WHETHER YOU MAKE OR BUY...

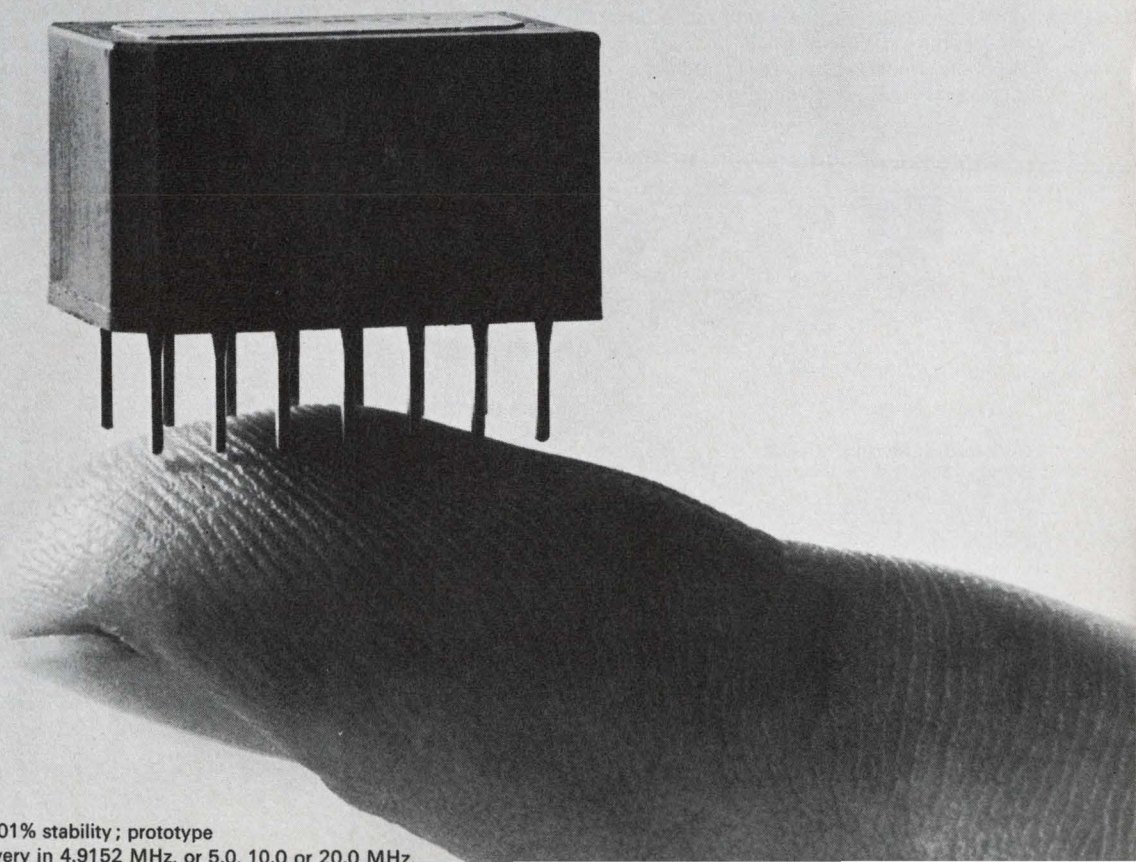
LAMBDA
ELECTRONICS CORP.
A Vesco Company

MELVILLE, NEW YORK 11746 515 Broad Hollow Road Tel. 516-694-4200 **ARLINGTON HEIGHTS, (CHICAGO) ILL. 60005** 2420 East Oakton St., Unit Q Tel. 312-593-2550
NORTH HOLLYWOOD, CALIF. 91605 7316 Varna Ave. Tel. 213-875-2744 **MONTREAL, QUEBEC** 100C Hymus Blvd., Pointe-Claire, Quebec-730 Tel. 514-697-6520

INFORMATION RETRIEVAL NUMBER 232

If you've been looking for a miniature crystal-controlled clock oscillator in a 14 pin DIP package to fit standard PC board sockets, stop looking and start ordering. Get details on model K1091A from Motorola Component Products Dept. 4545 W. Augusta Blvd. Chicago, Ill. 60651. MOTOROLA

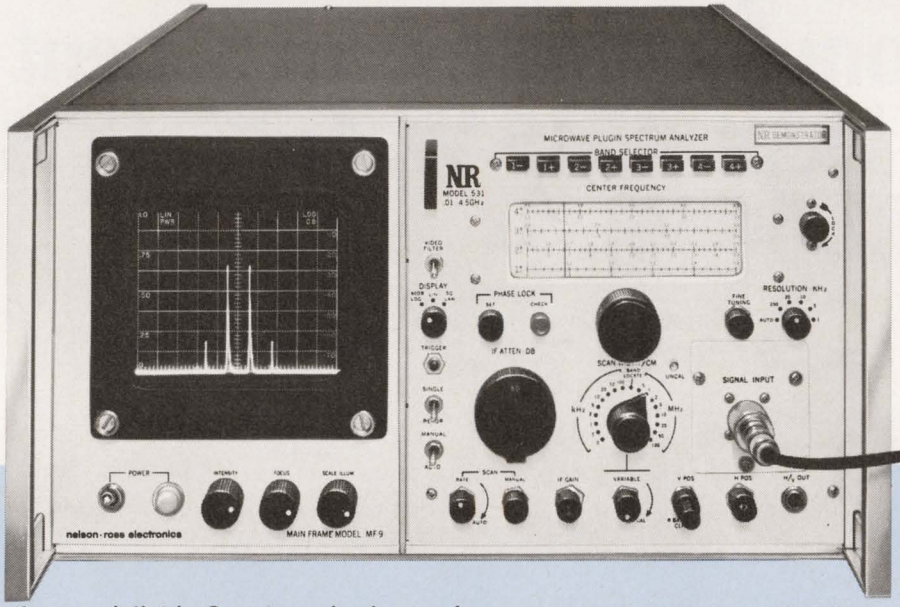
INFORMATION RETRIEVAL NUMBER 2



Specifications: 4 to 20 MHz range; 0.01% stability; prototype quantities available for immediate delivery in 4.9152 MHz, or 5.0, 10.0 or 20.0 MHz

14 NEW Lowest Cost Spectrum Analyzers

From Sub-Audio to Microwave



Nelson Ross Spectrum Analyzer Model 531
10 MHz to 4.5 GHz
Dispersion 0-1 GHz
Phase locked 1 KHz resolution
Price: $3,050

Nelson Ross, the specialist in Spectrum Analyzers, has the **Biggest Selection, Most Versatile Specifications and Proven Reliability . . . All This For The Lowest Prices.**

Now you can select a Spectrum Analyzer from 0.5 Hz to 6.5 GHz which is just right for your application. And, with Nelson Ross you'll save 50% or more by not paying for unnecessary extras that you'll probably never use.

The versatile Spectrum Analyzers illustrated here are typical of 14 complete analyzers and more than 30 plug-in analyzers available from Nelson Ross.

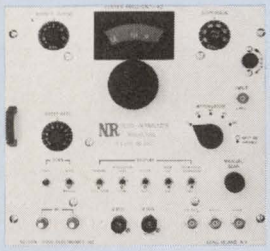
The complete instruments include the new MF-9 Calibrated Display Main Frame which provides bright, long persistence 8x10cm readouts, adjustable scale illumination and camera mount facility.

Our plug-in analyzers come in 3 complete series: • for the Tektronix "540/550 letter" series scopes • for the Tektronix 560 series scopes • for the HP 140/141 series scopes and the Nelson Ross MF-9 Display Main Frame.

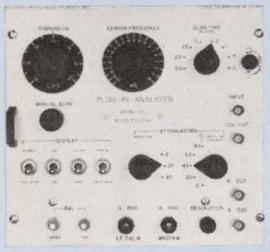
Compare specifications, quality, ease of use and price. We're sure you'll join the thousands who have been selecting Nelson Ross Spectrum Analyzers for more than a decade.

Call, write or circle the Reader Service Number to get your new Nelson Ross Spectrum Analyzer Catalog. Then **you** can compare and save.

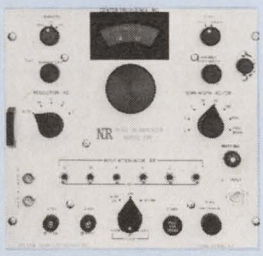
Typical Plug-In Spectrum Analyzers for Nelson Ross MF-9 Display Main Frame or HP 140/141 series scopes.



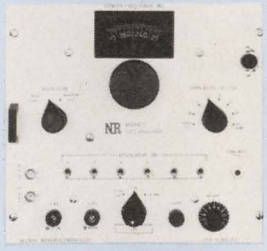
Sub-Audio: Model PSA-036
0.5 Hz - 2 KHz
0.5 Hz Resolution
Plug-In: $1,200
With MF-9: $2,200



Broadband: Model PSA-235
1 KHz - 25 MHz
200 Hz Resolution
Plug-In: $1,700
With MF-9: $2,700

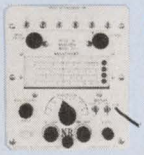


Audio: Model PSA-031
10 Hz - 20 KHz
10 Hz Resolution
Plug-In: $ 850
With MF-9: $1,850



RF-TV: Model CATV
1 MHz - 300 MHz
Plug-In: **$1,500**
With MF-9: **$2,500**

Typical of more than 25 Plug-In Analyzers for use with Tektronix scopes.



For "540/550 letter" series

SSB Narrow-Band RF
Model PSA-201
0.6 - 36 MHz
10 Hz Resolution
$1,675

For 560 Series

Ultrasonic
Model PSA-023
0.15 - 500 KHz
150 Hz Resolution
$850

nelson • ross electronics
A DIVISION OF POLARAD ELECTRONICS CORP.
5 Delaware Drive
Lake Success, New York 11040
516 - 328-1100 • TWX: 510 - 223-0414

INFORMATION RETRIEVAL NUMBER 3

VOL. 20 NO.

Electronic Design 20

FOR ENGINEERS AND ENGINEERING MANAGERS

SEPT. 28, 1972

NEWS

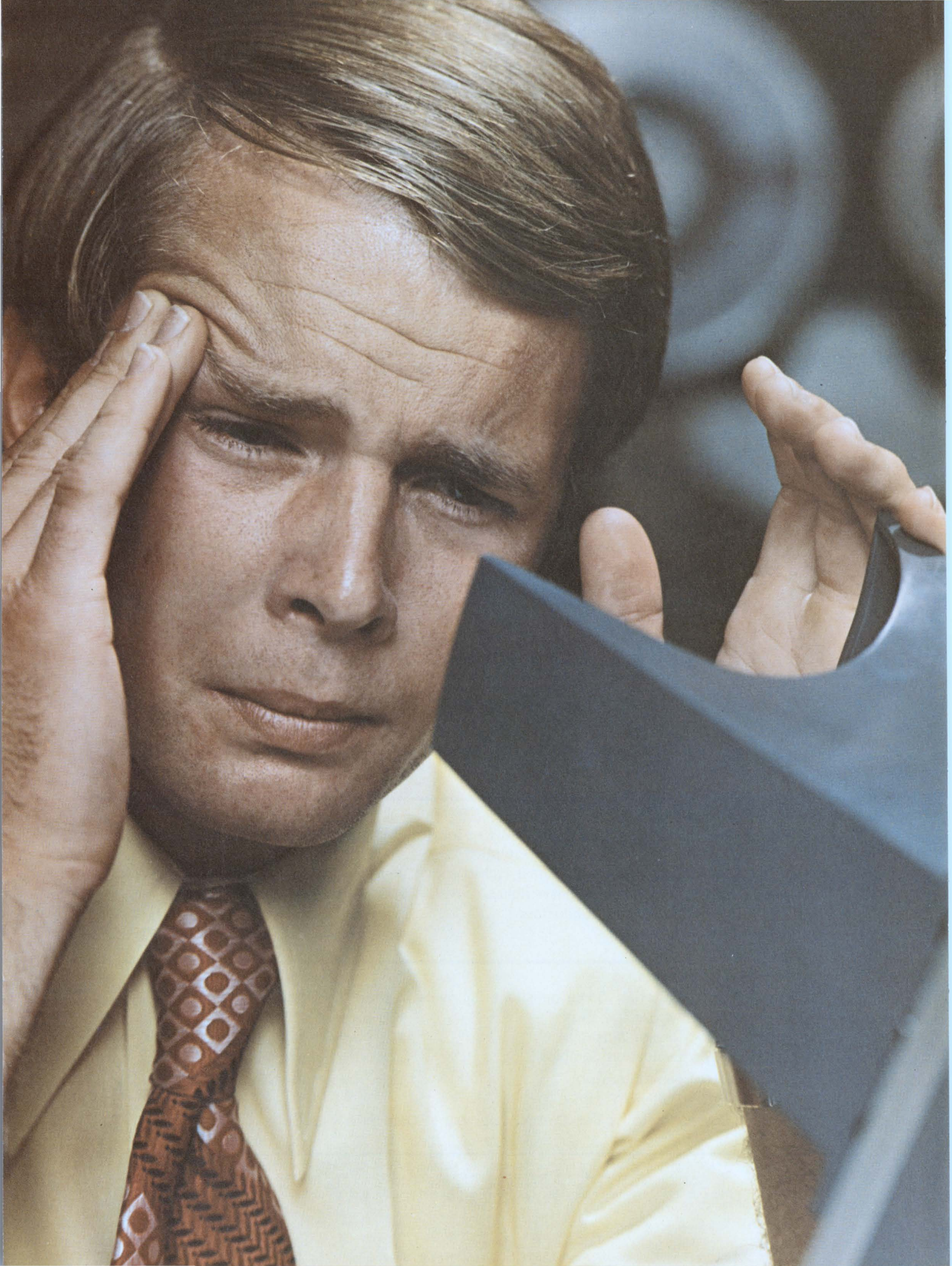
TECHNOLOGY

PRODUCTS

Departments

Cover: Photo by Lew Colson. Courtesy of Data Precision Corp.

ELECTRONIC DESIGN is published biweekly by Hayden Publishing Company, Inc., 50 Essex St. Rochelle Park, N. J. 0762. James S. Mulholland, Jr., President. Printed at Brown Printing Co., Inc., Waseca, Minn. Controlled circulation postage paid at Waseca, Minn., and New York, N. Y., postage pending Rochelle Park, N. J. 84,392 copies this issue.



Think Twice:

What's one of the biggest measurement problems in the computer industry today?

Low Duty-Cycle Measurements— Making timing-pulse adjustments, and finding noise pulses in, or locating missing bits from low duty-cycle digital signals. Countless lost hours and eye-strain have resulted from this problem—trying to view low rep-rate signals like those found in disc, tape, or drum peripheral units. But with your refresh cycle occurring at such long intervals, coupled with short phosphor persistence, it's no wonder that you've spent an inordinate amount of time making such measurements. And it's no wonder that you often came out from under your scope hood rubbing your eyes. Well, no more!

Storage CRT With Unmatched 400 cm/μs Writing Speed. Hewlett-Packard just made it possible for you to throw away your scope hood by developing a new bright, burn-resistant, high-speed, variable-persistence CRT—available in either 100 cm/μs or 400 cm/μs writing speeds. Placing these new CRT's into an all new mainframe that's optimized for high-writing-speed storage measurements, HP now gives you a new dimension in storage scopes—the HP 184A. This unique combination offers the highest writing speed available, and a display with brightness as great as you can find anywhere. For the first time you can find those elusive transients that before were too fast for your storage scope to follow—like nanosecond noise pulses.

Display True Replicas of Your Waveforms. You'll appreciate being able to adjust persistence down to 0.2 seconds; that's 75 times lower than a major competitive unit. For those measurements that require faster sweep times, you'll know you are displaying true replicas of your waveforms when you're using an HP 184A. Capture low duty-cycle pulse trains, through repetitive sweeps, simply by adjusting the persistence to "maximum," to build up the intensity of dim traces. This feature in the new 184A oscilloscope lets you do many jobs you previously allocated to expensive, single-shot scope/camera systems.

Variable-Persistence Storage and Standard in One Scope. Further, you'll find that your 184A is a true general purpose scope that offers you the capability to choose, by way of plug-ins, all the functional features of the HP 180 Series of oscilloscopes, including such items as selectable-input impedance, and sampling to 18 GHz. And for simplicity of operation, we think you're in for a pleasant surprise when you compare the 184A against the competitive unit.

Superior Technology. HP believes the most important part of a scope system is the CRT—the interface between you and your measurement. As the pioneer in practical applications of dome-mesh magnification, HP was first to expand the size of high-frequency CRT's to 6 x 10 cm; first to 8 x 10 cm; and first to 10.4 x 13 cm—all in high-frequency mainframes. HP was also the first to use dome-mesh technology to substantially lower power requirements for CRT deflection (making possible the only line of 35 and 75 MHz portable scopes with built-in battery packs—scopes that really are portable).

From The Storage Leader. HP was first with variable-persistence mesh storage for commercial applications—to give you a stored trace many times brighter than bi-stable tubes, and without annoying flicker. Variable-persistence, with its ability to build up waveform brightness, was the first CRT innovation that gave you a trace bright enough to let you tackle most single-shot or low rep-rate measurements problems. All you do is adjust persistence until the integrating storage effect brings your waveform up to a bright, clear display.

Burn-Resistant CRT's. HP placed variable-persistence in many of its scopes including the 181A, 1702A, and 1703A storage units. And now HP has developed, for its current line of storage instruments, carefree CRT's so highly burn resistant they require little more care than conventional CRT's. The new 184A high-writing-speed scope also has unprecedented inherent resistance to burns.

Yes, Scopes Are Changing. How many times have you wished for a scope that could display a low rep-rate digital signal brightly and clearly, and one that could also be used for a variety of general purpose measurements. That scope is here now in HP's 184A storage mainframe, $2200 (for only $500 more, you can boost your 184A's writing speed to 400 cm/μs), with plug-in capability to 100 MHz real time, or 18 GHz sampling. Think twice; put away your scope viewing hood and call your local HP field engineer for a demo today. Or write for our "No Nonsense Guide to Oscilloscope Selection." It covers the other members of HP's variable-persistence storage scopes. Hewlett-Packard, Palo Alto, California 94304. In Europe: P.O. Box 85, CH-1217 Meyrin 2, Geneva, Switzerland. In Japan: YHP, 1-59-1, Yoyogi, Shibuya-Ku, Tokyo, 151.

Scopes Are Changing; Think Twice.

HEWLETT hp PACKARD

OSCILLOSCOPE SYSTEMS

INFORMATION RETRIEVAL NUMBER 4

Vice President Publisher

Peter Coley

Editors

Editorial Offices
50 Essex St.
Rochelle Park, N.J. 07662
(201) 843-0550
TWX: 710-990 5071
Cable: Hadyenpubs Rochellepark

Editor: George Rostky

Managing Editors:
Ralph Dobriner
Michael Elphick

Associate Editors:
Jules H. Gilder
Richard Lee Goldberg
Morris Grossman
John F. Mason
Stanley Runyon
Edward A. Torrero
Richard L. Turmail

Contributing Editor:
Peter N. Budzilovich

Editorial Field Offices

East
Jim McDermott, Eastern Editor
P.O. Box 272
Easthampton, Mass. 01027
(413) 527-3632

West
David N. Kaye, Senior Western Editor
2930 West Imperial Highway
Inglewood, Calif. 90303
(213) 757-0183

Editorial Production

Marjorie A. Duffy

Art

Art Director, William Kelly
Richard Luce
Anthony J. Fischetto

Production

Manager, Dollie S. Viebig
Helen De Polo
Maxine Correal
Anne Molfetas

Circulation

Manager, Nancy L. Merritt
Ron Deramo

Information Retrieval

Peggy Long

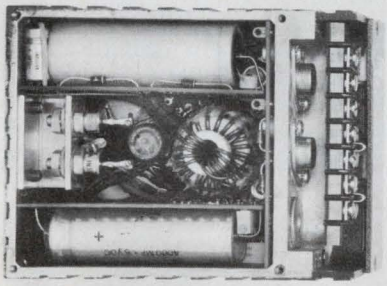
Promotion

Manager, Jeffrey A. Weiner
Karen Costa

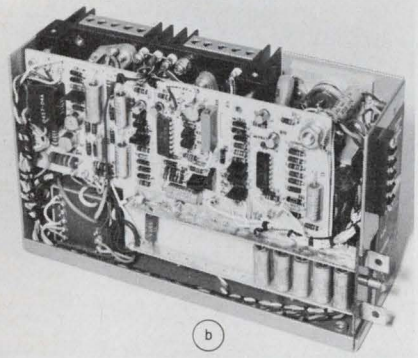
across the desk

Wrong picture and . . .

ELECTRONIC DESIGN apologizes for using the wrong photograph in the article, "Small, low-cost modular power supplies woo light-minded users," ED 15, July 20, 1972, p. 83. The article compared seven competing power supplies with a new 5-V, 12-A unit from Trio Labs. The photo, unfortunately, was not a shot of the Trio supply, but rather, one of a recent version of the RO Associates Model 210. The Trio supply (A) is shown here with the newest version of the RO unit (B), which now uses "throw-away" PC cards.



(a)



(b)

Two other points in the article were wrong or, at least, subject to dispute. The weight, taken from RO data, was given as 2.5 lb, but that's shipping weight. The actual weight is 2.1 lb.

Further, RO takes issue with ED's published current rating at 5 V, of 8.7 A at 40-C ambient (derived from RO's derating data for no air or conductive cooling), insisting that the supply should be rated at 10 A with a heat sink. At 10 A and 2.1 lb, the unit has a power density of 24 W/lb, which is more dense than Trio's 18.5 W/lb (5 V, 12 A, 3.25 lb).

For more information:

From RO **CIRCLE NO. 356**
From Trio **CIRCLE NO. 357**

Speedy technique stalled by errors

The article "Speed Computer-Aided Circuit Design," by R. D. Taylor, (ED 11, May 25, 1972, p. 54) proposes a computer technique as a design tool, but the references to the computer and computer program have completely obscured the proposed technique. I hope you will publish corrections to the article to clarify what appears to be a useful technique for minimizing a function.

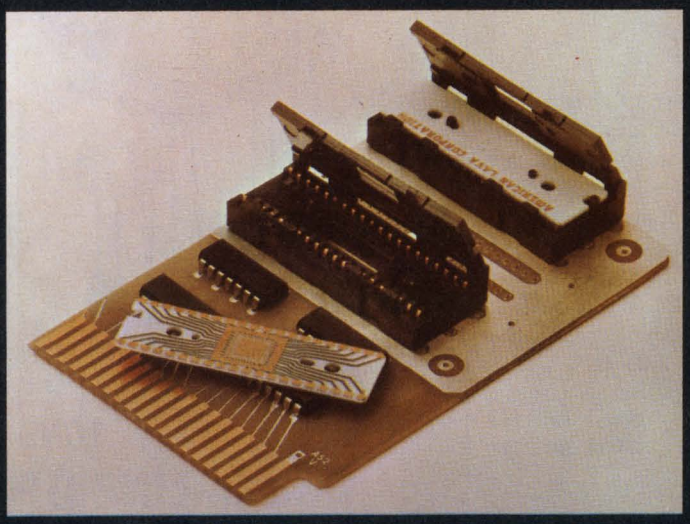
What is an IBM S/360 501 computer? If it is a custom model perhaps the computer time could be compared with that of a more familiar model—such as the IBM 360 models 30, 50, or 65—to give some estimate of the time required on another computer.

Although the article states that little or no debugging would be required for such a program, the program listing in Fig. 3 contains at least two "bugs"—aside from being incomplete and evidently not the program to optimize the active-filter values, as claimed. The first WRITE statement will write com-

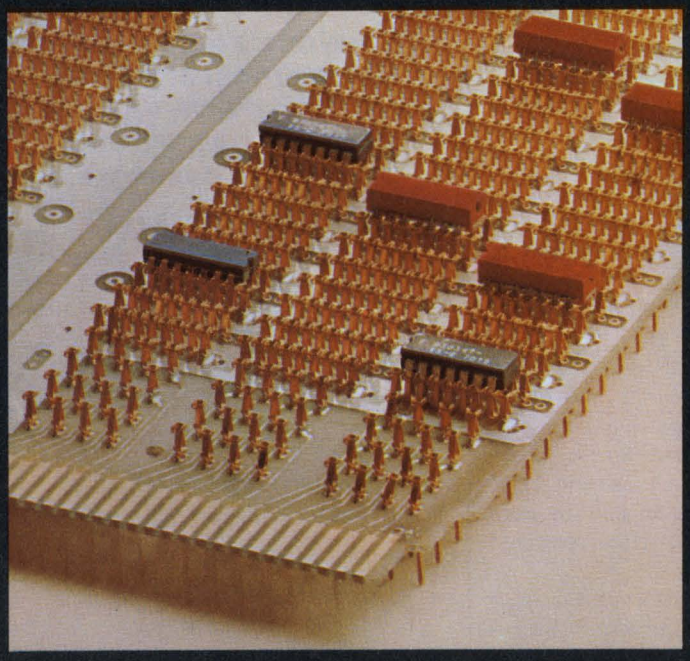
(continued on p. 10)

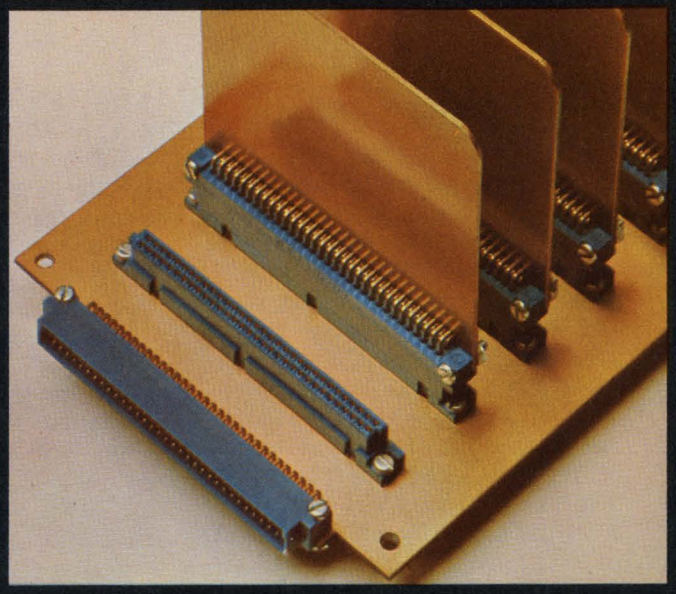
Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Managing Editor, Electronic Design, 50 Essex St. Rochelle Park, N. J. 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld on request.

New from Amphenol's Spectrum

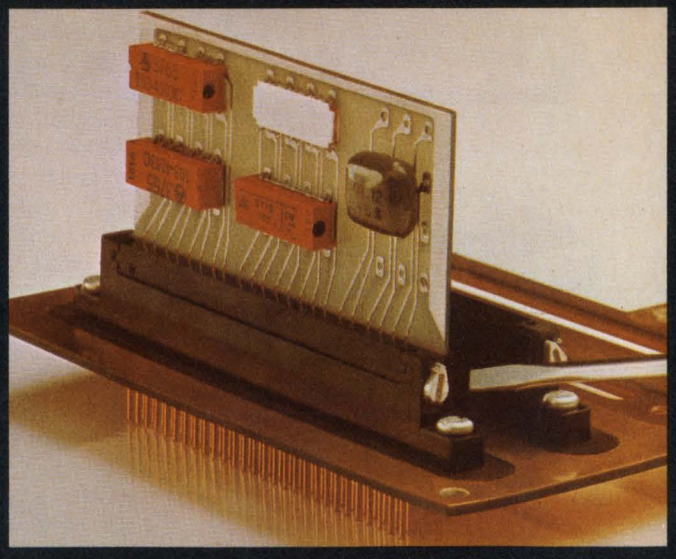


level 1 MOS/LSI Planar Plug-In connectors (above) for leadless, flat mount ceramic substrates. Permits fast, easy replacement of IC package, no screws, has snap-down lid. ■ Free-standing terminal (below) terminates IC's to PC boards for lowest total systems cost.





level 2 Box contact connectors (above) intermate with .025″ square or round contacts. Low insertion force. Terminations for crimp, wire wrapping or wave solder. ■ Zero insertion force connectors (below) improve PC board and connector life by eliminating strain and wear.



Above are seven new ideas from Amphenol Industrial Division's Spectrum of interconnection capability.

Amphenol's SPECTRUM offers you *all four* levels of interconnections from our unmatched breadth of product line:

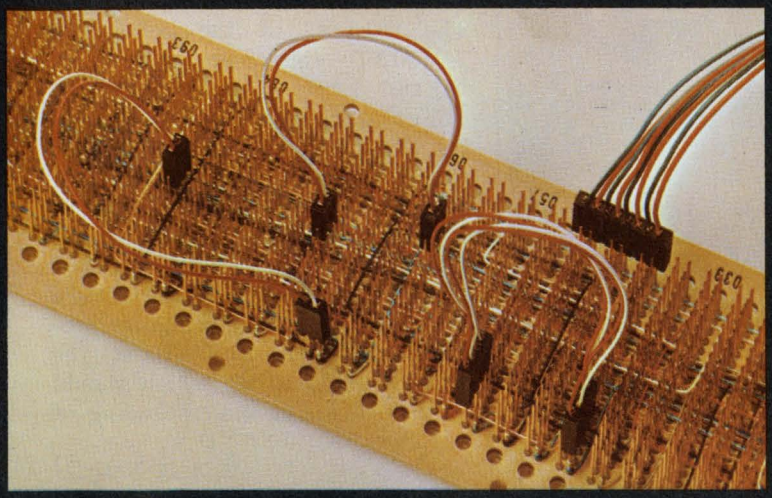
Level 1 . . . DEVICE TO BOARD OR CHASSIS. We offer interconnections for components such as tubes, relays, transistors, IC packages, trimmers, resistors or capacitors to a PC board or chassis.

Level 2 . . . BOARD TO MOTHERBOARD OR BACK PLANE. We offer interconnections for PC boards or other sub-circuit modules to a motherboard or to a back plane.

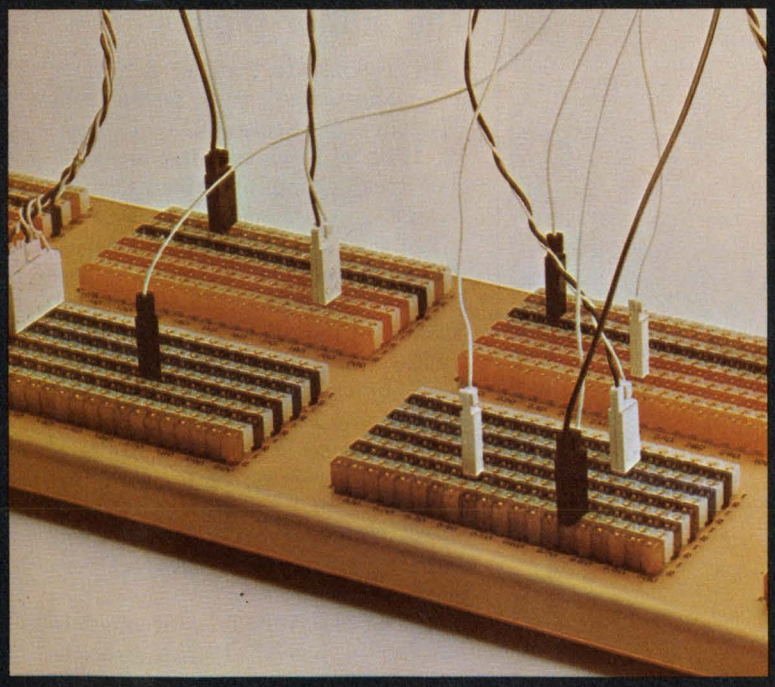
Level 3 . . . MOTHERBOARD OR BACK PLANE WIRING. We offer interconnections for levels to each other and to other sub-circuits with multi-layer circuit boards, wire wrapping, clip terminations, jumper techniques and dip-soldering.

Level 4 . . . INPUT/OUTPUT CONNECTIONS. We offer interconnections for power and signals to and from a system. This interface may be between sub-assemblies within the same enclosure or between individual units.

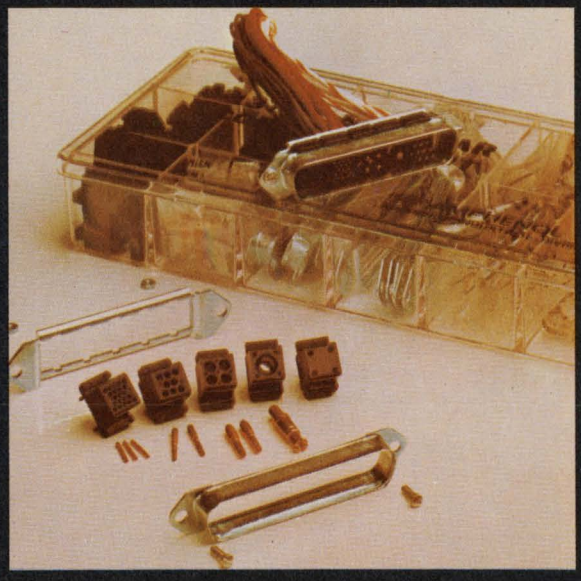
# of interconnections.



level 3 Low cost strip connectors (above) are used as jumpers in back plane wiring. Intermates with .025" square or round posts. ■ Circuit Concentration Bay (below) consists of wire wrappable panels that are five times as compact as the telephone distribution frames they replace.



level 4 Modular Integral Connector concept lets you make your own pin & socket connector to fit your needs. Five contact sizes, thousands of combinations. Sufficient components for six connectors in handy MIC-KIT. Design and assemble your own prototypes.



From the simple tube socket—to a myriad of electrical/electronic connectors—to complete and complex termination systems . . . SPECTRUM.

But SPECTRUM is far more than products. It is a depth of capability in engineering, manufacturing and quality control. Amphenol's SPECTRUM is a new height of service, availability and distribution backed by seven Amphenol interconnection-oriented divisions.

Amphenol can fulfill your total interconnection requirements because we are not limited to specifics such as one or two product lines, one or two levels. Therefore we approach your interconnection needs with complete open-mindedness.

For more new ideas and specific information, write for your copy of "SPECTRUM." Amphenol Industrial Division, Bunker Ramo Corp., 1830 South 54th Ave., Chicago, Illinois 60650.

BUNKER RAMO AMPHENOL

INFORMATION RETRIEVAL NUMBER 7

(continued from p. 7)

puter garbage when executed the first time, for it is in the wrong place. Should it replace the CONTINUE of statement 1 perhaps? The "31E18" of the referenced FORMAT statement should be "3E18."

The program references to RANDU should be explained, since this is not a standard FORTRAN subroutine. I would asume that it is the program by that name in IBM publication H20-0205, "System/360 Scientific Subroutine Package." The listed computer program will not run without the RANDU subroutine, which should be defined for an understanding of variables IX, IY, AND A.

Dale L. Schafer
Systems Analyst
Texas A & M University
Texas Transportation Institute
College Station, Tex. 77843

The author replies

In response to Dale L. Schafer's letter and to the earlier letter from Kittredge D. Seely (ED 17, Aug. 17, 1972, p. 7) concerning my article "Speed Computer-Aided Circuit Design":

1. Because of a printer's error, the model number of the computer appeared as S/360-501 instead of S/360 50I. But the comparative time estimates between the random-number method and Fletcher-Powell are still valid, no matter what machine is used.

2. Schafer is correct in saying that a format of 31E18.8 won't work. This was a typographical error on my part. The correct format is 3E18.8.

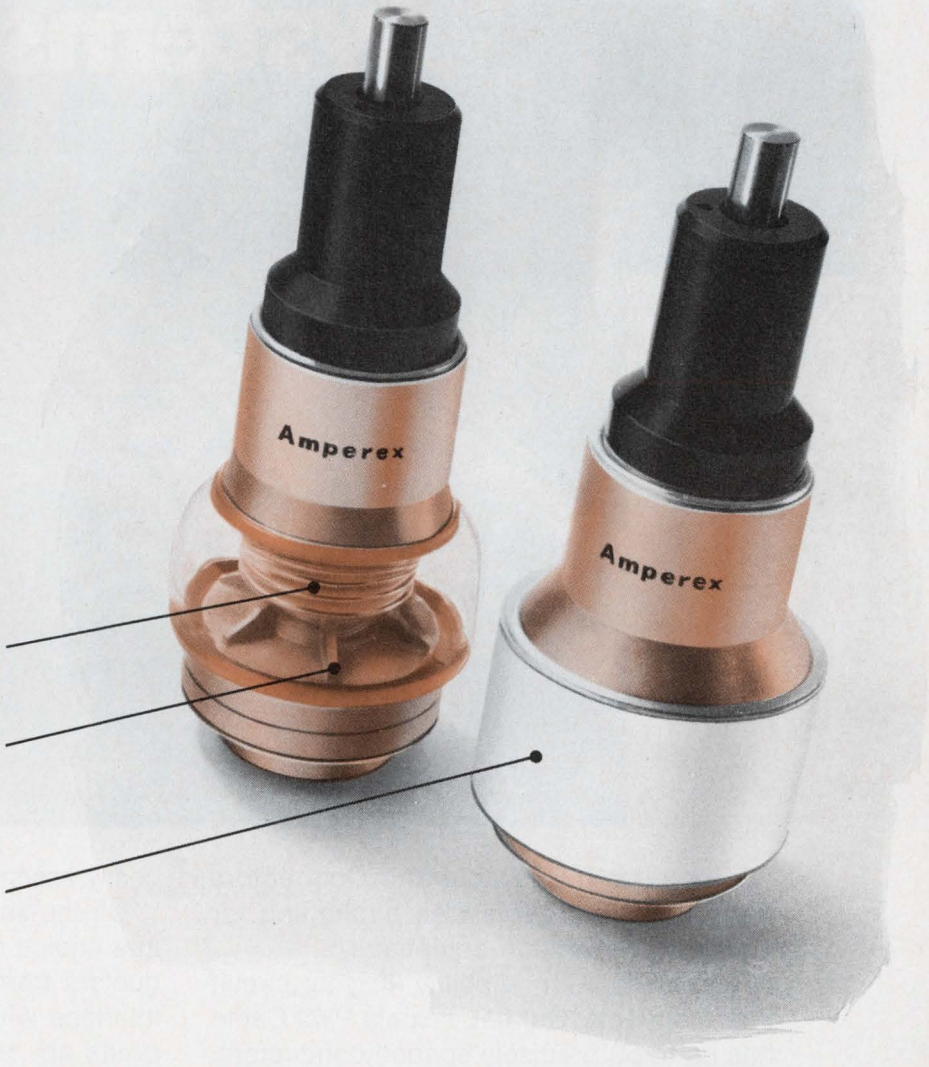
3. The first WRITE statement is incorrectly placed. It can precede statement 8, to prevent writing garbage the first time through the routine.

4. Statement 7 is the function to be minimized. This is not the sensitivity function of the active filter. Also, the two statements preceding statement 7 may or may not be desired, depending on how one wishes the minimization to proceed. Statement 7 is the location in this example of the function to be minimized. I

(continued on p. 13)

If you think that one line of variable vacuum capacitors is just about the same as the next- you're right...

...except for three things.



1. *Amperex uses short duty cycle LONG LIFE BELLOWS—practically doubles the cycle-life of the capacitor.*
2. *Amperex SHOCK SUPPRESSING BRACE permits capacitor to withstand shock level of 150 G's at a pulse width of 11 milliseconds.*
3. *Amperex can supply EVERY CAPACITOR IN ITS LINE with a CERAMIC envelope, increasing the capacitor's temperature-handling range from 85°C to 125°C.*

Outside of longer cycle life, greater ability to withstand shock, and increased temperature-handling capacity, Amperex variable vacuum capacitors are probably no better and no worse than the competition's. They are competitively-priced and directly interchangeable with existing types, both electrically and physically. They are tested to exceed MIL standard 23183B specifications. And every capacitor shown in the Amperex catalog with a glass envelope is available on request in a ceramic version.

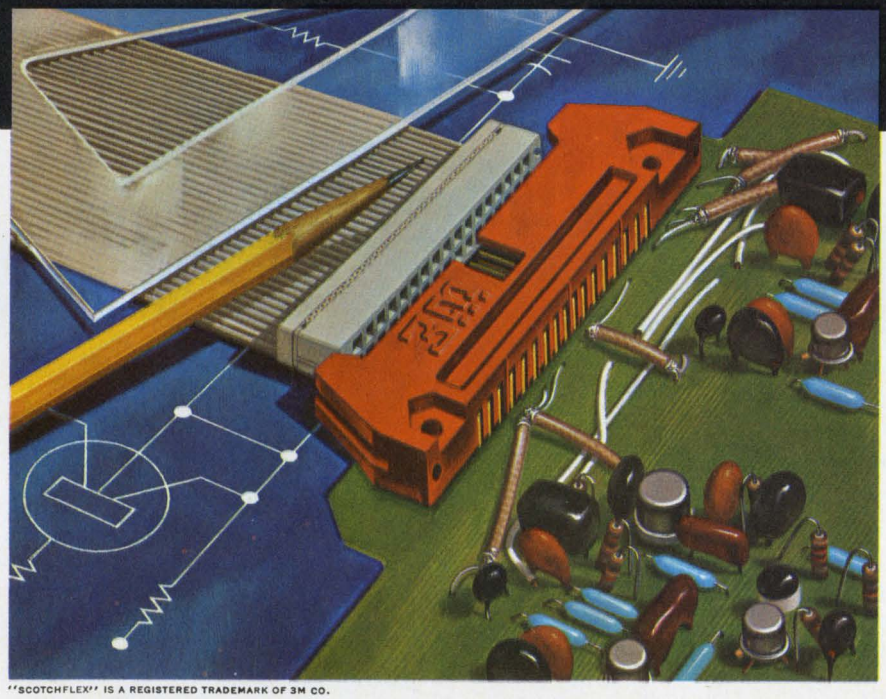
Application assistance on new or existing designs is available. For data, including complete replacement guide with prices, write: Amperex Electronic Corporation, Professional Tube Division, Hicksville, N.Y. 11802.

Amperex®

TOMORROW'S THINKING IN TODAY'S PRODUCTS

Sold through
North American Philips Electronic Component Corporation

For built-in reliability, design with "Scotchflex" Flat Cable/Connector Systems.



"SCOTCHFLEX" IS A REGISTERED TRADEMARK OF 3M CO.

"Scotchflex" Flat Cable and Connectors can offer you trouble-free packaging for your next generation equipment.

There's built-in reliability for your circuit inter-connects. Our flat, flexible PVC Cable has up to 50 precisely spaced conductors. The gold plated U-contacts are set into a plastic body to provide positive alignment. They strip through the insulation, capture the conductor, and provide a gas-tight pressure connection.

Assembly cost reductions are built-in, too. "Scotchflex" Connectors make up to 50 simultaneous connections without stripping or soldering. No special training or costly assembly equipment is needed.

Off-the-shelf stock offers you flat cable in a choice of lengths and number of conductors from 14 to 50. Connector models interface with standard DIP sockets, wrap posts on .100 x .100 in. grid, or printed circuit boards. Headers are available to provide a de-pluggable inter-connection between cable jumpers and printed circuit boards (as shown). Custom assemblies are also available on request.

For full information on the "Scotchflex" systems approach to circuitry, write to Dept. EAH-1, 3M Center, St. Paul, Minn. 55101.

3M COMPANY

INFORMATION RETRIEVAL NUMBER 10

(continued from p. 10)

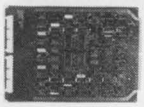
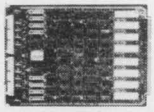
have used the program with the apparent corrections of Schafer and with various sensitivity functions to investigate cases for minimum sensitivity. The sensitivity function was not given in the article because of assumptions made to obtain it and because of its complexity. I did not feel this would have added to the article, which was trying to present an idea for general usage, not one particular example.

5. RANDU is a subroutine in the IBM Scientific Subroutine package. (The article stated that an IBM 360/50 was used.) IX and IY are used to generate a real number between 0 and 1 that is returned as A. The specifics of this routine or alternates must be explored for systems where the minimization routine is being programmed.

The program of Fig. 3 is intended to show that, for a minimum, one can set a function B3 to a very large number (B3 = 10**6), which would be much larger than the expected minimum. Then the random-number generator for the particular computer system employed is set up by initializing the routine (IX = 75773). Following this, 500 passes are set up to choose variables (DO 8 J = 1,500). The next correct statement can be the format statement for three variables. Following this the random number is generated and set to A (CALL RANDU (IX, IY, A)). RANDU is re-initiated for the next use (IX = IY). A variable of the function to be evaluated is set (A1 = 10*A) to scaled random number. A similar process is used for A (A2 = 10*A). Now the function is evaluated by an average of 10 passes of the function (X = X + 0.1, B = f(X) + B.) The next step is to determine if the new value of B is less than the old one (previously B3 = 10**6); if it is, save this B and the variables of the function and write out these values. If this value of the function is not smaller, then continue and choose a new set. After the number of guesses is exhausted (in this case 500 passes), write the minimum of the function and the variables that yielded the minimum. Then stop the program. ■■

Microdata moves into systems

Microdata, the company that made microprogramming irresistible, has moved into systems. We now offer all the modules, peripherals, software and application firmware you'll need to configure a high-performance system at a low price. Pick the items you need and add up their costs. Then compare the total with anything you get from our competition. You'll see what we mean.

System Computers 	Series 1600 Computers—CPU with power fail/auto restart, ROM control memory, real time clock, teletype controller, power supply, card cage and system control panel. Typically, $4,000	Model 2208 Magnetic Core Memory—8,192 byte, 8-bit module (up to 8 modules per computer). $1,800				
Utility Interfaces 	Model 2510 Byte I/O Controller—provides independent input and output controllers each with 8-bit data transfers. $800	Model 2511 Full Word I/O Interface—provides 32 input lines and 32 output lines with data transfers under program control. $700	Model 2512 Priority Interrupt Board—provides 8 levels of priority interrupt with individual arm/disarm. $550	Model 2513 Selector Channel—operates by way of direct memory access, accommodates up to four I/O devices. $850		
Communications Interfaces 	Model 2601 Synchronous Modem Interface—has auto call/answer unit, accommodates standard rates up to 9600 baud. $1,200	Model 2610 Asynchronous Communications Controller—single channel, full duplex, programmable baud rates to 9600 baud. $500	Model 2612 Asynchronous Communications Controller—provides simultaneous operation of 8 full duplex asynchronous channels. $1,600	Model 2613 Asynchronous Modem Interface—provides simultaneous operation of 8 full duplex 103 and 202 type data sets. $2,000	Model 2620 Modem/Communications Control—provides 16 discrete inputs and 16 discrete outputs. $800	Model 2630 Automatic Call Unit Controller—provides control function for four Bell Model 801 automatic call units. $950
Peripheral Systems 	Model 2710 Paper Tape System—300 cps fanfold 8-channel reader, 75 cps fanfold 8-channel punch. $3,955	Model 2720 Card Reader—300 cpm, 80 column cards. $3,750	Model 2731 Line Printer—80 column, 64 character set, 356 lpm. $9,750	Model 2732 Line Printer—132 column, 64 character set, 245 lpm. $12,500		
	Model 2810 Magnetic Tape System—with one 7", 9 track, 800 bpi, 10,000 bytes/second transport and controller for up to four transports. $4,630	Model 2811 Magnetic Tape System—with one 7", 9 track, 800 bpi, 20,000 bytes/second transport and controller for up to four transports. $4,760	Model 2820 Magnetic Tape Transport—7" reel, 12.5 ips, 9 track, 800 bpi. $2,830	Model 2821 Magnetic Tape Transport—7" reel, 25 ips, 9 track, 800 bpi. $2,960	Model 2822 Magnetic Tape Transport—8½" reel, 12.5 ips, 9 track, 800 bpi. $2,890	
	Model 2823 Magnetic Tape Transport—8½" reel, 25 ips, 9 track, 800 bpi. $3,020	Model 2851 Disc System—includes disc drive with moving head removable cartridge, 2.4 million bytes, 75 ms random access, 200 kb transfer rate. $11,730	Model 2852 Disc System—includes disc drive with moving head (one fixed and one removable), 4.9 million bytes, 95 ms random access, 200 kb transfer rate. $12,750			
					TOTAL	**$**

with top performance and the right price

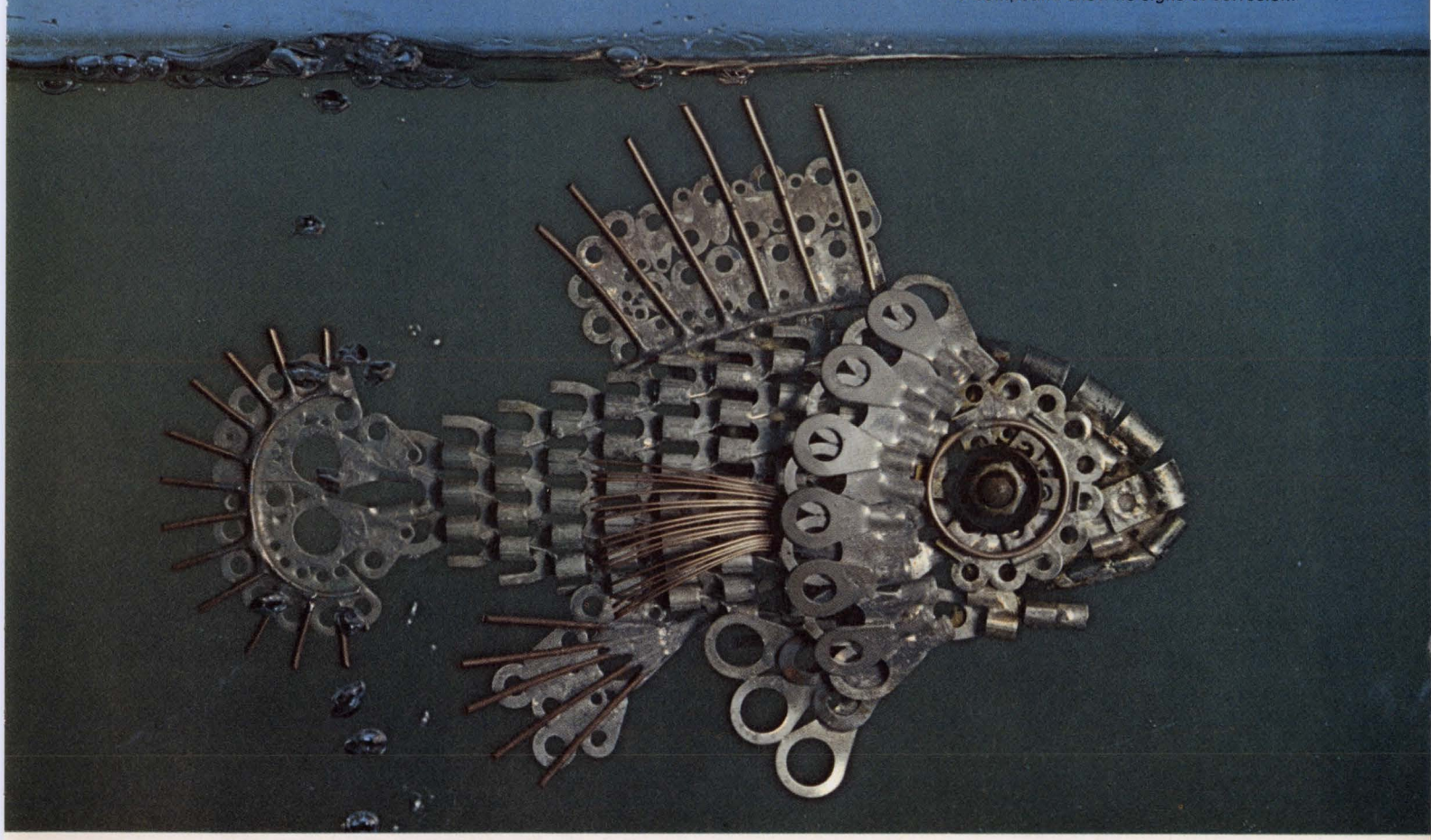
Microdata

Microdata Corporation
17481 Red Hill Avenue
Santa Ana, California 92705
(714) 540-6730

INFORMATION RETRIEVAL NUMBER 12

Rust. Corrosion. Galvanic coupling. Why tolerate them? Eliminate corrosion indefinitely with Dow Corning silicone dielectrics.

The fish, shown here in a tank of water, has since spent over 312 hours in a salt-fog chamber under accelerated aging test ASTM B117-64. Parts coated with Dow Corning® 6 Compound show no signs of corrosion.



Now you can inhibit corrosion for up to 20 or 30 years or more with Dow Corning® dielectric compounds. We offer a wide range to solve virtually all corrosion and moisture problems found in electrical and electronic equipment.

For example, Dow Corning 2 compound is especially formulated to protect copper conductors and device leads. Our 6 compound inhibits rusting of iron and steel. Number 19 compound prevents galvanic corrosion of electrical connectors, particularly aluminum-to-copper and steel-to-aluminum. All three greaselike compounds have excellent dielectric properties, are water repellent, resist drying out in service, retain protective properties from −40 to 400 F.

For tougher moisture and water problems, our dielectric sealing compounds protect better, longer, than any other sealing materials. Our 4 compound is particularly effective on ignition systems, disconnects, electronic assemblies, electrical terminals. Number 11 compound seals vacuum and pressure systems, transformers, sonar systems.

Take your first step now, to the prevention of corrosion. Write for full product information. Dow Corning Corporation, Dept. A-2308, Midland, Michigan 48640.

Dielectric compounds from

DOW CORNING

DOW CORNING

One of a series of quick guides for design engineers

Sometimes magnet specs are pushed to the limit. Here's a new limit.

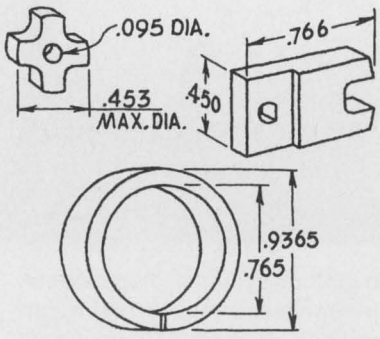
Sintered Alnico

When your magnet requirements include high coercive force, intricate shapes, and close tolerances, sintered Alnico 8HE and 8H now provide a wider range of parameters to choose from. Coercive force 1800 Oersted and higher. Tolerances within 0.005 in.

The powdered metal process has been expanded through new manufacturing technology at Indiana General to give you the advantages of all six sintered Alnico materials in a wider range of sizes and configurations. You can now get high resistance to demagnetization and the lowest temperature coefficient of any magnet material in magnets to one-fourth pound.

Intricate shapes

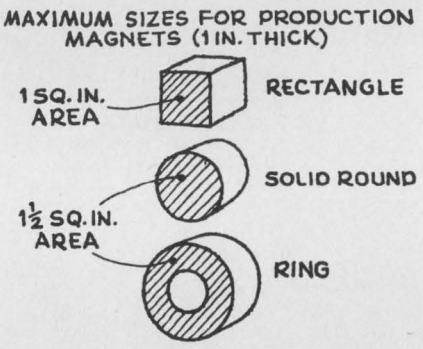
Higher consistency and homogeneity of the sintered process result in finished magnets with extremely close tolerances, smooth surfaces and high physical strength.



Intricate configurations such as these are typical of the many shapes produced through Indiana General's sintering facility. Precise tolerance and superior finish can eliminate grinding operations to lower your magnet cost in many applications.

Now—larger sizes

Our expanded sintering capability now offers you production magnets in the size ranges shown below.



A wide variety of configurations within these parameters of area and length are available to meet your production requirements.

For applications involving larger sizes, special manufacturing processes are employed. Sintered magnets up to *four inches* in surface area are being produced at Indiana General. Please contact us for specific recommendation.

High residual induction—high coercive force

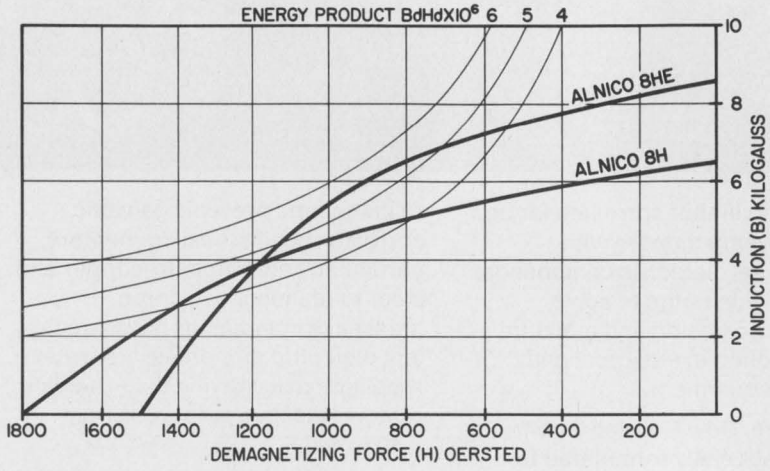
Alnico 8HE gives you highest residual induction (8,600 Gauss) and should be selected when the magnet material operates at the knee of the B/H curve (maximum energy) or above.

Alnico 8H has the highest coercive force (typically 1800 Oersted) and should be selected when the magnet material operates below the knee or near the coercive force of the material.

Get complete specs

Our new *Magnet Materials Manual* number 34 covers the complete family of sintered Alnico materials — 2, 4, 5, 6, 8HE and 8H. Magnetic and material characteristics, demagnetization curves and tolerances are shown for each Alnico grade.

For your copy of this comprehensive guide to the latest in metal magnet technology, just contact: Indiana General, Magnet Products, Valparaiso, Indiana 46383. Phone (219) 462-3131.



indiana general

a division of Electronic Memories & Magnetics Corporation

3014

INFORMATION RETRIEVAL NUMBER 14

No. 15-72

SEMICONDUCTOR
NEWSBRIEFS

PUBLISHED BY MOTOROLA SEMICONDUCTOR PRODUCTS INC.

Schottky Barrier Rectifiers Break Through To 40 V, 40 A

In 1970, Motorola technology brought you the first Schottky barrier rectifiers – with a peak inverse voltage rating of 20. In 1972, Motorola technology breaks through again – with the first 40 volt devices in the industry. Now you can get 12 new Schottkys ranging from 5 to 40 amperes in 20 V, 30 V, or 40 V PIV. And they're all JEDEC registered!!

Motorola Schottky technology uses majority carrier operation to do away with stored charge resulting in reverse recovery times that are virtually unmeasurable. Operation continues well up into the megahertz range.

Motorola Schottky technology uses epitaxial construction, oxide passivation and very closely controlled metal overlay contacts to produce surge capacity 3 to 5 times greater and forward voltage less than half that of conventional silicon power rectifiers.

When you use Motorola Schottky technology, you get:

- Rectification efficiency flat to beyond 100 kHz – perfect for high-efficiency switching power supplies.
- Power loss 50% less than with conventional power rectifier diodes. You use smaller heatsinks and transformers. Save space, weight.

Even when compared with existing Schottkys, Motorola technology comes through. The new Schottkys feature much lower leakage and transient voltage sensitivity, greater temperature stability and a higher operating junction temperature range to +125°C.

The new Schottkys are supplied in 4 current ratings, each in the 3 voltages – 20 V, 30 V, and 40 V. 1N5823, 4, 5 are 5 A versions in a metal axial lead case; 1N5826, 7, 8 are 15 A, DO-4 stud devices; 1N5829, 30, 31 are 25A, DO-4 stud cased devices; and 1N5832, 3, 4 are 40 A, DO-5 versions. And Motorola Schottkys will soon be available in plastic.

Let Motorola Schottky technology rectify your situation. See your Motorola salesman for evaluation samples and information.

For details, circle 211

Where Op Amps Go, ±15 V Regulator Follows

Mary had her little lamb, and now linear system designers have the MC-1568. For, everywhere their op amps go this dual ±15 V tracking regulator is sure to follow.

Both the MC1468 version and the full MIL temperature range MC1568 represent the best value/price-performance combination available in dual polarity tracking regulators. In addition to the standard metal and dual in-line ceramics, Motorola offers the "R" metal power package. Its 2.4 W power dissipation permits full use of the MC1568's 100 mA load current capability when running at higher voltages. And the MC1568 can handle input voltages up to ±30V.

Other important features of the MC-1568 regulator are excellent tracking with output voltages balanced to ±1%, and output voltage temperature stability assured to a maximum 1%.

Outputs are pre-set internally to ±15 V with initial tolerance of 0.2 V (max) at currents up to 100 mA. When desired, a simple external adjustment is all that's needed to change them. Line and load regulation are 0.6%.

Prices are amazingly low for devices of this sophistication. The MC1468G is a mere $2.80, the L version only $2.90, and the R a modest $3.75. MC1568G, L, and R range from $6.25 to only $7.00. Give a little lamb a place to go. Contact your Motorola distributor or sales office.

For details, circle 212

McMOS Grows On All Sides!

McMOS is the name, growth is the game. We've regularly recited the complementary MOS litany for more than a year: CMOS is the new logic for low power systems . . . CMOS is the new logic for noisy control systems . . . CMOS is the new logic for battery operated and battery back-up remote systems . . . And it's true. McMOS is the low power logic of the seventies.

And before you can say "Leading Edge Of Digital Technology," CMOS will present to designers like you a full range of system optimized functions on a broad scale providing a combination of benefits other digital technologies can't. No complementary MOS line has met this need completely. But McMOS is stretching . . . maturing . . . growing fast! And growth has already led to new lower pricing, too.

Twenty-nine new MSI and simpler functions were introduced from the first of the year through September. The result is an effective combination of the most popular second-source devices with carefully-designed, original Motorola functions filling in the gaps.

Benefits are as great as they have been from the beginning! And prices are even better.

- Lowest quiescent power dissipation . . . 10 nW per gate.
- Top noise immunity – 45% of V_{DD} (typ).
- Single supply operation – plus or minus – over a 3 to 18 V power supply range.
- Simple digital interfacing.
- Choice of standard mil operating temperature range: −55° to +125°C or unusually wide commercial temperature range: −40°C to +85°C.
- And more!

All types listed are available now.

EXPANDING McMOS FAMILY

These recent introductions have been added to the 20 devices previously available in the continuously expanding McMOS low power logic family. New low prices are available on McMOS logic, too, with some devices reduced more than one third.

Motorola Device #	Function	Replaces Pin-for-Pin	Price (100-999)
MC14000AL/CL	Dual 3-Input NOR Plus Inverter	CD4000AD/AE	3.10/0.78
MC14006AL/CL	18-Bit Shift Register	CD4006AD/AE	9.10/3.89
MC14007AL/CL	Dual Pair and Inverter	CD4007AD/AE	2.65/0.78
MC14008AL/CL	4-Bit Full Adder	CD4008AD/AE	10.15/4.02
MC14009AL/CL	Hex Inverter/Buffer	CD4009AD/AE	5.25/1.69
MC14010AL/CL	Hex Inverter	CD4010AD/AE	5.25/1.69
MC14016AL/CL	Quad Analog Switch/Quad Multiplexer	CD4016AD/AE	5.15/1.62
MC14023AL/CL	Triple-3 NAND Gate	CD4023AD/AE	3.40/0.78
MC14028AL/CL	BCD Decimal Decoder	CD4028AD/AE	7.92/3.67
MC14032AL/CL	Triple Full Adder (pos)	CD4032AD/AE	6.91/4.24
MC14038AL/CL	Triple Full Adder (neg)	CD4038AD/AE	6.91/4.24
MC14040AL/CL	12 Stage Binary Counter	CD4040AD/AE	10.20/5.40
MC14506AL/CL	Expandable A.O.I.	—	4.64/2.24
MC14516AL/CL	Binary Up/Down Counter	—	11.47/6.35
MC14522AL/CL	Programmable BCD Divide-by-N 4-Bit Counter	—	11.85/6.60
MC14526AL/CL	Programmable Binary Divide-by-N 4-Bit Counter	—	11.85/6.60
MC14527AL/CL	BCD Rate Multiplier	—	11.85/6.60

For details, circle 213

SEMICONDUCTOR newsbriefs
No. 15-72

Published by Motorola Semiconductor Products Inc., P. O. Box 20912 • Phoenix, Arizona 85036

Twelve MTTL Complex Functions Increase Your Design Options

Reduce package count, increase logic per function with 12 new MTTL building blocks — four data selectors, three counters, two shift registers, a bus transfer switch, encoder, and decoder.

Ideal for data-routing and multiplexing, the MC54150/74150 16-channel data selector generates any five-variable Boolean function. And for multiple data in and/or multiple data out jobs use the MC54460/74460 bus transfer switch.

Looking for 4-bit storage? The MC8280/7280 4-bit shift registers can divide decade or binary (MC8281/7281) or act as storage registers. The MC8280/7280 is sectioned into divide-by-two and divide-by-five functions (decade) while the MC8281/7281 is sectioned into divide-by-two and divide-by-eight functions (binary).

Decoding is simple with the MC9307/8307 BCD-to-seven segment decoder. It accepts a 4-bit BCD 8421 code input producing outputs for seven-segment displays. The MC9318/8318 8-input priority encoder converts a one-of-eight code to a 3-bit binary code in order of priority, with $\overline{D}$ assigned the highest priority.

Input/output conversions are prime applications for the MC8270/7270 and MC8271/7271 4-bit shift registers. And the MC9306/8306 presettable decade up/down counter offers four synchronously driven master-slave J-K flip-flops.

All are exact replacements — pin and function — for older designs and are available in limited and full temperature ranges. Call for evaluation units today.

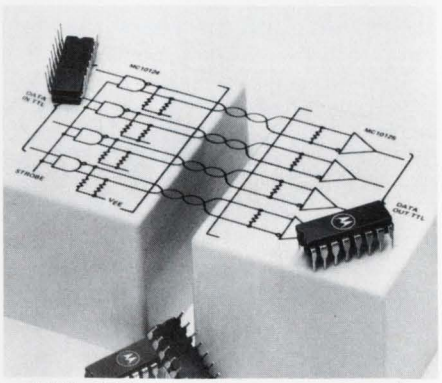
TYPE NO.	FUNCTION	PRICES (100-UP)
MC54150L MC74150L,P	16-Channel Data Selector	$9.70 6.45(L)/4.30(P)
MC54151L MC74151L,P	8-Channel Data Selector	$9.00 6.00(L)/3.45(P)
MC54460F,L MC74460F,L,P	Bus Transfer Switch	$8.05(F,L) 4.10(F,L)/3.15(P)
MC8266F,L MC7266F,L,P	2-Input, 4-Bit Data Selector	$6.08(F,L) 4.05(F,L)/2.70(P)
MC8267F,L MC7267F,L,P	2-Input, 4-Bit Data Selector (Open Collector)	$6.08(F,L) 4.05(F,L)/2.70(P)
MC8270F,L MC7270F,L,P	4-Bit Shift Register	$6.42(F,L) 4.28(F,L)/2.85(P)
MC8271F,L MC7271F,L,P	4-Bit Shift Register	$6.42(F,L) 4.28(F,L)/2.85(P)
MC8280F,L MC7280F,L,P	Presettable Decade Counter	$5.40(F,L) 3.60(F,L)/2.40(P)
MC8281F,L MC7281F,L,P	Presettable Binary Counter	$5.40(F,L) 3.60(F,L)/2.40(P)
MC9306L MC8306L,P	Presettable Decade Up/Down Counter	$11.55 7.70(L)/5.15(P)
MC9307F,L MC80307F,L,P	BCD To Seven Segment Decoder	$7.88(F,L) 5.25(F,L)/3.50(P)
MC9318F,L MC8318F,L,P	8-Input Priority Encoder	$12.00(F,L) 6.00(F,L)/4.20(P)

F Suffix = Ceramic Flat Pack
L Suffix = Ceramic Dual In-Line Pkg.
P Suffix = Plastic Dual In-Line Pkg.

For details, circle 214

MECL 10,000 Translators And Multiplexer/Latches Now Available

Mate low speed TTL sections with high speed ECL systems easier with the MC10124 MTTL to MECL translator



MECL 10,000 translators can materially improve data transmission within a TTL system.

and the MC10125 MECL to MTTL translator.

The MC10124 is a quad translator having TTL compatible inputs and MECL complementary open-emitter outputs that allow its use as an inverting/non-inverting translator or as a differential line driver. Typical prop delay is 5.0 ns. MC10124 can drive 50 ohm lines with high fanout capability.

MC10125 is a quad translator incorporating differential inputs and Schottky TTL "Totem Pole" outputs. Differential inputs allow its use as an inverting/non-inverting translator or as a differential line receiver. And a V_{BB} reference voltage is available for Schmitt trigger applications.

The translators can also improve data transmission between TTL equipments. In the illustration, the complementary outputs of the MC10124 drive a twisted pair data line connected to the differential receiver inputs of the 10125. This application provides a toggle rate typically in excess of 75 MHz, excellent noise rejection, and the quad translators offer minimum package count over conventional duals.

Two new multiplexer/latches are ideal for application in high speed central processors, register files, instrumentation, and high speed digital communication systems. The MC10132 dual multiplexer with latch and common reset provides a common select input for both latches. Information selected at the input is latched on the rising edge of the clock pulse. The common reset input is used to reset the latches.

The MC10134 offers two latches with separate select inputs for each of the two pairs of data inputs. Each select input determines the information that will be provided to the appropriate latch.

All four devices are available in the 16-pin dual in-line ceramic package (L). 100-up prices are: MC10124L — $4.50; MC10125L—$4.50; MC10132L—$5.02; MC10134L — $5.02.

Evaluate these new additions to the expanding MECL 10,000 line.

For details, circle 215

First Plastic Power Darlingtons Registered

Here they are! — the first 2N-registered plastic power Darlingtons with super-high gain, voltage and current for those super-low-priced series regulators, hammer drivers and general-purpose amplifiers.

They're the 2N6040 series of 5 and 8 A THERMOPAD devices in two optimum plastic packages. And they're complementary, too, for your transformerless, direct-coupled designs.

Gain? Much! 2,500 h_{FE} typically at 4 amperes with 1,000 minimum spec'd. Lets you go from milliamperes to amperes directly, compatibly and easily with T^2L-to-Darlington hookups. No bother with interface componentry.

Voltage? High! Up to 100 V sustaining capability for your more demanding designs. Safe operating area is excellent with all types providing 1.5 A @ 40 V SOA. On the other end of the scale, a low, low, 2V maximum saturation voltage ensures minimum power loss.

Packaging? Optional! Your choice of the ever-popular, THERMOPAD case 90 with all the traditional, high-efficiency, compact mounting advantages or the newer, easy-mounting THERMOPAD case 199 offering more power-handling, more lead forms, more chip sizes, and more technology than TO-220 parts.

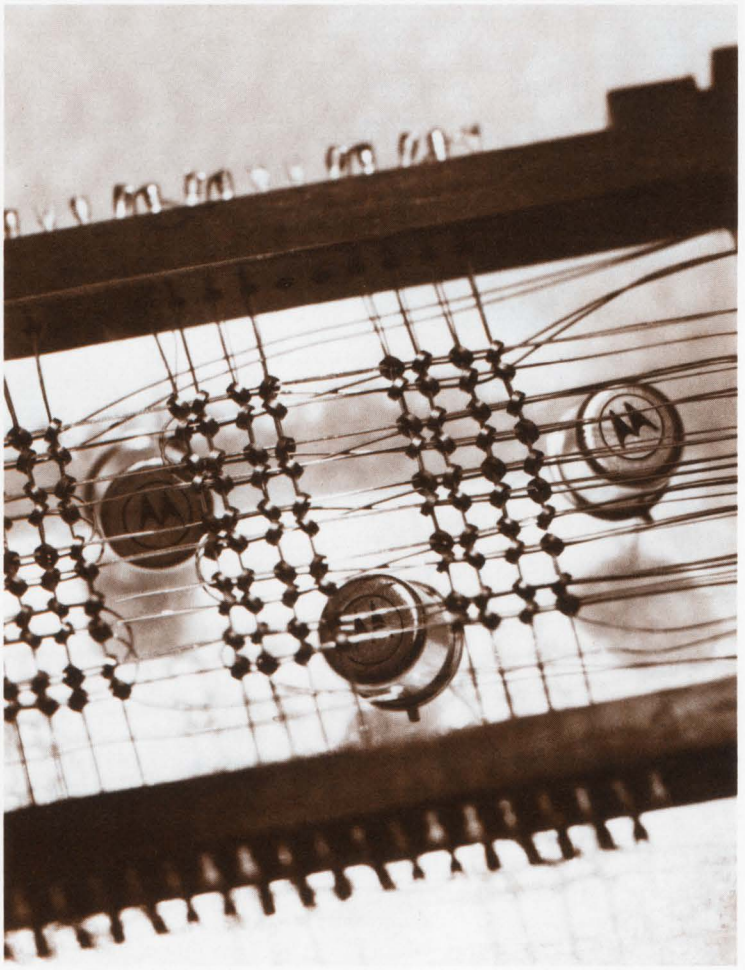
Other advantages include 60 and 80 V ratings, monolithic construction with emitter-base resistors on the one chip, and low price tags. To prove the last, the 2N6043 is only $1.64, 100-up. Not only better-than-discrete performance, but better in price, too!

Check the specs . . . then see your distributor about evaluation units.

For details, circle 216

		1-99	100-999
Case 90/199	2N6040/MJE6040	$3.05	$2.31
	2N6041/MJE6041	3.33	2.52
8 A	2N6042/MJE6042	3.83	2.90
60-100 V	2N6043/MJE6043	2.14	1.64
NPN/PNP	2N6044/MJE6044	2.37	1.83
	2N6045/MJE6045	2.77	2.14
Case 90/199	MJE1090/2090	2.70	2.05
	MJE1091/2091	2.90	2.23
5 A	MJE1092/2092	3.10	2.40
60-80 V	MJE1093/2093	3.50	2.65
NPN/PNP	MJE1100/2100	1.82	1.40
	MJE1101/2101	1.99	1.53
	MJE1102/2102	2.21	1.70
	MJE1103/2103	2.44	1.88

2N3725 Joins The Motorola Core Corps



Whether your frames are large or small, Motorola's 2N3725 gets to the core of the induction problem by providing a 50 volt BV_{CEO}.

Here's a new recruit to help you restore core to its rightful place in the store war. After a short campaign as a house quad in the dual in-line ceramic case, the NPN silicon Annular memory driver transistor that offers the best trade-off between high breakdown voltage and fast switching is here fully armed and JEDEC registered as the 2N3725.

The high f_T and low C_{ob} of the 2N-3725 assure fast switching (at 500 mA, t_r is typically 18 ns, t_f is 15 ns) yet BV_{CEO} is a high 50 V minimum to prevent problems from the "kickback voltages" induced by switching highly inductive lines. And Motorola's 2N3725 is the first to offer the JEDEC-required 500 mA $V_{BE(sat)}$ of 0.8 to 1.1 V.

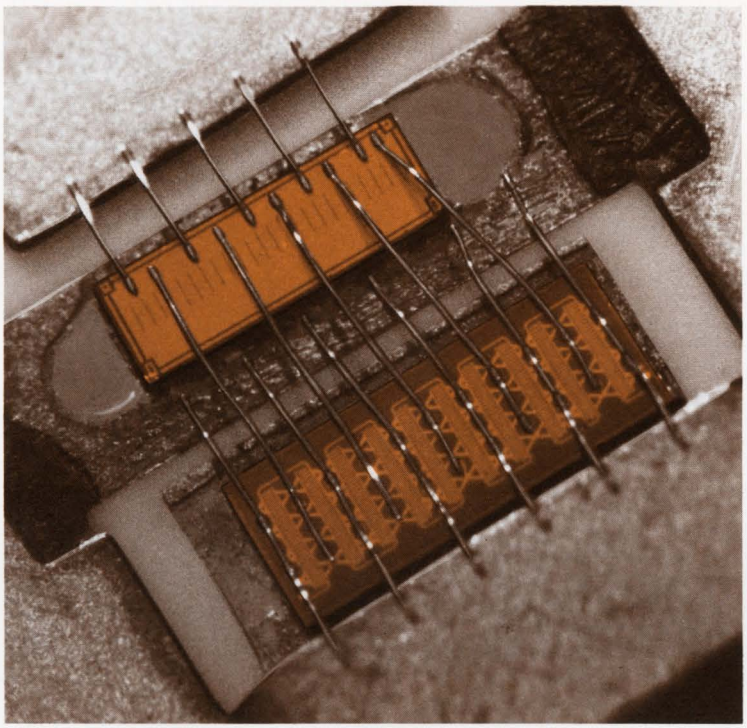
Whether your application is voltage or current driving or both, 2N3725 has the gain, h_{FE} is 35 (min) at 500 mA. And the popular driver is supplied in the TO-39 outline package with untwisted ½" leads for quick, easy assembly into your systems.

Look for the core corps to grow into a driving army. 2N3725 is just the latest recruit. More enlistments announced this fall.

See your nearest Motorola salesman for more information on the 2N3725. And don't let its 100-up price of 75¢ change your battle plans — we're competitive.

Up your esprit de core. Think 2N3725!!

For details, circle 217



Controlled-Q RF transistors employ MOS capacitor chips to transform base impedance and improve broadband performance.

RF Technology Controls Q For Broadband Performance

Brilliant new lights in the RF spectrum – the new MRF618 and MRF620 NPN silicon RF power transistors for large signal applications to 520 MHz in frequency-modulated industrial/commercial equipment. They're operated by 12.5 V supplies.

And, they have Controlled-Q!

Latest evolutionary highlight in the Motorola-developed Stripline-Opposed-Emitter configuration, Controlled-Q devices employ internal impedance-transforming techniques to lower Q at the base aiding broadband designs. An MOS capacitor chip is connected in a T-network with internal and external lead inductances to transform the typical 0.5 ohm input impedance to 4 ohms at 470 MHz. Broadband performance is improved, input matching network problems reduced. And the flange-mounted, Controlled-Q package permits easy, one-sided assembly into your amplifiers.

Characterization provides series-equivalent, large signal parameters. Major specs are: With a 12.5 V supply, MRF-620 offers 40 W at 470 MHz, 4.3 dB minimum common-emitter gain. Collector efficiency is 55%. Under the same conditions, MRF618 provides 15 W, 6.0 dB minimum gain and collector efficiency of 60%.

Rugged? . . . MR620 and MR618's Isothermal chips utilize nichrome-resistor emitter ballasting techniques for load mis-match protection. Isothermal design decreases emitter current under load mismatch conditions and compensates for variations in local temperatures over the chip. They're tested for a 20:1 VSWR at all phase angles at rated output power. So you know they'll last and *last!!*

To focus on the potential performance of an amplifier built using MRF618, we did just that, built a broadband amplifier using 2N5944/MRF618. Testing showed that with 120 mW in, the 11 W output was flat from 410 to 510 MHz. VSWR was less than 1.5:1 across that band.

Try MRF620 or 618 in your amplifier. They're on your distributor's shelf today at the 25-99 price of $40.00 (620) and $21.00 (618). But wear your sunglasses.

For details, circle 218

Hybrid IC Line Fattened By Five Fet Analog Switches

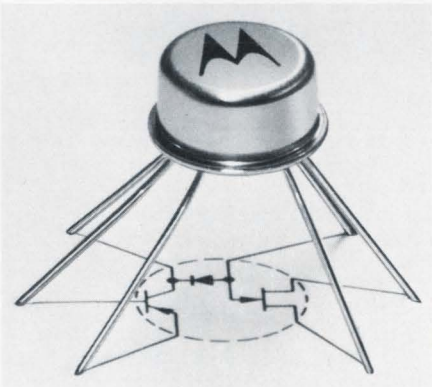
Five new analog switches – the MCH-2222-1,2 and MCH2223,1,2,3 – are now offered as standard off-the-shelf functions.

The hybrid ICs feature as low as 10 ohms (max) drain-source "ON" resistance at 1.0 mA and a signal handling capacity up to 20 volts peak-to-peak.

Minimum signal error is assured by zero intrinsic offset voltage and outstanding logic noise isolation.

They're designed for switching applications in A/D and D/A converters, sample and hold circuits, and track and hold circuits for instrumentation and in modulators and demodulators for communications equipment.

Both the MCH2222 and MCH2223 series have other important applications in solid state relays, commutators, gain changers and in general-purpose low-level switching. Their low static drain-source "ON" resistance capability offers designers minimum voltage loss and they have a nimble 300 ns typical turn-on and turn-off switching time.



Separate FET, transistor and diode chips on a common substrate are wire-bond connected in the MCH2222/23 series of Fet Analog Switches.

Available in 6-leaded TO-5 metal cans, and are mechanical pin-for-pin replacements for competitive devices.

Warehouse shelves are now well-stocked with devices carrying the following 100-up price tags:

MCH2222-1: $5.60 and MCH2222-2: $6.00; MCH2223-1: $10.00; MCH-2223-2: $15.00 and MCH-2223-3: $21.50.

For details, circle 219

NEW PRODUCT BRIEFS

MLM 101A OP AMP SERIES

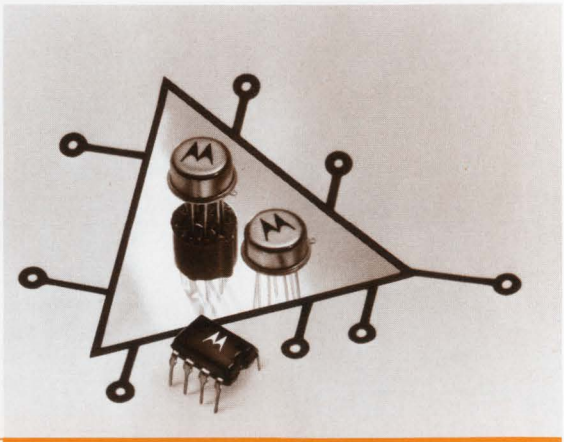
— Leads Growing Linear Second Source Availability

Two op amps and a negative voltage regulator expand Motorola's linear second source offerings. Heading the new intros are the MLM101A series, pin-for-pin equivalents to the popular general purpose LM101A series op amps.

MLM210G and MLM310G are direct replacements for the LM210 and LM310 op amp/voltage followers, and the MLM104G series negative regulators directly replace the LM104 types. These three introductions join the MLM105G series positive regulators, MLM107G series internally-compensated op amps, and the fixed 5.0 V MLM109K regulators, bringing to six the number of LM device series made available by Motorola in recent months. All are supplied in standard metal packages, and the MLM301A is also available in plastic.

Prices (100-999) range from $7.95 for the MLM101A down to $0.60 for the MLM301AP and from $8.00, MLM104, down to $2.50, MLM304. MLM210s sell for $6.00 and MLM310s for $3.25 in 100-999 quantities. All are available off-the-shelf.

For details, circle 220

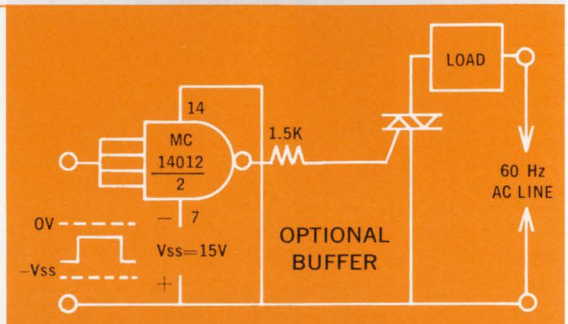


SENSITIVE GATE TRIACS FORM IC ALLIANCE

— Operates Loads To 4 A-600 V

Hooking T²L, HTL, McMOS and op amp drives to full-wave Triacs is a snap — all you need in one hand is your own IC drive . . . and the new 2N-6068A/B series sensitive gate plastic Triacs in the other. Put them together and presto: simple, economical control logic functioning for most any design. The 2N6068A/B series will trigger in various quadrants to match input drive requirements — II and III for HTL, I and IV for McMOS buffers and op amps and II and III for McMOS NAND gates and T²L. Trigger levels for this series in the 4 quadrants vary from 3 mA (for McMOS) to 60 mA for higher-level drives. Voltage ratings range from 25 to 600 V and surge current protection reaches to 30 A. You can also get control completely free of electromagnetic interference by combining a Triac, MFC8070 zero voltage switch and an MOC series opto coupler. With 100-up prices low as 59¢ you ought to try the 2N6068A/B series. You'll like it!

For details, circle 221



McMOS NAND — SENSITIVE GATE 4A TRIAC OPERATION IN MODES II & III (MOS DRIVE LEVELS)

MECL II QUAD TRANSLATORS

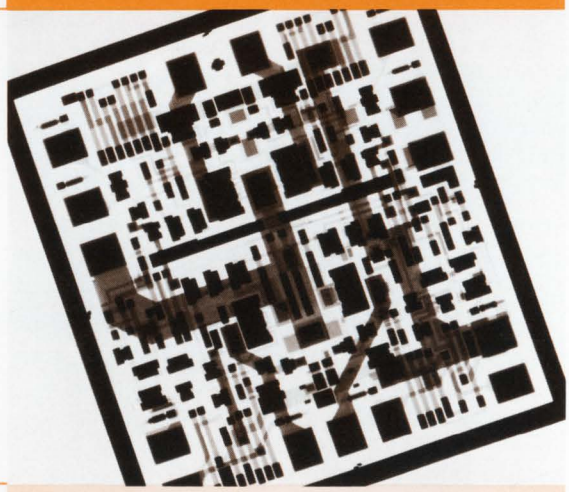
— Speak System Savings Language

Now your high speed MECL II systems TTL sections of digital equipment can "talk" through the MC1067P/1267L MECL II/TTL and MC1068P/1268L TTL/MECL II translators. Both devices are quad translators; i.e., four translating circuits on one chip in a single package — thereby reducing board space and package cost.

The MC1067/1267 features complementary open emitter outputs from all gates and a strobe input to facilitate bussing and wired-OR capability. Complementary outputs permit balanced transmission on twisted pair cable. The MC1068/1268 provides the quad NOR logic function with standard MECL II inputs and Schottky TTL "Totem Pole" outputs. Typical propagation delay for both devices is 5 ns.

MC1067P and 1068P (0° to +75°C versions) are available in 16-pin plastic dual in-line packages at a unit cost of $4.33 (100-up). For wide temperature versions (−55°C to +125°C) specify MC1267L or 1268L in ceramic dual in-line. Unit price is $5.42 (100-up).

For details, circle 222



MHTL 4-BIT SHIFT REGISTER

— First In 30-Device High-Noise Immunity Line

The MC686 is Motorola's first high-threshold logic shift register. It consists of four J-K flip-flops connected in serial fashion and offers designers the shift register function for applications in high-noise industrial environments. The new device brings the total number of noise-immune MHTL ICs to 30.

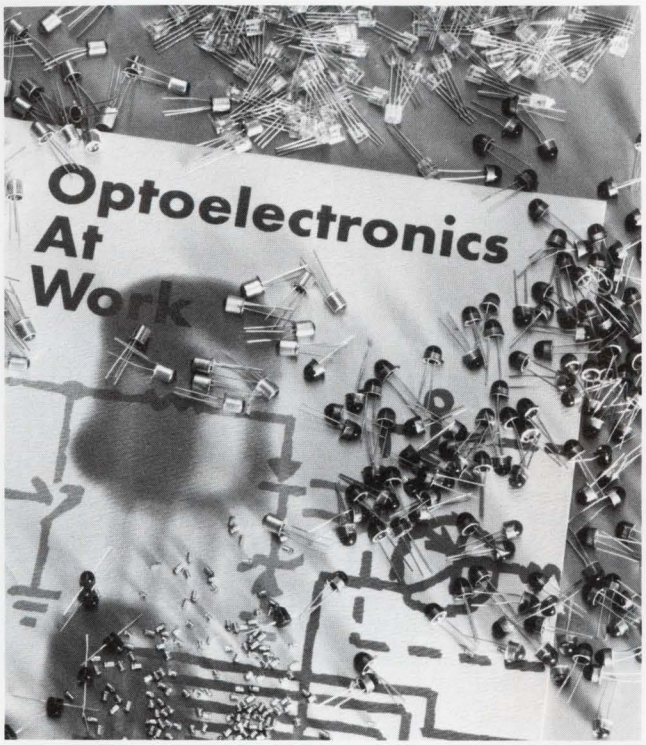
MC686's flip-flop change state on the negative transition of the clock pulse. Q outputs are available from all four stages, and $\overline{Q}$ from the last register stage. A clock-independent asynchronous master reset (MR) clears all flip-flops simultaneously. Individual set inputs ($\overline{S}$) enable any flip-flop to be set regardless of the state of the clock.

This new MHTL 4-Bit shift register operates across the −30°C to +75°C temperature range and is also available for use over the −55°C to +125°C range and/or with hi-rel processing on special order. 100-up prices, in the dual-in-line 16-pin plastic or ceramic package are $3.25 and $4.25, respectively.

For details, circle 223

COUNT	D	Q3	Q2	Q1	Q0
0	1	0	0	0	0
1	1	0	0	0	1
2	1	0	0	1	1
3	1	0	1	1	1
4	1	1	1	1	1
0	0	1	1	1	1
1	0	1	1	1	0
2	0	1	1	0	0
3	0	1	0	0	0
4	0	0	0	0	0

NEW LITERATURE



Put Opto To Work With New "Opto At Work" Book

Suddenly, optoelectronics has become a hot topic in the electronics industry, with many designers looking to it for the answers to long-standing problems. Like reliable, top-performing solid-state relays . . . simple, line-voltage indicators . . . solid-state displays . . . TTL-to-MOS interfacing . . . computer/peripheral interconnects . . .and on and on.

You'll find many of the basic answers to these and other design problems in this new "Optoelectronics At Work" book. Compiled with the express purpose of furnishing an all-around look at what optoelectronic devices can do in a variety of circumstances, the contents include more than 40 complete circuits, the industry's most comprehensive compilation of opto terminology, a selection guide to Motorola devices and the latest cross-referencing of those devices with other industry types.

All in all, up-to-date info on a fast-moving technology.

Write on your company letterhead for your copy. Put "Optoelectronics At Work" to work in your circuit designs!

Initial MECL 10,000 Reliability Report Available

A report summarizing reliability levels achieved by Motorola's MECL 10,000 family of Emitter Coupled Logic integrated circuits over an 8-month period has been prepared. The report presents results determined from operating and storage life tests as well as thermal and mechanical tests. Failure rates are estimated and discussed.

The report has been prepared in the form of an Application Note. When you write for your copy, ask for AN572.

Meanwhile, testing goes on. We'll report periodically.

Tear Along Perforated Line and Drop in Mail (No Postage Required)

LITERATURE ORDER FORM

NOTICE: Requests for literature on items described in this publication cannot be honored after **December 1, 1972.**

NEWSBRIEFS No. 15-72

Please circle the Reader Service number of item(s) you are interested in receiving.

ED

211	212	213	214	215
216	217	218	219	220
221	222	223	224	

Please Print Clearly

NAME _____

TITLE _____

COMPANY NAME _____

DIVISION _____

DEPARTMENT _____

COMPANY ADDRESS (Street or P.O. Box) _____

CITY _____

STATE _____ ZIP CODE _____

If you wish to receive mail at a different address, fill out below:

ADDRESS _____

CITY _____

STATE _____ ZIP CODE _____

Do you wish a Motorola Representative to contact you?

☐ VISIT ☐ PHONE

Phone No. _____ Area Code _____

FOLD HERE

Four New Dielectrically Isolated IC's For Radiation Environment Applications

Need to specify radiation-hard devices to satisfy computer and peripheral applications in radiation environments? If so, be sure to check out these four new D.I.C.s:

Designated the MCE7003 (7-Diode Array), MCE7005 (Diode-Resistor Network), MCE7006 (16-Diode Array), and MCE7007 (12-Resistor Network), the new devices all use a dielectric isolation instead of the usual junction isolation to combat the effects of gamma radiation. Each component is isolated by a high-resistance (10^{10} ohms) layer of SiO_2. Dielectric isolation also lowers inter-component capacitance and improves efficiency.

These DICs utilize nichrome resistors, post-metalization passivation, monometallic interconnections, and very small, high-frequency transistor structures. Their circuit designs feature the isolation of individual components in high-resistance islands, preventing metal interconnection burnout or power failure due to destructive photo currents.

For details, circle 224

D.I.C. DEVICE TYPE NO.	FUNCTION	PACKAGE	100-UP PRICE UNIT
MCE7003	7-Diode Array	(Case 607) TO-86 14-pin ceramic flat pack	$14.00
MCE7005	Diode-Resistor Network	(Case 606) TO-91 10-pin ceramic flat pack	11.00
MCE7006	16-Diode Array	Case 606	16.00
MCE7007	12-Resistor Network	Case 607	8.00

FOLD HERE

FIRST CLASS
Permit No. 2565
PHOENIX
ARIZONA

BUSINESS REPLY MAIL
NO POSTAGE NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

Semiconductor NEWSBRIEFS No. 15-72
Motorola Semiconductor Products Inc.
P. O. Box 20924
Phoenix, Arizona 85036

SEAL HERE
(Please use tape — **do not staple**)

NEWS BREAKS

LocaLogic...A New Concept In LSI Circuit Design

With the opening of the first LocaLogic Design Center, Motorola has brought complete LSI design capability into the field under the direct control of customer engineers. The design center utilizes the Polycell system . . . industry's most practical approach for designing custom LSI. In this system, Polycells (proven, completely characterized logic cells, each comprised of several interconnected components) are handled on the computer as standard building block units.

LocaLogic design — a look into "do it yourself" LSI.

Upon arrival at the center you are assigned an office as a base of operation during the course of your program. If you are new to the Polycell system, the Motorola design staff conducts a training program and once a design is started, the staff can help with any step in the sequence. Experience proves that, after brief on-site training, a logician or circuit designer with no prior background in semiconductor design or processing can very effectively use the system.

The LocaLogic Design Center is a completely self-contained operation and covers the stages of design between original logic definition and mask artwork generations. For most design programs, the center has two outputs:

1. A verified data base for generating production mask artwork.
2. A completely graded program for computer testing of the final product.

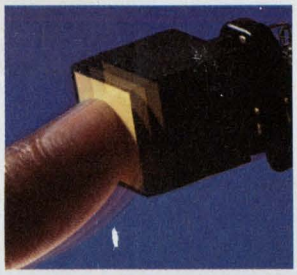
In Motorola's new LocaLogic Design Center, two designers use an X-Y plotter to visualize cell placement.

Custom LSI approaches are the answer to increased system performance and lower costs. Now these designs can be accomplished by designers working close to their own facilities; quickly, easily and economically designing their own custom LSI. Investigate this new tool and make LocaLogic a part of your design team. Write for details.

Press here to save on lighted pushbutton switches.

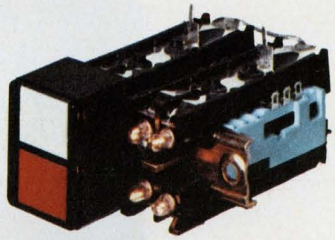
buys all the switch you need.

Oak's Series 300 gives you good looks and a small price-tag in lighted pushbutton switches. Plenty of switching performance for most jobs, without paying a premium. Even the Series 300 Split-Legend/4 Lamp Switch is less than $1.60 (normal latch, 2P2T, glass alkyd insulation, no engraving, less lamps.)



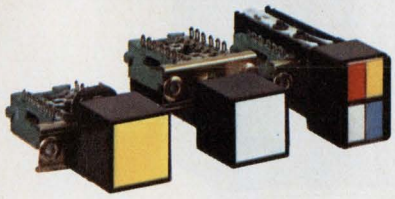
Built to take it.

Series 300 is built for reliable performance and long life. Applications galore —bank terminals, calculators, and copy equipment.



Modular design.

Single-legend/single-lamp, split-legend /4-lamp, and single-legend/redundant lamp switches have snap-on lamp holders. Plus replaceable legend plates, lens caps, and button assemblies. Front-panel relamping, too, without special tools on all types.

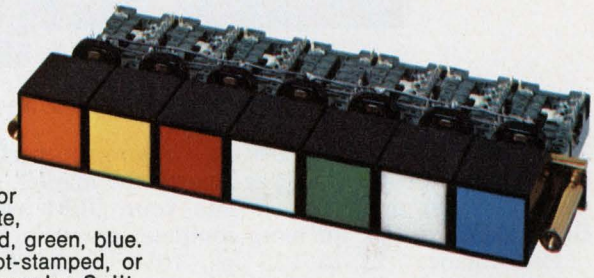


Three versions with switching up to 4P2T.

Choose from single, dual, or four lamp display as well as non-lighted type. One to twelve station, momentary, interlock, alternate action, or any combination available on the same switch bank. Lockout feature available for all types. Power Module 3A125VAC. Lighted indicators are identical in size and appearance, but without switching.

Gang them up by the dozen.

Order up to 12 switching stations on a single channel, any switching mix, with convenient panel-mounting studs. Color selection: white, lunar white, yellow, amber, orange, red, green, blue. Choose silk-screened, hot-stamped, or engraved-and-filled legends. Split-legend switches can be specified with any two, three, or four colors on insertable legend plates.



Write for our Series 300 Brochure

OAK Industries Inc.
SWITCH DIVISION / CRYSTAL LAKE, ILLINOIS 60014
TELEPHONE: 815 • 459 • 5000 ■ TWX: 910 • 634•3353 ■ TELEX: 72 • 2447

INFORMATION RETRIEVAL NUMBER 15

World's Smallest High-Performance Tape Drive.

25-125 ips, auto-threading, vacuum tape handling.

The Ampex TMA Tape Drive gives you top performance in the most compact package on the market. Only 19x24x18″, it designs itself into your OEM system. Bargain priced, too, for more computer power.

Performance: 25 to 125 ips, 10½″ reels, ANSI/ECMA 7 or 9 track standards, NRZI with 200, 556, 800 bpi or 9 track 1600 bpi. Diode and triac switching for all control circuits. Option of auto-threading or manual. Single capstan. Linear reel servo system with vacuum columns for tender loving care of your tape. A series of drives and electronics to meet your needs.

Reliable all the way. A compact performance giant.

And a super-charged buy — the best price/performance computer tape drive you can find. Special bargains when you buy in quantity. All this backed by Ampex worldwide service, 95% interchangeable parts. Get more details on better tape drives, plus Ampex disk drives and core memories, with a call to your Ampex computer specialist.

AMPEX

AMPEX COMPUTER PRODUCTS DIVISION
13031 West Jefferson Boulevard
Marina del Rey, CA 90291, (213) 821-8933

INFORMATION RETRIEVAL NUMBER 16

news scope

SEPTEMBER 28, 1972

Red Chinese are turning out computers with 'modest' ICs

In a recent trip to mainland China, six American computer experts were amazed to find the Chinese producing their own third-generation computers. So reports Severo Ornstein, computer systems designer for Bolt, Beranek & Newman, Inc., of Cambridge, Mass., and the organizer of the trip.

Ornstein has told ELECTRONIC DESIGN in an interview that the integrated circuits used in the third-generation Chinese machines are "modest" compared with American ICs, containing a maximum of only a few gates per chip. "They seem to favor a five-input NAND gate with an extender on it," he says. Although they have only smaller quantities of emitter-coupled logic, the Chinese have some that are fairly fast. Ornstein reports.

The group's tour in China included a visit to a computer manufacturing plant. Ornstein differs, however, with a production estimate made by another member of the visiting group, Prof. Thomas E. Cheatham Jr., director of Harvard's Center for Research in Computing Technology. Cheatham, an expert on computer languages and programming, estimated the Chinese factory's output at between 100 and 300 computers a year. Ornstein believes the factory is capable of producing only about 20 to 30 computers a year.

Ornstein reports that one of the great voids in the Chinese computer systems is a lack of "sensible" peripheral equipment.

"The typical machine we saw," he says, "had on it a reasonably high-speed paper-tape reader for inputting data, and a printer, generally of the teletypewriter variety, for outputting data. There were some home-brew xerographic printers and high-speed impact printers, but they were only capable of printing about 80 columns, and they were certainly not the clean type of printing that we are used to."

As for other peripherals, Ornstein says that the group saw no sign of any card equipment or high-speed paper-tape punches.

In addition the Chinese have no time-sharing of computers or disc memory systems, he says. They do, however, have small drum memories, reasonably advanced core memories and primitive magnetic tape systems, Ornstein says.

The development of the Chinese computers appears to have been strictly by "brute force," Ornstein says, without foreign assistance. Each manufacturing plant, he observes, makes the machinery to make a tool, which in turn makes more machinery to make another tool, which makes the equipment needed to build the computer.

A good example of this, Ornstein continues, can be found in the universities where the students go through the whole process of building equipment to make ICs, then make the ICs and finally use the ICs to build computers.

The use of computers in China is generally limited to scientific and engineering calculations, such as those needed for building dams and bridges, Ornstein says. The Chinese do virtually no process control with computers, he notes, because most things in China are done by hand.

"You've got to have factories before you can have process control," he observes.

While in China the visiting group saw about a dozen computers. "My guess," says Ornstein, "is that we saw most of the computers in China."

Does this mean that U.S. computer manufacturers have a new, large potential market to exploit? For the immediate future, Ornstein thinks not.

"They're not ready for a great number of computers," he believes. "If someone were to suddenly give them 30 computers, they wouldn't know what to do with them. Most of the technology there is very primitive. They need trucks much more than they need computers."

Color TV disc player is shown by Philips

N. V. Philips of the Netherlands has demonstrated in New York its Video Long Play television disc system, which—by way of a record-player attachment—plays color programs through an ordinary television set. The company says the system will be marketed in the U.S. "within a few" years by the North American Philips Corp.

Unlike other video tape systems, the VLP uses a new type of record that closely resembles an ordinary long-playing disc but that has an additional reflective coating. Both records are pressed in essentially the same way.

The playback unit of the TV disc system employs a low-powered helium-neon laser, in place of a stylus, and an electro-optical pick-up, thereby completely eliminating record wear.

The VLP disc provides color programs that run up to 45 minutes on each side. The cost will be slightly more than that for conventional records, according to a Philips spokesman. But the playback unit, he adds, is expected to cost as much as a color TV set does.

The system permits random access, image speedup, slowdown, stills, reverse or picture-by-picture display. It is being designed for the American broadcast standard (NTSC), from the Philips version that was developed for the European broadcast standard (PAL). Record speed is 1800 rpm for the NTSC system.

Machine Tool Show lures Soviet buyers

Two years ago the main attraction at the Machine Tool Show in Chicago was direct numerical control. DNC was where the action was going to be. The money. But

that hope fizzled.

This year the big attraction was not equipment—least of all DNC, which seems almost to have withered on the vine. It was the Russians. The 116-man team of Soviet engineers was watched with warmth, hope and open order books by exhibitors and visitors alike.

The gigantic show filled Chicago's International Amphitheatre and McCormick Place, playing to an audience estimated at 75,000 from Sept. 5 to 15. As always, the show was sponsored by the National Machine Tool Builders Association of Washington, D.C.

Were the Russians there to learn or to buy? Both, it seems. There was a lot of note-taking and picture-snapping.

"They had a good system worked out," one American electronics manufacturer observed. "Always operating in a group, they would pass by an exhibit, take the literature and leave. A few hours later, or the following day, they would come back. The literature had obviously been thoroughly assimilated, and they had a lot of good questions to ask."

But there were also orders. By the second day, the Russians were actively negotiating with several companies.

How much would they spend? "It could reach $20-million, but to say specifically could be in error by a factor of 10," says G. G. Ignatyev, Deputy Chairman of Stankoimport of the Soviet Ministry of Foreign Trade.

The Russians planned to visit 25 to 30 machine-tool plants in the U.S. and if "the technology and price" were right, they would buy, according to the Soviet Minister of Machine-Tool Industry, Anatoliy I. Kostousov.

Much equipment will eventually have to be bought. The Soviet Union's five-year-plan, Ignatyev pointed out, calls for an 89% increase in productivity. To do this, he added, the Russians will place great emphasis on "automated tools, NC machines and all the new, advanced machinery."

Other foreign countries visiting and exhibiting at the show included Belgium, Canada, Czechoslovakia, Denmark, France, Great Britain, Hungary, Italy, Japan, the Netherlands, Portugal, Spain, Sweden, Switzerland and West Germany.

Better crystals seen with new furnace

Materials of higher purity and crystals with improved characteristics are promised with a new furnace that uses mirrors to focus the heat of a xenon arc lamp. Temperatures of 3500 C are reported readily obtainable.

The furnace, designed at the Cambridge Air Force Research Laboratories in Bedford, Mass., is the first to be designed from scratch with the objective of controlled crystal growth in mind, according to William Field, staff physicist at the installation.

The mirrors, he says, are specially coated so they match the radiation of the xenon lamp. The radiation from the lamp is maintained constant by a servo system that uses a new type of optical pyrometer—one that is highly sensitive to the arc's temperature.

New ILS overcomes rf reflection effects

A new instrument landing system (ILS) antenna array recently tested at Boeing Field, Seattle, demonstrated that it can keep the pilot lined up with the runway centerline despite severe rf reflections from the terrain and airport environment. In addition the system is substantially less costly to install than present ones.

The test was made at Boeing, says James L. Ramsey, a member of the FAA's Research and Development Section, Washington, D.C., because reflections of ILS localizer signals from jetliner hangars, surrounding power and telephone lines and fences, as well as from nearby hills, give a "worst case" situation.

These reflections, he points out, ordinarily interfere with the pilot's vertical on-course indicator needle (when centered, it indicates he's lined up with the runway centerline). The needle may drift to one side or the other, or fluctuate so badly it can't be used.

The reflection problem arises, Ramsey says, because in ILS localizer systems two signal patterns—both aligned with the runway centerline and of the same frequency—are radiated. The first pattern is that of a ±5° on-course signal, while the second is a broader one extending to ±35° on either side of the centerline. This helps the pilot "capture" the precision localizer beam. It is this second, broader beam that is reflected and that interferes with the sharp beam.

The ILS antenna system tested at Boeing Field consists of two arrays—one for the precision pattern, the other for the ±35° "clearance" pattern. It works on the "capture effect" principle invented by Andrew Alford of Andrew Alford Consulting Engineers, Winchester, Mass., designer of the new system.

"The tests turned out to be very favorable, Ramsey reports.

An important factor that Ramsey points out is that these arrays cost less than conventional ones. They are modular—"like an erector set," he notes. They are broadband devices that have no mutual coupling. As a result, the cables are all cut at the factory, and the field installation does not require hand-tuning of stubs.

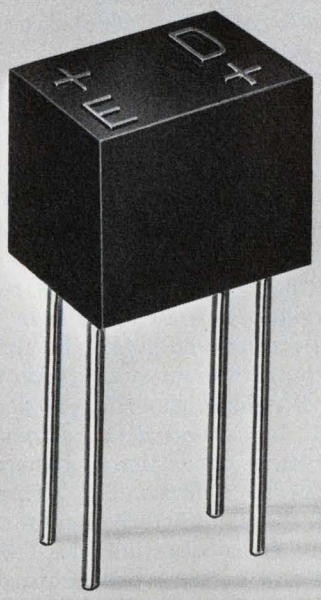
Installation of the new system takes only two or three days, Ramsey notes, in contrast with nine to 10 weeks for the tuned-waveguide systems now in use.

News Briefs

NASA has selected Hughes Aircraft, El Segundo, Calif., and Avco, Wilmington, Mass., to conduct parallel studies for system design for a series of proposed missions to carry out scientific investigations of the planet Venus and its environment with Pioneer-class spacecraft beginning in January, 1977.

Laser-beam communications are being flight-tested at high altitudes by NASA to determine the effects of the atmosphere on vertical transmission of the beams. The space agency is experimenting with a helium-neon laser transceiver in an aircraft and an argon-laser ground-acquisition and tracking station.

4000V ISOLATION!



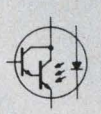
NEW LOW COST COUPLERS FROM GENERAL ELECTRIC

FOUR MODELS

H15A1 H15A2 FOR SPEED

- Minimum 4000V isolation
- Typical 3 μsec. rise/fall time
- IC compatible
- $1.35*

H15B1 H15B2 FOR GAIN



- Minimum 4000V isolation
- Up to 400% min. transfer ratio
- IC compatible
- 1.45*

For more information, contact your authorized GE distributor, GE Electronic Components Sales Office or use Inquiry Card #165.

*Suggested resale price 1,000 lot quantities

GENERAL ELECTRIC

Semiconductor Products Department, Syracuse, New York

BEST BUY
Our No. 1 Goal
QUALITY...SERVICE...VALUE

OUR NO. 1 GOAL:
TO MAKE
GENERAL ELECTRIC
YOUR BEST BUY

news

How good are the new watches? Electronic claims split industry

. . . *Minute-a-year timekeeping accuracy with a quartz-crystal wristwatch.*

Is that fact or fiction?

. . . *A watch with an advanced all-solid-state design—the watch with the liquid-crystal display.*

Is it an effective display or merely a gimmicky sales device?

There is sharp division in the American watchmaking industry over these two claims, inquiries by ELECTRONIC DESIGN show.

On the question of timing accuracy, one manufacturer—Bulova—says flatly that no one can live up to the minute-a-year guarantee with a mass-produced electronic wristwatch. Another—Hamilton—is inclined to agree, and three manufacturers—Gruen, Waltham and Microma Universal—say they stand by the claim, though they decline to elaborate technically.

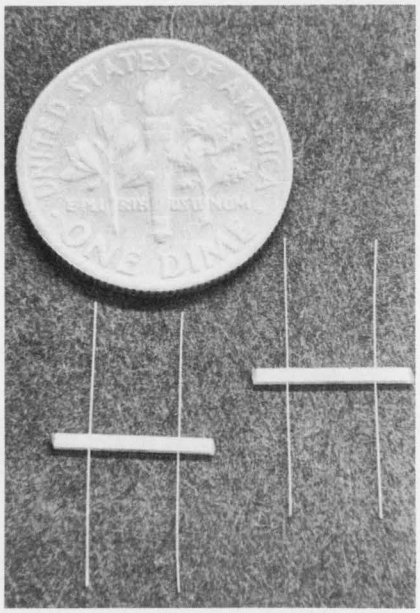
As for the liquid-crystal display, even boosters of it concede it has flaws. But solutions are envisioned.

The timing-accuracy issue was propelled into the spotlight at a jewelers' convention in New York City in July when the Bulova Watch Co. of New York cautioned delegates in an official statement:

"The present state of the technology makes it unrealistic to make claim to or to offer a specific guarantee for minute-a-year timekeeping for any quartz-crystal watch, including the Bulova Accuquartz."

Dr. Dale Koehler, manager of Bulova's Advanced Research Laboratory in Flushing, New York City, has told ELECTRONIC DESIGN that changes in the frequency of low-frequency crystals that are being used can produce a substantially higher error than a minute a year.

The quartz-crystal frequency is affected by three principal factors, he explains: aging, shock and temperature change. As an example, he gives Motorola's guaranteed maximum aging specification of 5 ppm per year, which is equivalent to a loss in timing accuracy of about 0.4 second a day. From this error alone, he notes, there is a potential loss of about two minutes a year.



These tiny bars of quartz are the 32.786 kHz frequency standards that drive the Bulova Accuquartz watch. The leads shown are shortened and attached to a sealed can assembly.

A four-digit dynamic-scattering liquid crystal display gives the time on this Microma Universal watch.

Koehler points out that future developments in crystals will bring an improvement in aging.

David Bingham, manager of micropower products for Intersil, Inc., Cupertino, Calif.—a maker of electronic watch parts—agrees with Bulova. The low-frequency crystals now in use are in the 32-kHz range, he notes, and they have a built-in error in their aging rate.

Bingham sees this problem solved by eventual development of crystals operating anywhere from 0.25 to 4 MHz. The aging rates of these higher-frequency crystals will be substantially less, he says, as will be their temperature sensitivity. But the adverse influence that high-frequency crystals will not be able to be guaranteed against, he points out, is shock.

Bulova's Koehler explains that when the present quartz-crystal wristwatches are dropped, the shock introduces a strain in the wire supports (see photo). Crystal manufacturers equate the change in frequency caused by shock in terms of a deceleration-time profile, he says. This profile is for a drop from a one-meter height with a deceleration of 3000 G for a 0.25-ms-wide half-sine deceleration pulse.

Bulova's experience, Koehler says, is that the frequency can change from 0.6 to 10 ppm after such a shock. If the watch is dropped halfway through the year, he explains, and if it develops a 2-ppm change in frequency, there will be a 31-second time error for that year as a result of one shock alone.

On temperature effects on crystal operation, Koehler says that the change in frequency is a para-

Jim McDermott
Eastern Editor

WHICH COMPANY IN THE WORLD OFFERS THE BROADEST LINE OF Trimmer Capacitors?

CERAMIC

ERIE offers the world's broadest variety of styles and capacitance ranges in its extensive line of Ceramic Trimmers. Style 518 above, for example, is a compact little Monobloc Trimmer designed for applications where saving space is vital. Easily mounted ERIE Trimmers are available in terminal arrangements to meet your P.C. board or point-to-point wiring needs. Voltage ratings to 500 WVdc. A full 180° min. to max. tuning. Designed to meet or exceed applicable requirements of MIL-C-81A.

NEW . . .

TAKE A LOOK AT THIS LITTLE GEM!

VARI-Thin

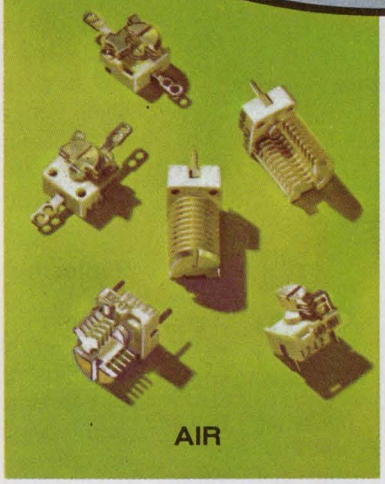
WORLD'S SMALLEST PRECISION VARIABLE CAPACITOR

Imagine, our new VARI-Thin measures only .221" dia. x .080" thin. And it has a capacitance range from 5 to 30 pF. This latest low profile ERIE Trimmer was designed by the foremost capacitor engineers for the burgeoning quartz watch industry, and now its advantages are being utilized in a variety of miniaturized instrument and communication gear. We suggest the advantages of VARI-Thin can be applied to your newest packaging schemes. Write for further data . . . VARI-Thin.

ERIE 515

Shown 5 times actual size.

Actual Size

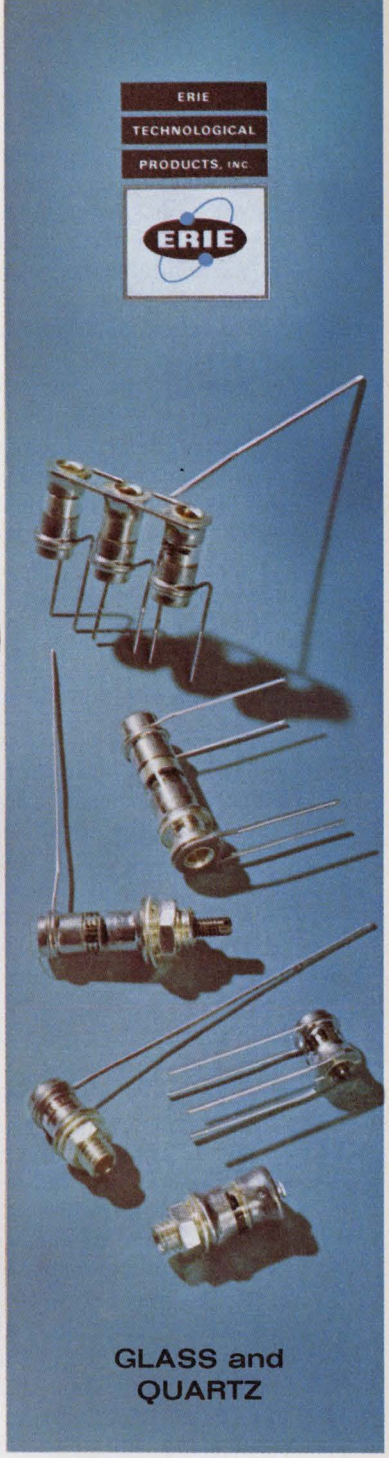


AIR

Performance stability is assured with ERIE Air Trimmers. Rotor and stator plates are precision machined from solid brass extrusions. Erie's unique design provides strong top plate construction. Terminal arrangements to meet every mounting need. Special designs available for L-C tuned circuits and for higher voltage applications.

PLASTIC

ERIE Plastic Trimmers are ideal for applications calling for low minimum capacitance and high ratio of min. to max. capacitance range. These popular trimmers are economical, provide excellent resolution, High Q, stability and high self resonance. Available in both Teflon® and polystryene dielectrics.



GLASS and QUARTZ

ERIE Glass and Quartz Trimmers are excellent for fine tuning resolution. ERIE Quartz Trimmers are ideal where highest Q possible is essential . . . and for applications requiring higher maximum capacitance. ERIE Hi-K Glass Trimmers provide up to 30% greater capacitance. Hermetically sealed units available. And our 590 series features an embedded electrode, combining very high capacitance with a rugged outer wall . . . perfect for RF circuits requiring maximum stability. Units meet or exceed applicable requirements of MIL-C-14409.

A lot of companies talk about variable capacitors. Some offer ceramic. Others air . . . or glass. Erie manufactures the total line of sophisticated miniature Trimmer Capacitors. In fact, most knowledgeable engineers look to Erie first for the Trimmer Capacitor of their choice. Ceramic. Air. Glass. Quartz. Plastic. Erie has them all . . . 10 different dielectrics . . . more than 1,000 variations . . . and the quality is typically Erie.

Applications for Erie Precision Trimmer Capacitors include avionics apparatus, communications equipment, oscilloscopes, crystal oscillators, crystal filters . . . *and now the newest of them all, electronic quartz watch systems.* Any circuit demanding very precise tuning and stable performance.

So design with Erie in mind. Let us serve as your one-stop source for Trimmer Capacitors. Chances are we have a cataloged trimmer that's just right for your application.

Call your nearby Erie man TODAY . . . or write for our complete Trimmer Capacitor catalog — 500.

ERIE TECHNOLOGICAL PRODUCTS, INC.
Erie, Pennsylvania 16512

ERIE

bolic curve with the zero-error point on the crystal set at about 28 C. Since temperature varies from day to day, it is reasonable to take one-third of the maximum temperature error and assume that it accumulates for a half year at 2 ppm, Koehler says. This is equal to another 31-second-a-year error in timing.

Adding the potential errors caused by aging, shock and temperature drift, Koehler comes up with a total error of 141 seconds for the first year of watch use. With this potential, he asserts, it is not possible to guarantee a mass-produced watch for minute-a-year accuracy.

Hamilton inclined to agree

John M. Bergey, president of Hamilton's Pulsar Time Computer Center in Lancaster, Pa., manufacturer of the first all-solid-state watch using LEDs for a display, told ELECTRONIC DESIGN that Bulova's statement to the jewelers' convention was "reasonably accurate" and "put things in perspective."

But minute-a-year accuracy is possible, Bergey says.

"We have been producing the Pulsar for over a year now," he reports, "and we find that a large distribution of the watches fall within the minute-a-year category. In fact, some of the watches show a zero-second error rate per month."

Spokesmen for Gruen Watch, Inc., New York City, and the Waltham Watch Co., Chicago, said without elaboration that their companies stood by earlier statements indicating minute-a-year accuracy for their quartz-crystal wristwatches.

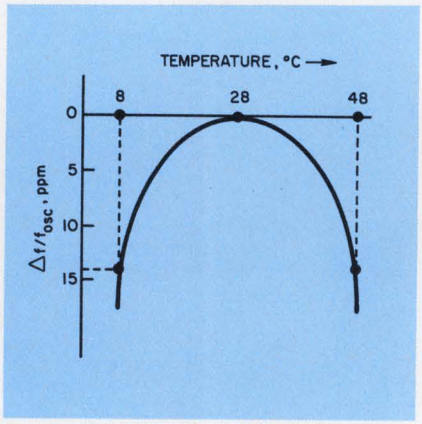
Donald Rogers, director of marketing for Microma Universal, Inc., of Mountain View, Calif., asserted: "We guarantee five-seconds-per-month accuracy for our all-solid-state watch."

Liquid crystals stir debate

The liquid-crystal displays being introduced in some all-solid-state versions of electronic watches have their champions and detractors. Criticism of the present generation of dynamic-scattering displays centers on three points: They're hard to see at certain angles and under certain lighting conditions; they have a large number of leads, making them difficult to replace or repair; and the life of the devices has not yet been demonstrated over extended periods of time.

Because the dynamic-scattering display requires a mirror that reflects the ambient, scattered light when the digits are energized, the display tends to wash out at certain angles.

"I'll admit that the watch has to be angled right in order to view it properly," says Ian McCrae, marketing manager for Texas Instruments' optoelectronics products. "But a simple movement of the wrist is ordinarily enough to bring the display into the proper viewing angle. The only real limitation of this type display is that you can't see it in the dark."



Wristwatch crystal operating temperature limits are typically established between 8 C and 48 C, with the normal wrist temperature (zero-error point) at 28 C.

TI is supplying liquid-crystal displays to Swiss watchmakers.

A newer type of display, called the field-effect liquid crystal (Felix), operates on somewhat different principles that give it better optical and electrical characteristics see "The Felix, a Fast Liquid Crystal, Is Easy on Power, Easy on Eye, (p. 44 this issue).

McCrae admits the field-effect unit is better in several respects. However, he points out that it has a narrower viewing angle and is more expensive.

Rogers of Microma Universal, which is introducing its own watch with a dynamic-scattering liquid crystal display (see photo), says:

"There's no question, at the present state of the art, that a lot of things could be better. But we've optimized our display so it's salable. We didn't want to spend five more years engineering it.

"We've been doing work with polarizing filters and with colors in an effort to improve our display. Another important factor in the quality of the display is the fact that we make our own crystals. The commercially available materials are not very good."

As far as life and servicing of the liquid-crystal display is concerned, Bulova says that at the present state of the art replacement within 12 months is not unrealistic. Bulova has been investigating the use of the liquid crystals for the past few years.

Dr. Zolton J. Kiss, president of the Optel Corp., Princeton, N.J., supplier of liquid-crystal displays to Waltham and others, notes that while the history of these devices has not been long, displays have been run as long as five years in some company's laboratories. He expects this figure to be realistic for watches.

Replacing display a problem

Bulova contends that replacing a liquid-crystal display is a far more complex operation than replacing a conventional watch dial. Kiss counters that the displays can be designed as snap-in or plug-in units.

Intersil's Bingham believes that liquid crystals for watches will be successful when they are designed to allow multiplexing to reduce the number of leads. As an example, he points to the current four seven-segment digits on a watch. They require 28 leads for the segments plus at least one more for the ground.

With a multiplexing—or strobing—system, Bingham says, there are four rows and seven columns. The number of connections is reduced, depending on the scheme used. However, he says, the real problem here is that this method can be expensive.

Microma Universal's Don Rogers is convinced that whatever type of liquid crystal display wins out, this will be the ultimate choice. ■■

Heinemann Series AM1 circuit breakers are priced to compete with other people's look-alikes.

A five-year warranty is exclusive with Heinemann.

We can offer it with confidence because (1) we invented the hydraulic-magnetic circuit breaker and (2) we've been making h-m breakers for over 40 years.

That's about six times as long as anyone else has been making this type of breaker.

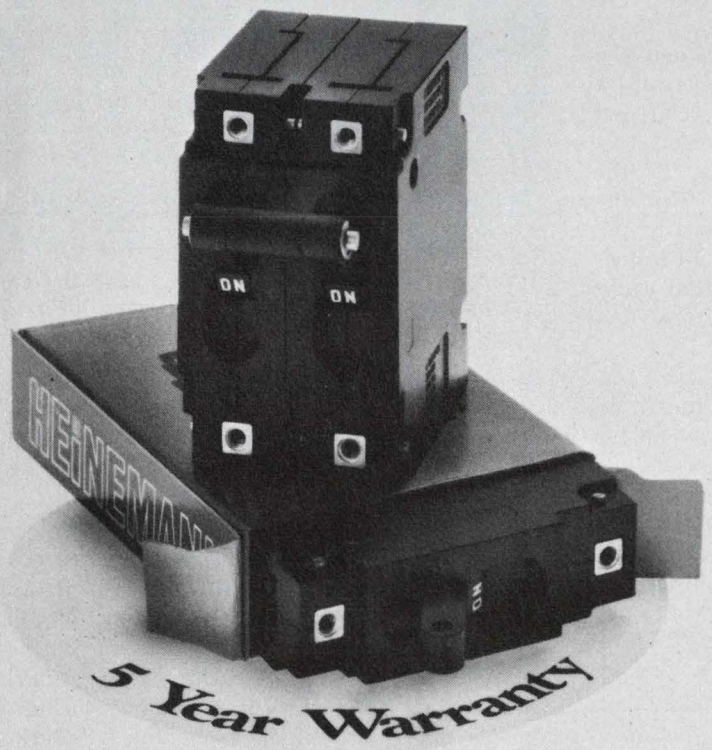
This is not to say that no one else builds good circuit breakers. But at their stage of the game, a five-year warranty could be a bit risky. It takes a while to find out how well a product will stand up under the unpredictable conditions of extended end use.

We've been around long enough to know.

Heinemann Electric Company, 2616 Brunswick Pike, Trenton, N.J. 08602.

HEINEMANN

But if you look real close, you'll see we don't look alike at all.



5302

The 'smart' bombing technique is about to become smarter

A multisensor system for finding military targets from the air and guiding "smart" bombs and missiles to them is being designed into the Navy's A-6E attack aircraft by a team of engineers at Grumman Aerospace in Bethpage, N.Y.

So-called smart weapons, which have been used so successfully in Vietnam, are manueverable after release from an aircraft and can be guided toward a target illuminated by laser light. Usually the target must be found and identified visually by the pilot before the laser is turned on.

The new system, called Tram (for Target Recognition Attack Multisensor), will spot targets day and night with a forward-looking infrared detector (Flir) that is bore-sighted with a laser rangefinder to illuminate the target. Tram is being developed for Grumman by Hughes Aircraft in Culver City, Calif.

The operation begins when the bombardier-navigator picks up a target on the aircraft's relatively long-range radar, Norden's AN/APQ-148. He then waits for the target to appear on his Flir display, a TV-like screen sitting on top of the radar scope. Flir does not have the long range that radar does, but it has much better resolution.

When the operator sees the target on Flir, he manually lines it up with a Flir reticle and flips on the laser rangefinder. The laser and the infrared detector then remain pointed toward the target on instruction from the radar's computer, an IBM AN/ASQ-133.

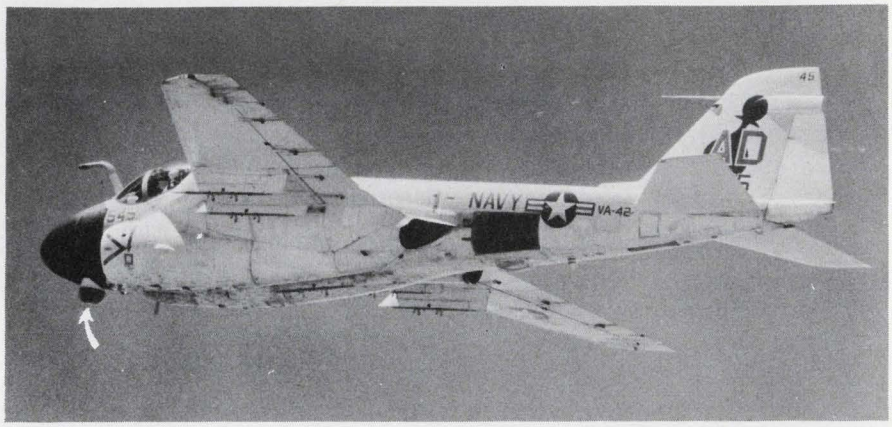
The computer knows where the target is because the inertial system tells it the aircraft's ground-speed and track. If the target begins to drift off center, it's because the inertial system is drifting. The operator corrects this manually—by slewing a control stick—a correction that goes through the computer, telling it not only the target's true position but also how much it can expect the inertial system to continue to drift.

When the moment is right, the bombardier drops the smart bomb, which homes in on the spot the laser is illuminating.

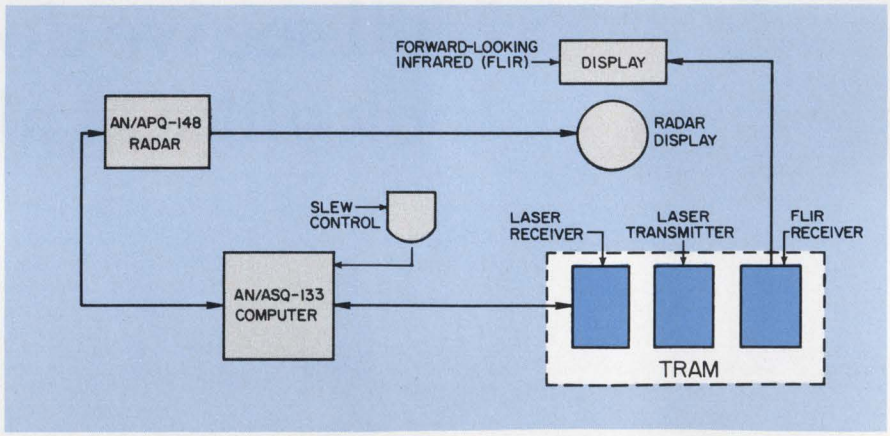
To play back the entire mission on the ground later, a video tape recorder is trained on both the radar and Flir scopes during the significant portions of the mission. The video display is capable of recording for approximately 40 minutes.

"Integrating Tram equipment with the aircraft's radar, with the radar's computer, which Tram also uses, and with the inertial navigation and bombing system is our job," says Grumman's Vernon

John F. Mason
Associate Editor

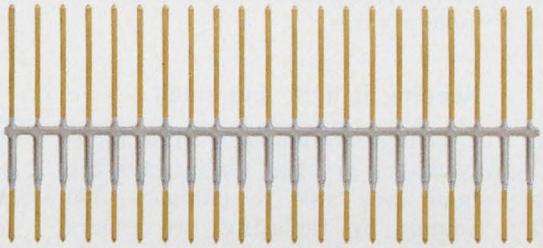


A small bulge had to be built into the A-6E attack plane to accommodate the new infrared-laser sensor system called Tram.



Tram will work with the aircraft's radar and computer system. The slew control realigns the infrared detector when the target drifts off center.

There's only one good way to solder posts and contacts to a PC board.

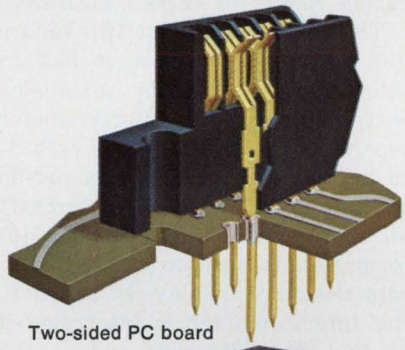


Presolder them before insertion.

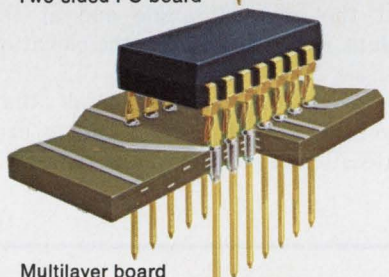
That's how *we* do it. And it's proved to be less costly and more reliable than wave, dip or hand soldering. Here's how it works.

We predeposit solder bands on our feedthrough posts, IC receptacles and PC connectors. In the exact widths and locations you want—within .005-inch. So—with solder already in place—all you have to do is insert and reflow. No masking, preforms or complex wave soldering.

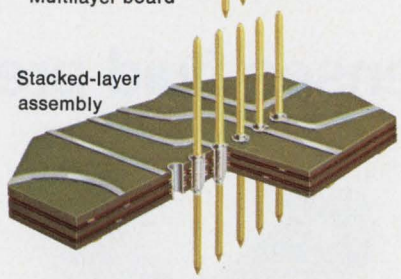
And no problems with wicking, bridging, peaks, icicles, board delamination or damaged plated through-holes. After reflow, post and contact ends are clean and ready for point-to-point wiring. And can be replaced without damage to the board.



Two-sided PC board



Multilayer board



Stacked-layer assembly

Find out *specifically* how our selective presoldering can give you better panels at lower cost. In your house or ours.

Write to: **AMP Incorporated, Industrial Division, Harrisburg, Pa. 17105.**

AMP
INCORPORATED

Manufacturing and direct sales facilities worldwide: Barcelona, Brussels, Buenos Aires, Frankfurt, London, Mexico City, Paris, Puerto Rico, Sao Paulo, s'Hertogenbosch (Holland), Sydney, Stockholm, Tokyo, Toronto, Turin, Vienna.

INFORMATION RETRIEVAL NUMBER 20

Kramer, who heads up the program management team for installing an R&D Tram system in an A-6E under a $23-million contract.

"We've broken the design problems down into five categories," explains Dan Collins, Grumman's deputy director for the A-6 program. "Electromagnetic interference, weight and space, temperature, software and interface.

"If you set up your EMI philosophy correctly, you won't have any EMI problems."

Grumman achieved this in two steps. "First of all," Collins says, "we decided not to be influenced by the traditional airframe designer's preoccupation with weight." Airframe designers generally use the airframe as a ground instead of designing a radio with a central grounding system of its own.

Using the airframe "sounds good," Collins says, "but it doesn't work."

"The airframe is not continuous," he explains. "It's got spaces along the way, and you **really don't bond to it properly."**

The result, he says, is an undefined grounding system with significant resistances. When the signal has to come back through the low-impedance circuitry, the grounds aren't at 0 V. They are at 0.5 to 1 V—"which is like having a signal 0.5 to 1 V below what it should be," Collins says.

Grumman designed a separate grounding system for Tram, providing separate copper wires to bring the current back—wires big enough to carry the current without getting induced transients down the line.

"We've also taken care of the resistance path, the inductance path, and we have eliminated the ground loop problems," Collins says. "The airframe ties into the signal circuit in only one place."

The main three-phase power distribution from the generator system does go back through a ground return, which ties into the airframe, but this all goes through transformers that isolate it, so the power supply separates the ground return from the main power return.

"The second thing we did," Collins says, "was to shield the wires heavily. You have to do this in an aircraft because there isn't room to isolate wires."

Keeping it light and small

Though weight was not a highly critical problem, Collins says, the team was able to eliminate 300 pounds by replacing two radars with one. The new one, Norden's AN/APQ-148, presents a normal plan-position-indicator picture, or map; it tracks and it provides elevation range for terrain clearance.

The radar does what two radars did previously, because it has an interferometer on its gimabaled search antenna. The interferometer receives the search radar's reflected signals and generates a profile of the terrain ahead of the aircraft at every azimuth angle. This information is used to create a terrain-clearance display. In addition, the interferometer is interrogated at the azimuth angle and at the slant range to develop the elevation angle to the target.

Space is more crucial than weight, and Grumman had to create a small pod below the radar under the nose of the A-6E to house Tram. But this is the only aerodynamic change planned.

Keeping it cool

Tram alone pulls 4 kW of power. Keeping heat-vulnerable components cool was a prime requirement. Overheating could easily damage the laser and the power supply, Collins says, adding: "We had to provide a totally separate cooling system for the additional equipment; we had more electrical energy going in than we could have taken out. We pump cool air through the equipment, and we have a general cold plate that transfers heat out of the equipment.

"Some software problems are inevitable, but we're starting early. We've already sized the software job. We know the number of bits required in the computer, and we have already recognized that for our program the computer has a basic iteration rate of about 10 per second.

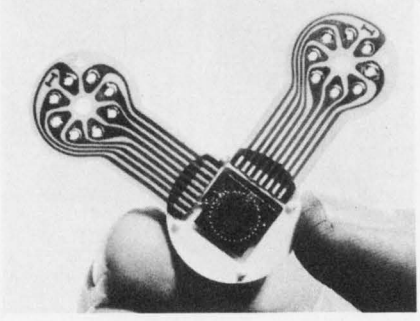
"This has to be increased for some specific Tram applications. For this we have developed a high-speed subroutine to be used when needed.

"When we deliver the aircraft, there may be a few software errors, but there will not be any goofs."

The largest problem Collins expects is the man-machine interface. "And this can't be checked out," he concedes, "until the plane flies and the operators come back and tell us what's wrong. Other than this, we only foresee the usual interface problems that occur in assembly and are easily rectified." ■■

Silicon crystal senses fluid pressure

A piezoresistive strain-gauge bridge diffused into the surface of a 1-cm² silicon crystal is the sensing element of two new solid-state fluid pressure transmitters. Developed by the Honeywell Industrial Div., Fort Washington, Pa., for process control, the silicon gauge has no bonds or creep joints and consequently is stable with time and temperature.



The silicon element—used in differential pressure and direct pressure transmitters—is sealed in a silicon fluid through which the fluid pressure is transmitted.

Integrated circuits, mounted on the main substrate, convert changes in pressure, ranging from 30 to 10,000 psig, to current outputs of 4 to 20 mA with 24 V dc excitation. ■■

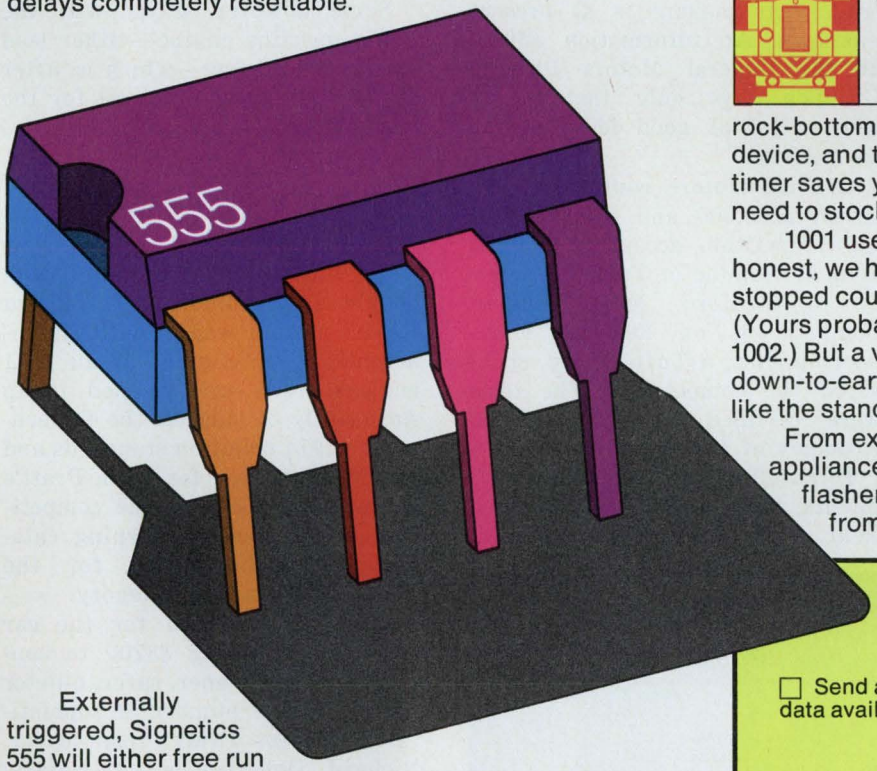
The timer of 1001 uses.

(Priced so low it's measured in cents.)

At last. A true standard IC timer with almost universal applications. The new low-cost 555. From Signetics-Linear, of course.

And the most extraordinary advantage of 555: it's so ordinary, and so simple to use. With designed-in flexibility that's never been matched, spec for spec.

555 functions interchangeably as a time delay, oscillator, pulse detector or power modulator. Timing from microseconds through one hour. With time delays completely resettable.

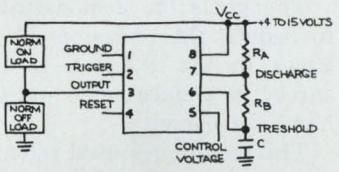


Externally triggered, Signetics 555 will either free run or latch, in adjustable duty cycles from 50% to 0.01%. Timing can be changed 10:1 with control. Operating from 5 to 15 volts with only a 1% change in timing. Output can source or sink 200mA. Temperature stability: 0.005% per °C.

And applying the adaptable 555 is practically child's play (if the kid knows basic math). Requires only a resistor and capacitor to do the job. With all kinds of options for starting the timing action. And you can operate 555 from just a single power supply.

All this, in one simple 8-pin dual in-line circuit. Available off-the-shelf now, from your distributor at

rock-bottom cost. The 100-up price is only 75¢ per device, and the multi-function capability of our 555 timer saves you still more on the parts you no longer need to stock.



1001 uses? To be honest, we haven't stopped counting yet. (Yours probably makes 1002.) But a versatile down-to-earth IC timer like the standard 555 suggests applications unlimited.

From exotic technology to household appliances... from copying machines to barricade flashers... Start thinking. And you can take it from there.

Signetics-Linear
811 E. Arques Avenue
Sunnyvale, California 94086

☐ Send all the literature, specs and applications data available for the great 555 breakthrough.

Name

Title

Company

Address

City State Zip

Telephone

Signetics Corporation. A Subsidiary of Corning Glass Works.

signetics

INFORMATION RETRIEVAL NUMBER 21

Electronics whiz kids display better ideas for building cars

Can a group of undergraduates, led by a 20-year-old electrical engineering student in his junior or senior year, make design improvements in cars that are significant enough to influence the pros in Detroit?

To find out, 65 such groups, representing more than 2000 students from universities and schools throughout the United States and Canada, last month sent 65 newly designed or modified vehicles to the General Motors Proving Grounds at Milford, Mich., for a competition.

The goals: to demonstrate ways to reduce the emission of noxious gases in the exhaust, to improve safety, to reduce noise and to make handling easier.

The techniques used relied heavily on electronics. Besides sensors and catalysts in the engine, closed-circuit television replaced rear-view mirrors, pushbuttons called up data on displays when needed, a variety of electronic tricks awaited drunken drivers and thieves, and one car had an electronic diagnostic system.

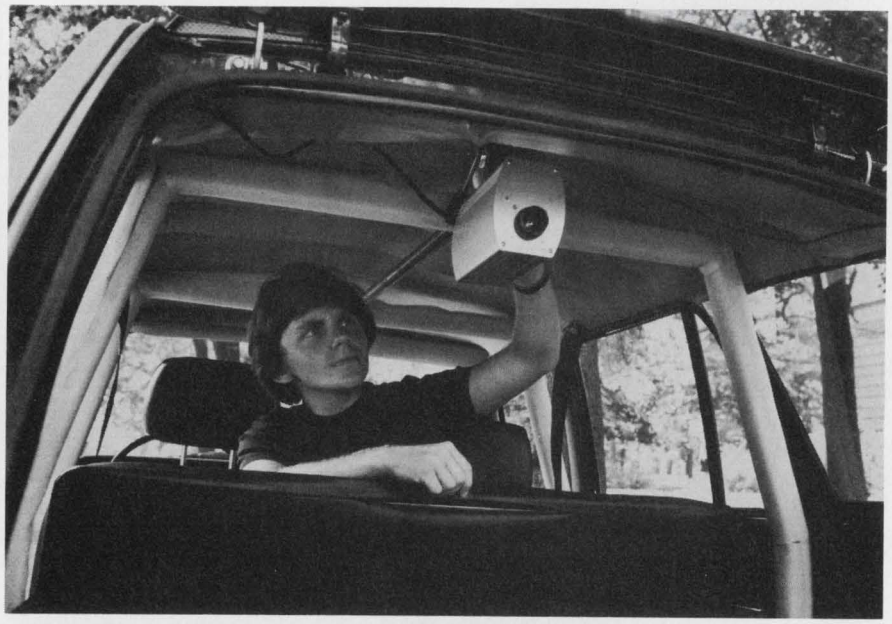
Successes and failures were mixed. And their influence on Detroit's car makers is at present unknown. An information official at the General Motors Proving Grounds says only that "there were a lot of good ideas at the competition."

General Motors contributed between $250,000 and $500,000 for the competition, according to Dean John H. Sununu of Tufts University in Medford, Mass. Student Competitions on Relevant Engineering, Inc., a Tufts group, sponsored the competition. The tests were certified by the National Academy of Engineers.

In an effort to avoid noxious effluents, some of the groups steered clear of the conventional internal-combustion engine and went to other sources of power: steam, pressurized propane gas, hydrogen, CNG (compressed natural gas), electricity and hybrids—one, a combination of electric battery with internal combustion and another, hydraulics and internal combustion.

Some, however, stayed with the liquid gasoline engine—either lead sterile or lead free—which is, after all, still the most practical for the near future.

John F. Mason
Associate Editor



A television camera looks out the rear window in place of a mirror. It covers 90 degrees, operating well in moonlight and in rain.

Pratt buys second-hand car

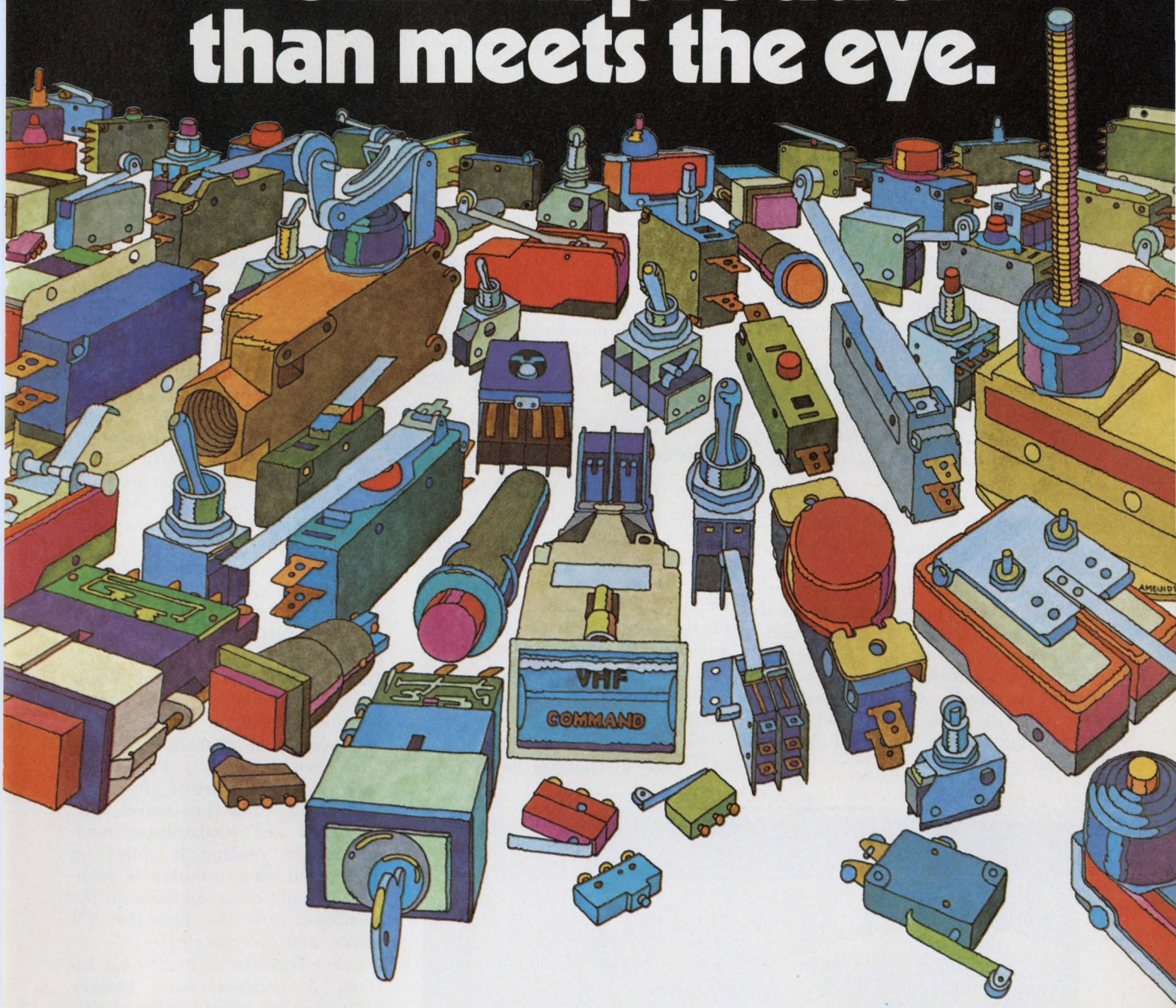
Pratt Institute in Brooklyn, New York, with a small budget of $5200, bought a secondhand 1971 Subaru FF-1G station wagon with its inherently dirty engine—as all 1971 engines were—and cleaned it up sufficiently to surpass the Government's 1974 pollution standards and nearly meet those for 1975. Pratt's car won the clean-engine competition in the gasoline-burning category, and the award for the quietest car in any category.

Pratt spent $1500 for the car and the remaining $3700 to convert it into a cleaner, safer, quieter vehicle with a number of sophisticated features. Pratt's team leader, Richard Doherty, is particularly proud that his was the only car that was driven to and from the competition. All the others were taken by truck or train—"some because their fuel was too dangerous to be used on highways and in tunnels."

To tackle nitric oxide, the constituent in the exhaust that is the most difficult to control, Doherty's team added capacitor discharge ignition to make burning more complete, and this also lowered hydrocarbon emission.

A second step was to add an air pump to the engine that feeds

There's more to a Unimax product than meets the eye.



More quality. More reliability. More choice. More service.

When it comes to switches, you'll find that our models cover almost any conceivable snap-acting switch requirement.

BASIC PRECISION switches that are the first choice of the volume OEM users.

The most complete GENERAL PURPOSE line in the industry.

All styles of MINIATURE, SUBMINIATURE, and MINIATURE SUBMINIATURE types.

Big, rugged, METAL-CASED LIMIT switches. Thousands of specials in minimum turn-around time, at minimum cost.

And to see the light, ask about our ILLUMINATED PUSHBUTTON CONTROLS. They offer you the broadest variety of styles in the business—in the widest choice of displays, colors, illuminations and actuations. From simple pilot light applications to the most sophisticated multi lamp—multi switch—multi legend control, you'll find a Unimax LPB to meet your requirements. At a competitive price.

You'll also find special key lock or mushroom cap models. Mountings that are simplicity itself. Electrical and mechanical performances that are uniformly high.

Let us give you more. Write for detailed information concerning your applications to Unimax Switch Corporation, a Riker-Maxson Subsidiary, Ives Road, Wallingford, Conn. 06492. Or call (203) 269-8701.

Unimax®

We give you more.

compressed air into the exhaust to reignite unburned fuel. A provocative by-product of this, Doherty says, is the 1200-F heat produced by burning the unused fuel. Eventually he hopes to come up with a use for this wasted energy —possibly to power a sealed evaporative type of air-conditioner.

Besides extra structural support, several modifications were made to improve the car's safety. Doherty is particularly pleased with his device for keeping drunkards off the highway. Three seconds after the ignition is turned on, a red light of the car's dashboard goes on. If the driver doesn't hit the brake with his foot in 3/4 second, the car doesn't start. If after 12 attempts the driver still hasn't made it, the ignition locks for five minutes.

The red light-brake device required simple, straightforward designing, Doherty says. It uses four relays, one relay time-delay tube and two unit function-transistor timing circuits.

Doherty sees at least one major advantage to his system over General Motors' drunken driver's test, which requires the driver to remember a series of numbers that flash on a dashboard display and then "type" the correct series back.

Some people just don't have good memory retention for numbers, he says—a faculty that has nothing to do with good driving, whereas reacting quickly with the brake does.

The safety panel at the General Motors competition, however, maintained that a clever drunkard could probably get Pratt's car started by standing outside the car and keeping his hand on the brake, pushing it down when the light came on.

MIT won the drunken-driver tester competition with a red-light reaction tester that went a step further than Pratt's. Instead of allowing the driver a fixed 3/4 second to respond to the red light, the MIT system contains a memory that knows the normal reaction time for every member of the family and allows him his particular time. It distinguishes each by a signature card—like a credit card—that is inserted into a slot. It has learned each driver's reaction time by measuring it for the first 20 times he drives the car. This device, of course, costs more than Pratt's.

A device to foil thieves

The University of British Columbia also entered a device that doubles to foil drunkards and thieves. To unlock the door, a correct three-digit combination must be pushed on a nine-button panel on the door. Then, before the car will start, another three-digit combination must be pushed on another nine-button panel on the dashboard.

To see well to the rear of the car, two alternatives to mirrors were tried: periscopes and closed-loop television. Six cars had periscopes rising from their roofs, and Pratt used a television. Doherty's team discarded the periscope for several reasons.

"It only displays the tops of nearby cars in the rear," Doherty says. "Its visibility would be impaired by dirt, rain, snow and ice."

A television camera inside the car—pointed through the back window, with a small display on the dashboard—works beautifully, Doherty says. "Oddly enough, though," he notes, "we had to reverse the perfectly normal picture you get with the TV to a mirror image, because that's the way drivers are conditioned to see behind them as they drive."

The TV camera is a standard unit made by the GBC Corp. in New York City. Using a 2/3-inch vidicon tube that covers a 90-degree angle, it is sensitive enough to see the highway markings by moonlight. The display is a five-inch, 110-V TV receiver made by Sony. Parts not needed were removed—the i-f stages, tuner and audio amplifier.

The set has a 450-line resolution, and its contrast can be adjusted during rain. And, Doherty says, it is more effective than a mirror at night and during rain. The whole system cost $300, but if mass-produced, Doherty estimates that it could be sold for about $100.

Conventional dashboard gauges have been replaced in Pratt's car with a single three-digit Nixie tube display that time-shares voltage, fuel and temperature readings. Each reading is called up on demand when a button is pushed. The only other displays on the dashboard are the rearview TV screen and speedometer.

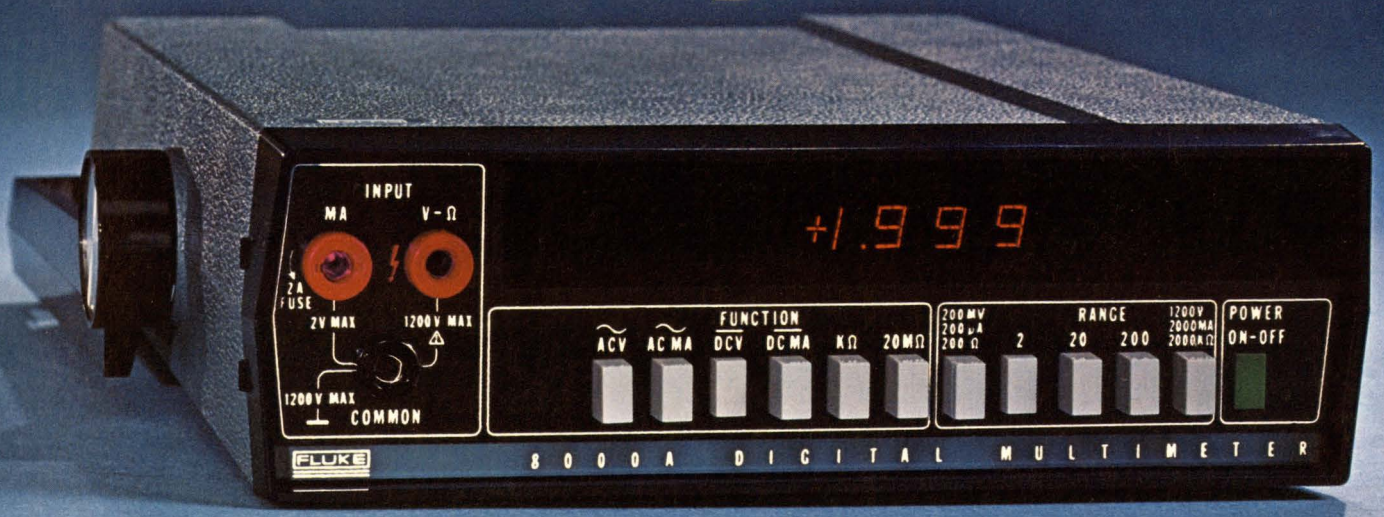
Other features in Pratt's car include a crash-resistant battery containing acid-neutralizing chemicals housed in a semi-foam, impact-absorbing material. The car also has an automatic burglar alarm that activates if a key other than a coded electronic one is used. And for fire control, an automatic fire-extinguishing system is activated by heat sensors in the engine compartment.

Pratt's vehicle could retail, Doherty says, for $2435 if 100,000 were produced. ■■

The dashboard instruments (from left to right) are the speedometer, the rearview TV display and the digital Nixie tube display.

Fluke problem solvers

The new multimeter with advanced L.S.I. for more function power. 26 ranges, 5 functions.



$299... Fluke's new 8000A, Try one for fifteen days, no obligation.

Now you can put the unmatched quality of Fluke instrumentation to work for you at the price of an ordinary multimeter.

Here's the DMM with more function power. Its got 26 ranges, including five ranges of ac and dc volts, five ranges of ac and dc current, and six ranges of resistance. Push button control gives you the simplest most reliable error-free operation possible. The new Fluke 8000A is the only multimeter using an A-to-D converter with inherent self-zeroing to completely eliminate offset uncertainty.

More details are on the next page, but we think you'll want to try this low-priced measurement system now. Fill in the coupon; we'll do the rest.

Circle 240 for more information

Ship me a Fluke 8000A for $299 plus $_____ for additional options checked below. I prefer the following payment option:

- ☐ Charge my ☐ Master Charge, ☐ BankAmericard, or ☐ American Express account for the full amount plus $5 shipping and handling.
  If using Master Charge, please indicate the 4 digit number appearing above your name ☐☐☐☐
- ☐ Bill against the attached company purchase order for the full amount plus $5 shipping and handling.
- ☐ Cash Order. My check for the full amount is enclosed. Fluke pays shipping and handling.
  (Washington state residents add 5% sales tax.)
  Return within 15 days for full refund if not delighted.

Add the following options:

- ☐ Rechargeable Battery — $50*
- ☐ BCD Data Output — $75*
- ☐ RF Probe — $75
- ☐ AC Probe 20A & 200A — $50
- ☐ HV Probe — $25
- ☐ Deluxe Test Leads — $5
- ☐ Carrying Case — $15
- ☐ Dust Cover — $8
- ☐ Rack Kit-Center — $30
- ☐ Rack Kit — ½ Rt or Left — $30
- ☐ **Send me literature only**

*Choose BCD data output or battery pack; both cannot be ordered in the same instrument.

Name _____

Company/Institution _____

Address _____

City & State _____ Zip _____

Credit Card No. _____ Phone _____

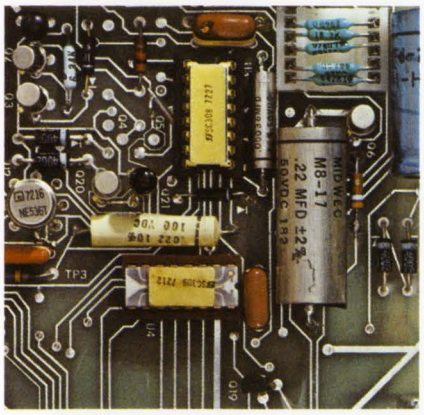
_____
(Signature authorizing charge to credit card)

For even more convenience, let your nearby Fluke sales office handle the details. For location, dial toll-free 800-426-0361.

FLUKE®

When you look inside you'll find the same high technology and quality we put in our $3000 DVM's.

Take a look inside. The LSI chips, equivalent to over 3,000 circuit elements, are the most advanced proven semiconductor devices on the market today. Fluke is the only manufacturer using **both analog LSI and digital LSI** to give you increased reliability at lower cost with fewer parts. The Fluke 8000A has only ⅓ the number of parts used in a typical 3½ digit multimeter.



A simple guarantee
You can understand our 12-month guarantee. It's straightforward and honest. And you can believe we live up to it. If anything happens to your 8000A, take it or send it to your nearest factory service center. We'll give you 48-hour turnaround service in the U.S., Canada, Europe and the Far East.

Specs to work by
The new Fluke 8000A has a dc accuracy of 0.1% when you buy it. We guarantee it will still measure within that accuracy without recalibration a year later.
The case is rugged and tough. Drop this multimeter from a bench. Nothing happens to the works inside. We guarantee it.

Wide range of measurements
Measurement flexibility is broad enough to meet all the situations you're likely to encounter. The Fluke 8000A gives you 26 ranges to measure ac and dc voltages from 100 microvolts to 1200 volts, currents from 100 nanoamps to 2 amperes; and resistance from 100 milliohms to 20 megohms.

Wide choice of options
For a few dollars more, you can add a rechargeable battery pack to give you completely portable operation for over eight hours. And when you're back on the line, the batteries will recharge automatically. Other options include digital printer output, deluxe test leads, high voltage probe, rf probe, 200-amp ac probe, carrying case and rack mount kits.

A complete digital multimeter
But with or without options, the Fluke 8000A comes complete with test leads and spare fuses. It all adds up to an instrument you can count on day after day, year after year. Isn't this what you want in a digital multimeter at any price? Fluke thinks so.

FIRST CLASS
Permit No. 5464
Seattle, Wash.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in the United States

Postage Will Be Paid By

FLUKE®

John Fluke Mfg. Co., Inc.
P.O. Box 7428
Seattle, Wash. 98133

The pollution problem. Maybe your engineers deserve a little help.

The engineers will be the ones to find the technical solutions to pollution problems. There's no doubt about it.

But pollution is a people problem, too. And the engineers' technological approach to pollution isn't going to solve people problems.

Maybe this booklet can help. It lists some of the things all people can do to fight pollution. And with all the people supporting your engineers we'll have a better chance of winning the fight.

For a free copy or a list of bulk rates write to Keep America Beautiful, Inc., Box 1771, Radio City Station, New York, N.Y. 10020

Keep America Beautiful

Advertising contributed for the public good

People start pollution. People can stop it.

Half price sale on sapphire substrates.

(Tyco's cost that much less.)

Here it is, almost off-the-shelf. Polished, single-crystal sapphire substrates from Tyco, at about half the price of other suppliers'. If you've been settling for substitute materials because of cost, forget it. Now you can afford the positive isolation, perfect surfaces, and orientations you need for SOS, hybrid IC, and other microcircuit designs.

For full details about sapphire substrates, or the many other applications of Tyco's synthetic sapphire, call today. Collect. Frank Reed will tell you all about it.

tyco

SAPHIKON DIVISION
16 Hickory Dr., Waltham, Mass. 02154
(617) 890-2400

INFORMATION RETRIEVAL NUMBER 23

The Felix, a fast liquid crystal, is easy on power, easy on the eye

Field-effect liquid crystals are joining gas-discharge, light-emitting diode and dynamic-scattering liquid-crystal displays in the marketplace, and designers are gaining in flexibility as a result. The new display—called a Felix—offers significant improvements in performance and visibility.

Dr. James L. Fergason of the International Liquid Xtal Corp., Cleveland, which began initial production of displays with field-effect liquid crystals earlier this month, contrasts them with dynamic-scattering types.

Compared with the dynamic-scattering display, he says, the field effect device:

- Requires about one-tenth the current to operate.
- Has substantially higher contrast ratio—on the order of 40:1 for both reflective and transmissive displays.
- Is about four times faster—typical turn-off time is 50 ms compared with 200 ms, and it can be energized by 60-Hz to 10-kHz voltages.
- Can operate over a wider temperature range of 0 to 70 C.
- Can be operated at lower voltages.

Jim McDermott
Eastern Editor

Less current with Felix

As an example of comparative current drains, Fergason cites a four-digit display. The dynamic-scattering unit, operating at 15 V, requires about 35 μA. A comparable Felix display, operating at 7 V, draws but 35 nA, he says.

The differences in performance, Fergason explains, are caused by the different methods of cell operation. The basic dynamic-scattering unit has a thin layer of transparent liquid crystal sandwiched between two conductive sheets of glass. The front electrode is transparent. The rear electrodes are shaped in the form of segments of alphanumeric characters. The rear panel is transparent in transmissive displays and is an opaque, mirror-like element in reflective displays.

When the voltage is applied between the front and rear electrodes of either type, the current flow between them causes turbulence in the areas between the electrodes. This turbulence scatters the ambient light in the form of the rear electrode pattern.

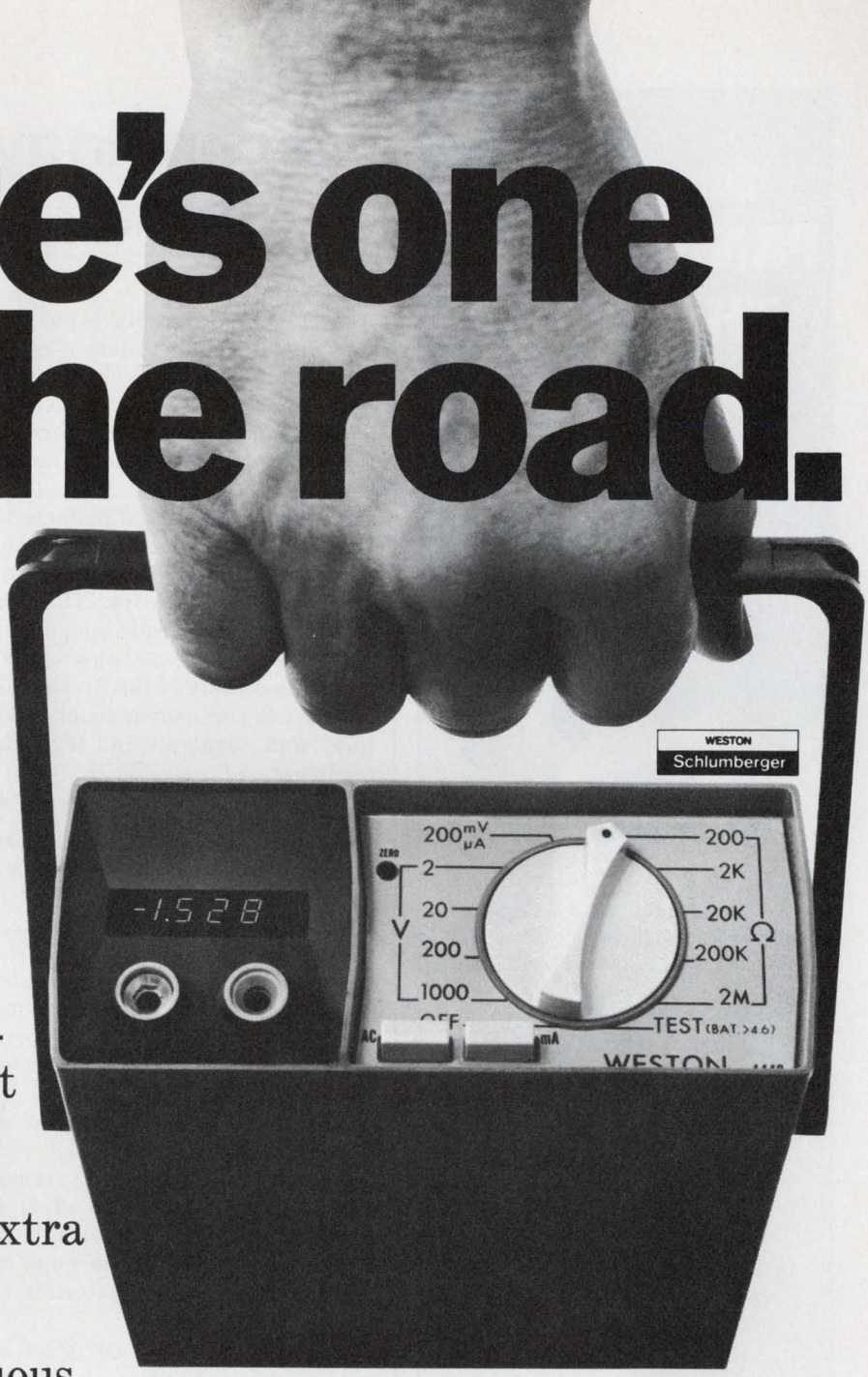
With Felix displays, the construction of the cells is somewhat different in that the liquid crystal material is sandwiched between two polarizers, Fergason says. The liquid-crystal material is dielectrically anisotropic—that is, in the unenergized state, the crystal molecules are aligned parallel to the front of the display glass. In this case light is absorbed by the polarizers. Upon applying a voltage, the dielectric anisotropism causes the crystals to rotate under the influence of the electrostatic field, so they are at 90° to the face of the display. This rotates the plane of polarization and allows either ambient or transmitted light to pass through, depending on the display.

Exceptionally high-purity liquid-crystal material is required for the Felix display, Fergason points out. For this reason Ilixco prepares its own proprietary crystals.

The lifetime of liquid-crystal displays is, in general, limited by contamination of the material through the seals, Fergason notes. Based on accelerated life tests, he predicts a life of 18 months for present Felix displays. ■■

The field-effect, liquid-crystal reflective type display (above) provides better all-angle viewing in diffuse light than does the standard dynamic scattering display. The segments use 7 V from a 60 Hz to 10 kHz source.

Here's one for the road.



Our new Model 4440 mini-multimeter is the smallest battery operated digital multimeter on the market.

A true portable in every sense of the word, it's shock-proofed, fully overload-protected, and usable at up to 122°F. Fuses are externally replaceable. (We even throw in an extra set, on the house.)

You get eight to twelve hours of continuous field operation before you have to recharge. In an emergency, you can run it five hours or more on ordinary flashlight batteries!

For all its littleness, this rugged portable features a new 3½-digit LED display with automatic polarity, the latest LSI circuitry for more reliability than ever, and 17 full scale ranges that cover 200 MV to 1000 volts AC/DC, 200 ohms to 2 megohms, plus AC and DC current.

(A cordless DMM for only $285.)

Your local distributor will set you up with a Weston 4440 for $285—complete with leads, batteries and recharger. Grab one. Weston Instruments Division, Weston Instruments, Inc., Newark, N.J. 07114. **WESTON®**

technology abroad

A MOS chip to replace pushbuttons in television tuners uses low threshold p-MOS technology. A six-channel sense circuit is driven directly from a two-terminal touch plate that replaces the conventional mechanical push-button selection. Neon lamps indicate the channel selected. The circuit drives a varicap tuner through a bias-selection network. The company—Emihaus Microcomponents, Ltd., Surrey, England—claims that this circuit is the first single-chip MOS for use in touch selection and control in television receivers.

CIRCLE NO. 441

An improved method of etching integrated circuit masks has been developed by Philips at its research laboratory in Hamburg. Research has shown that a low mask etching rate can be achieved with sputter etching, provided a target with strong gettering power is used as a substrate holder. A titanium target has been used with success, and the technique insures that the reactive gases are adequately removed, thus reducing their effect on the mask. Further research is being carried out to determine effectiveness of other materials for the target.

CIRCLE NO. 442

Advanced techniques for measuring air pollution are being developed by the Federal German Research Association's Observation Network, to analyze elements with atomic numbers from 9 (fluorine) to 92 (uranium). The monitoring system, which has a sequential X-ray spectrometer with tabulator control, uses secondary X-ray emission methods to measure aerosol specimens deposited on a filter paper. Nine spectral lines can be automatically scanned and measured, although the tabulator control can be extended to operate on a maximum of 36 spectral lines. The measured results are recorded as pulse counts and then transferred to punched cards for subsequent evaluation at the University of Darmstadt's computer center.

CIRCLE NO. 443

A new antiaircraft missile guidance head using semiactive radar techniques has been developed by Marconi Space and Defense Systems, Ltd., under a contract from the British Government. The semiactive radar techniques to give the missile all-weather performance. Microstrip circuits are used exclusively to eliminate bulky and costly waveguide assemblies. The result is a unit that can be tailored to fit into a wide variety of missile types. The complete unit is 330 mm long and 190 mm in diameter.

CIRCLE NO. 444

Two experimental optical glass fiber transmission routes for studying the transmission of videotelephone and speech signals have been assembled in the Siemens research laboratories in Munich. With present glass fiber materials, the transmission rate is expected to be more than 50 Mbits/s—sufficient for a least one television picture channel. The signals are converted to amplitude modulated pulses with a repetition frequency of 2 MHz, prior to being fed to a gallium-arsenide laser diode attached to one end of the glass fiber. Repeater amplifiers of laser diodes and photodiodes boost the signal.

CIRCLE NO. 445

A system for transmitting color pictures from transparencies over an international wire network was used for coverage of the recent Olympic Games in Munich. The colors were separated into magenta, cyan and yellow, and these signals were processed by dc and logarithmic amplifiers. The signals were then fed through nonlinear color-boost amplifiers and finally through antilog amplifiers, so that the transmitted signal was compatible with existing picture transmission systems.

CIRCLE NO. 446

INFORMATION RETRIEVAL NUMBER 26 ►

Look! The world's smallest dual output power supplies.

Mini modules only 2.3″ x 1.8″ x 1″. Tracking ±15V outputs have regulation of ±0.1% and ripple of 1 mv. Model D15-03 has outputs rated at 25 ma and costs only $24.00. Model D15-05 has 50 ma outputs; price $39. Models furnishing other matched voltages and/or higher currents are also available. Some are slightly larger, but all are comfortably priced.

Also available are dual mini modules with electrically independent dissimilar outputs in more than 400 different voltage combinations.

And if two outputs aren't enough, we have triple output mini modules. Plus/minus voltages for linear circuits, and a third output for companion logic. For example, Model 5E25D-D15E05 provides ±15 VDC @ 50 ma, 5V @ 250 ma. Price $88.00.

The world's smallest module for powering Nixie* tubes is the Model NX-25. Only 3.5″ x 2.3″ x 1″. Its 25 ma output will drive up to seven digits. Price $35.00.

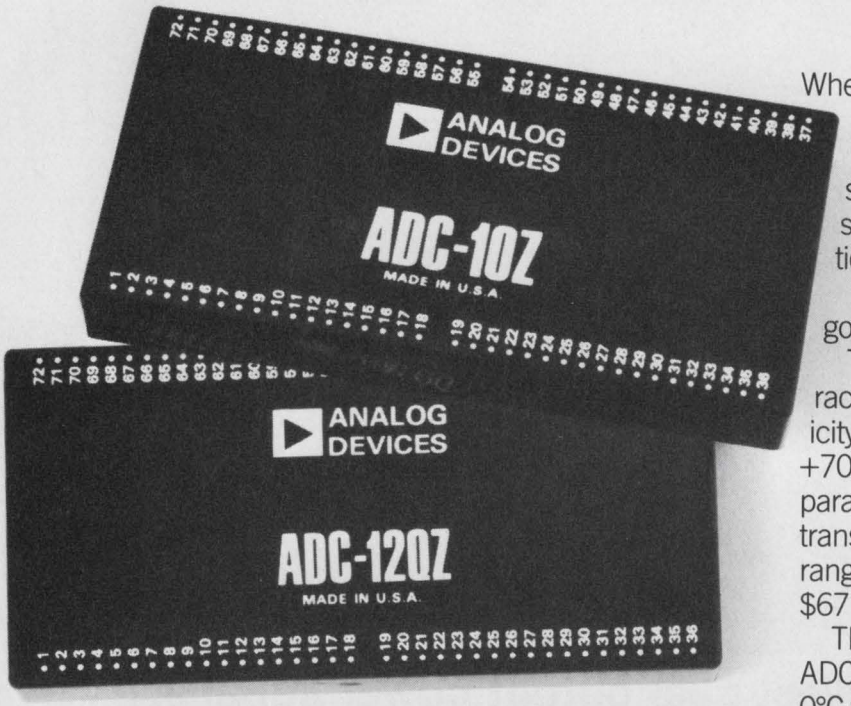
Other mini modules with single outputs ranging from 1 to 50 volts. provide up to 500 ma. With regulation as tight as ±.02%. Easily mounted to a printed circuit board. Like all Acopian mini modules, they are ruggedly built and short circuit protected.

For more details, write Acopian Corp., Easton, Penna. 18042 or call 215-258-5441.

For shipping information, just look at our tag . . .

*Registered trademark, Burroughs Corporation

Introducing two new A to D converters built the way you would if you could. Same with the price.



The first is our ADC-10Z.

The second is our ADC-12QZ.

Before we designed them, we asked ourselves two questions.

What do you really need?

How will you use it and how will it interface into your system?

Our two new converters are the answer. They not only have the performance but they're easier to use and design in.

Easier because:

1) The parallel data outputs can be connected for binary, offset binary, or two's complement coding.

2) We built in a status signal you can count on. When it says the parallel output data is ready, it's ready.

3) There's a serial output that really works. A strobe output we built inside synchronizes the serial data so that no external timing or synchronization logic is needed.

So even before you buy one, you know you're going to save time and money.

The ADC-10Z has 10-bit resolution and accuracy, 20μsec maximum conversion time, monotonicity over its operating temperature range of 0°C to +70°C, temperature coefficient of ±40ppm/°C, parallel and serial outputs, simplified serial data transfer, TTL/DTL logic levels, user selectable input ranges, an optional input buffer, and a price tag of $67 for one hundred or more.

The ADC-12QZ has all the good features of the ADC-10Z at 12-bit resolution. It's monotonic from 0°C to +50°C, has a temperature coefficient of ±30ppm/°C, converts in 40μsec (max.), and is priced at $92 for one hundred or more.

Through October 31st of this year, we'll sell you any quantity of these converters for the 100-piece price. And, we can ship them off the shelf right now when you need them.

Along with our 1972 Product Guide which shows you all the other things that we make to solve more of your problems better than anyone else.

Analog Devices, Inc., Norwood, Mass. 02062.
Tel. (617) 329-4700.

ANALOG DEVICES

INFORMATION RETRIEVAL NUMBER 27

washington report

Export controls to loosen

The Secretary of Commerce has been ordered by Congress to report in six months on his actions in loosening export controls on U.S.-produced items as a result of the enactment into law of the Equal Export Opportunity Act. The law calls for a study to determine which goods and technology should no longer be restricted on grounds of national security. Electronics industry representatives had complained of inability to sell items already marketed freely abroad by foreign sources.

Electronics industry antitrust hearings looming

Hearings on a Congressional bill that eventually could have considerable impact on competition in the electronics industry may yet be started this year, say sources on Sen. Philip A. Hart's Senate Judiciary Antitrust Subcommittee. Hart (D-Mich.) is looking at some seven industrial areas, including electronics and electrical machinery, to determine the extent, if any, of monopoly practices. His proposed bill (S3832) would create a Federal Industrial Reorganization Commission to develop and administer a plan to make competition more effective within each industry.

Review of Army helicopter program asked

A review of the Army's new heavy-duty helicopter program, known as the Uttas, has been asked by Rep. Aspin. The Army awarded two competitive prototype contracts—to Boeing Vertol and Sikorsky—for a total of $153.2-million. Each is to build seven models for evaluation. The estimated cost of the total program including production, Aspin charges, already has jumped from $2-billion to $2.344-billion.

FCC remains firm on TV-tuner accuracy requirements

Electronics companies are waiting anxiously to see if the single producer of 70-position TV tuners can meet Federal Communications Commission standards for accuracy. The FCC is making it clear that it will frown on any further manufacturer requests for extensions past Jan. 1, 1973. By that date, it says, all TV receivers must meet a tuning accuracy

of ±3 MHz. The FCC recently permitted RCA to use Sarkes-Tarzian tuners with an accuracy of ±6 MHz till the end of the year. But Sarkes-Tarzian, supplier to all U.S. television manufacturers, must improve the accuracy of all its tuners by next Jan. 1, or sets made after that time cannot be sold.

Litton challenged on helicopter ship costs

Litton Industries has been sent back to the drawing board by the Navy to rejustify its claim on the trouble-plagued landing helicopter assault program. Litton is asking $270-million extra for "changes" and "excusable delays." The Navy agreed to keep paying the company's cost for six more months while the claims were reworked and negotiated.

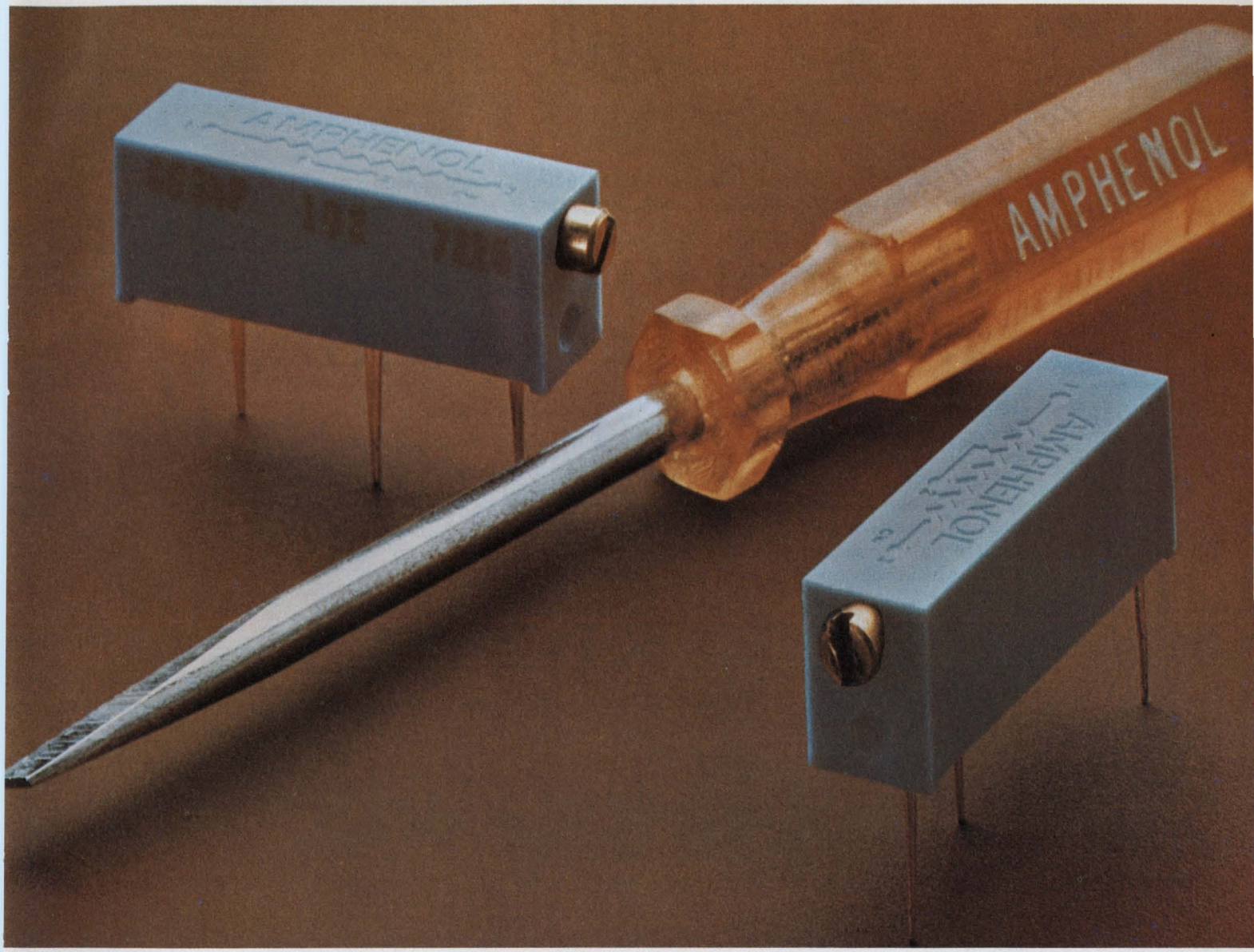
The action prompted Rep. Les Aspin (D-Wis.) to call for a General Accounting Office investigation of the Navy's decision to keep paying costs. Aspin also charged that the Navy was hiding overruns on a Government-furnished sonar system to be put on another Litton ship program, the DD-963 destroyer. Litton meanwhile says that despite Congressional concern, the DD-963 program is in good shape and is meeting both its budget and production schedules.

FCC to unsnarl communications satellite tangle

The Federal Communications Commission is expected to rule soon on the complicated question of domestic communications satellites in the wake of a new alignment by the Comsat Corp. and the MCI Lockheed Satellite Corp. The two companies, both of which were applying for domestic satellite systems, have agreed on a proposed jointly owned system. Comsat, which also is applying to lease satellite service to AT&T through a separate system, says now it would withdraw another earlier application for a system to serve all customers other than AT&T. All the would-be communications-satellite operations, including Western Union which already has ordered satellites for an as-yet unapproved system of its own, are anxiously awaiting the FCC's ruling on their applications.

Capital Capsules: The Engineering Dept. of the Electronic Industries Association has issued the **first recommended standard for thyristors.** The 192-page document is available from EIA, 2001 Eye St. N.W., Washington, D.C. 20006. . . . **The Government Printing Office has published a Handy Metric-Conversion wallet card.** . . . NASA has selected the **Hughes Aircraft Co., TRW Systems and Avco to study system design for a Pioneer-class spacecraft to probe Venus.** . . . ITT Gilfillan has won a NASA contract to develop a **visible laser communications experiment for the Applications Technology Satellite.** . . . **The International Voluntary Standards Cooperation Act** (S1798), which would provide Federal participation in setting international electronics standards and thus help U.S. industry abroad, **has passed the Senate but is stalled in the House Commerce Committee.** . . . The new Transit navigational satellite that went into a near-polar orbit earlier this month is transmitting experimental data at 400 and at 150 MHz. **After experiments lasting until early spring, the satellite will be available to all Transit users, Navy and commercial.** The new satellite updates the Transit that went up in 1964.

For fast, accurate settings,



test drive our 6034 trimmer.

Amphenol's 6034 Series trimmers have multi-finger contacts to give you better setability, lower CRV, and longer rotational life.

This ¾" cermet trimmer is designed with a low profile for maximum board stacking and has a solvent-resistant nylon case with epoxy seal for automated board cleaning processes. The Amphenol 6034 Series trimmer will operate at ambient temperatures up to 125°C and is completely humidity-proof. Three termination styles—P, K or Y terminals—are available.

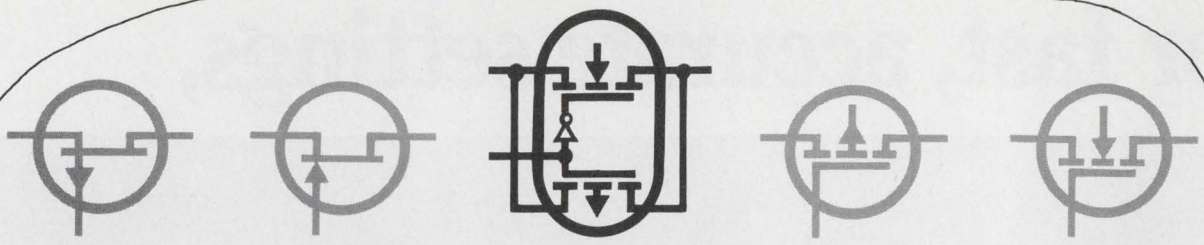
The low-cost 6034 has a rotation life of 200 cycles minimum with no discontinuity. All are 100% inspected for noise, total resistance, continuity and end resistance before shipping.

A barbed lead screw, with a 15-turn shaft adjustment, positively seals and eliminates end play. Without the typical O-ring there is no chance of pinching or breaking the seal.

Your local Amphenol distributor can arrange a "test drive" on your board. Let us set it up for you. Write Al Nemetz, Amphenol Connector Division, Controls Operations, Bunker Ramo Corporation, 2801 South 25th Avenue, Broadview, Illinois 60153.

BUNKER RAMO AMPHENOL

INFORMATION RETRIEVAL NUMBER 28



Since 1962, Siliconix has evolved FET technology and applied it to a complete line of singles, duals, arrays, and IC's. So what's new?

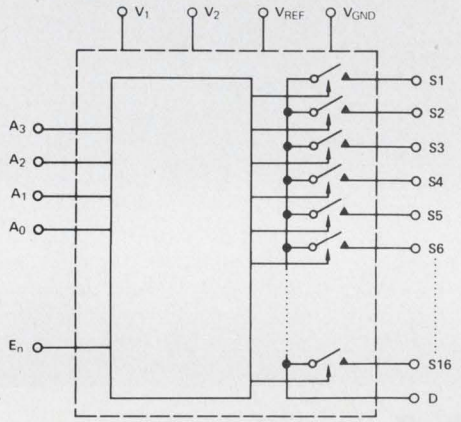
Switch 16 channels with CMOS DG506.

Here is a single-pole 16-channel multiplexer using paired CMOS FETs, with drivers controlled by a 4-bit binary word input plus an Enable-Inhibit input – all on one chip! Check the functional diagram and then refer to the decode truth table to see what binary word input selects which switch.

The DG506 features:

- ±15 V Analog signal range
- Break-before-make switches
- ON resistance <500 ohms
- TTL, DTL, and CMOS direct control interface
- 36 mW standby power

DG506 Function Diagram



Decode Truth Table

A_3	A_2	A_1	A_0	E_n	ON SWITCH
X	X	X	X	0	NONE
0	0	0	0	1	1
0	0	0	1	1	2
0	0	1	0	1	3
0	0	1	1	1	4
0	1	0	0	1	5
0	1	0	1	1	6
0	1	1	0	1	7
0	1	1	1	1	8
1	0	0	0	1	9
1	0	0	1	1	10
1	0	1	0	1	11
1	0	1	1	1	12
1	1	0	0	1	13
1	1	0	1	1	14
1	1	1	0	1	15
1	1	1	1	1	16

Our catalog line of drivers and switches will cover most applications. If your switching problems are unique – and whose aren't – call our applications people. They're eager to help. For complete information,

write for data

Applications Engineering: (408) 246-8905

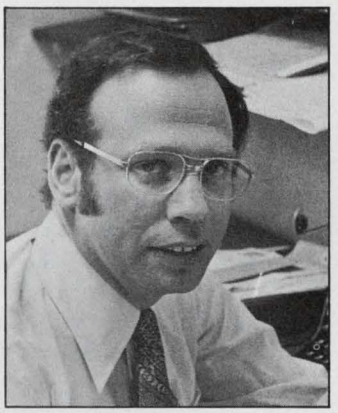
Siliconix incorporated

2201 Laurelwood Road, Santa Clara, California 95054

INFORMATION RETRIEVAL NUMBER 29

editorial

Some questions for rivals in the Presidential race



It is difficult to recall a Presidential election campaign in which the two candidates held such divergent views on so many issues—defense spending, Vietnam, the economy, national priorities and so on.

On defense, Senator McGovern believes that the military budget can be reduced substantially with no weakening of national security. President Nixon categorically rejects the slash-now, beg-later approach to defense policy. He views such programs as the B-1 bomber, F-14 and F-15 fighters, along with the Trident submarine, as necessary to this nation's defense in the decade ahead. The Senator from South Dakota, on the other hand, calls for a $30-billion cut in defense spending over the next three years and cancellation of the B-1, F-14, F-15 and Safeguard ABM programs.

These and other important issues will be discussed and scrutinized by the electorate in the weeks ahead. However, there are other questions that remain to be answered—questions that have an important bearing on engineering. For example:

What steps will the candidates take to stabilize once and for all, the cyclical unemployment in major sectors of the electronics industry?

What can be done with the thousands of unemployed and underemployed electronics engineers as a result of the recent recession?

What can be done to make the electronics industry less dependent upon fluctuations in defense spending?

Since research is the key to maintenance of technical superiority, what plans do the candidates have to keep the U.S. on top through consistent government support of research and development?

What steps will the Administration take to make the public aware that more technology—not less—is needed to solve the problems of shrinking resources, urban blight, transportation decay and increasing pollution?

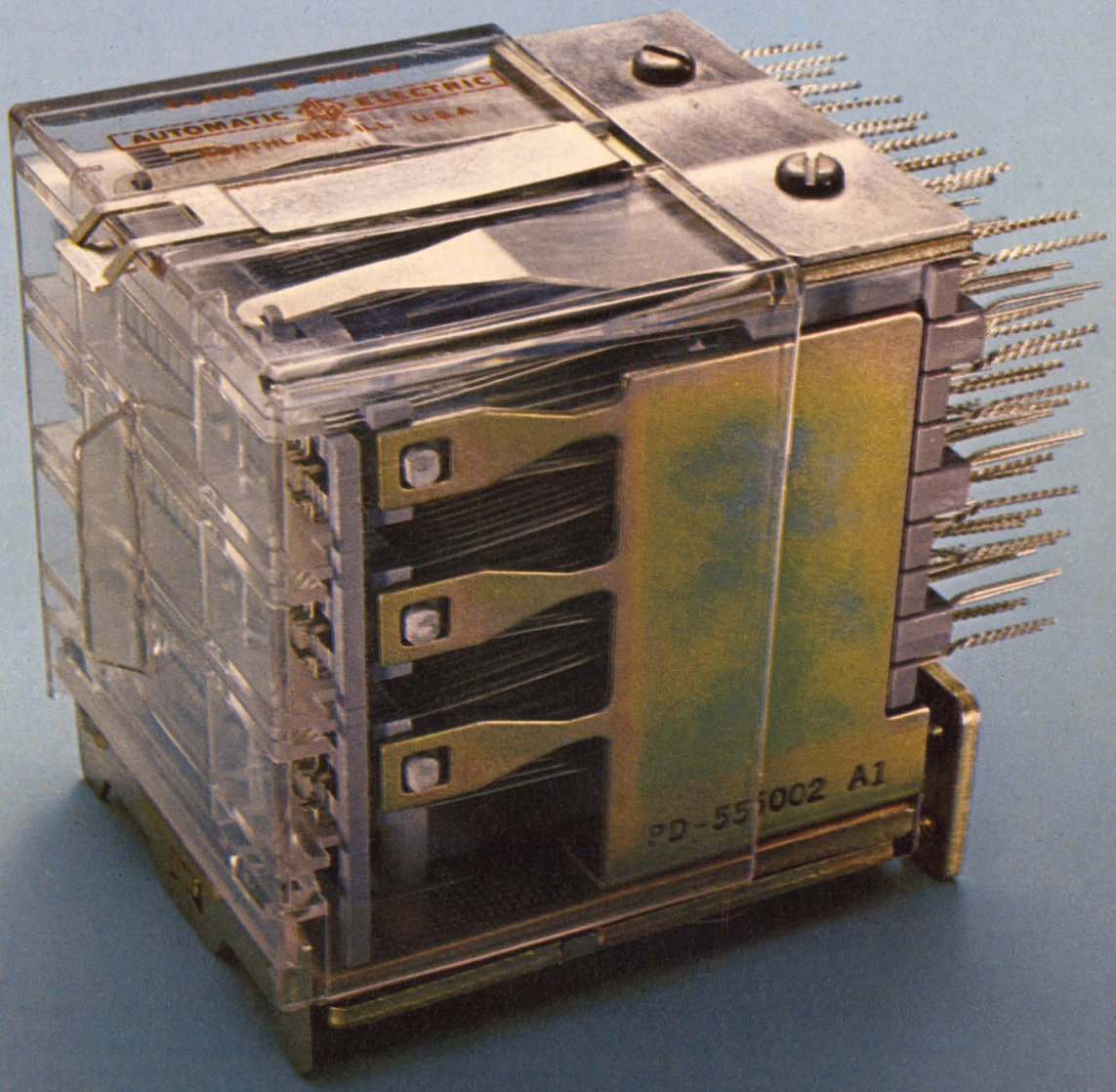
What plans do the challenger and President have to modify the winner-take-all method of awarding Government contracts, with its crippling effects upon both the losing company and the latter's geographic region?

We hope that in the remaining weeks of this campaign the two candidates will address themselves to these questions. They affect the welfare and professional status of the engineer.

Ralph Dobriner

RALPH DOBRINER
Managing Editor

Reliability is staggered steps and a hunk of DAP.



Expect over a billion operations.

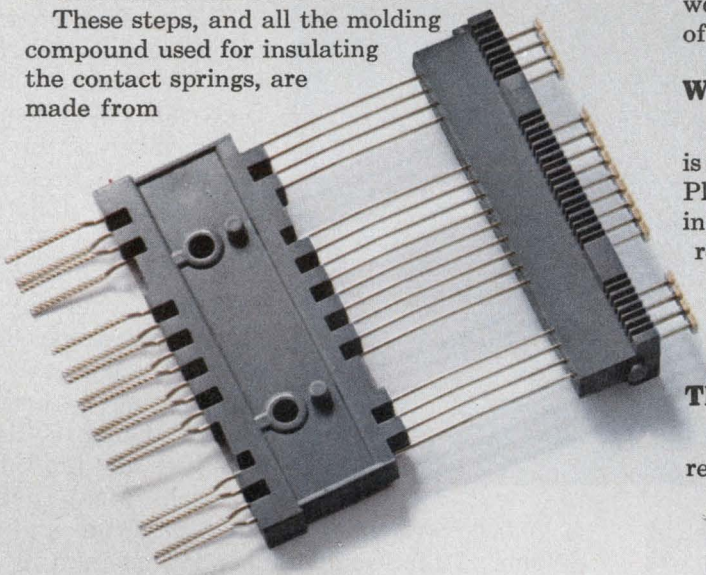
Our Class W wire-spring relay is different. In fact, there's nothing like it in the entire industry. Where else can you find a relay with lots of contacts and a mechanical life of more than a billion operations! That's about two and a half times the life of the best conventional relay around.

Another nice thing about our Class W is that it takes up a lot less space and costs less than using a bunch of other relays. That's because we build our Class W relay with one, two or three levels of contact assemblies, with 17 form C combinations per level. By the way, they're available with gold contacts for low-level switching.

Making it tough on creepage.

All those staggered steps you see on the side were put in to raise the breakdown voltage between terminals. These molded steps add extra creepage distance between the terminals. This really counts for high voltage testing, or when using our Class W in unfavorable ambient conditions.

These steps, and all the molding compound used for insulating the contact springs, are made from

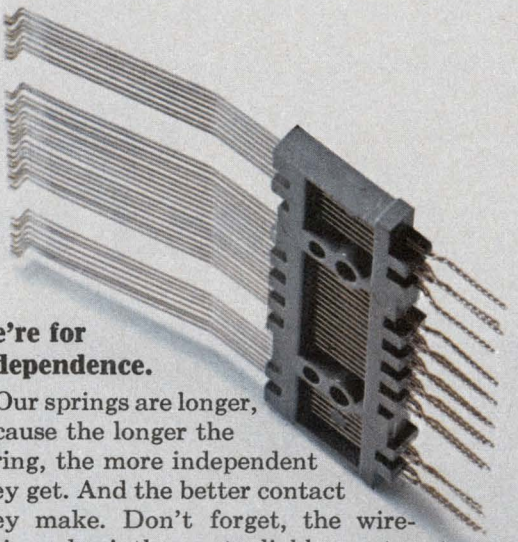


diallyl phthalate. (They call it DAP for short.) It has great insulating properties and it wears like iron. Even if the humidity is high, you have excellent protection.

Redundancy—two springs are better than one.

Each of our long wire-spring contacts has an independent twin with the same function. One tiny particle of dust could prevent contact on other relays. Not with our Class W. You can be sure one of the twins will function. That's back-up reliability.

The twin contacts are twisted together at the terminal end. Then we give them a spanking (you might call it swedging) to provide solderless wrap.



We're for independence.

Our springs are longer, because the longer the spring, the more independent they get. And the better contact they make. Don't forget, the wire-spring relay is the most reliable way to get a permissive make or break contact. You can rely on it.

The middle contact springs have to be stationary. To make sure they stay that way forever, we actually mold them between two thick pieces of DAP on both ends. Just try to move one.

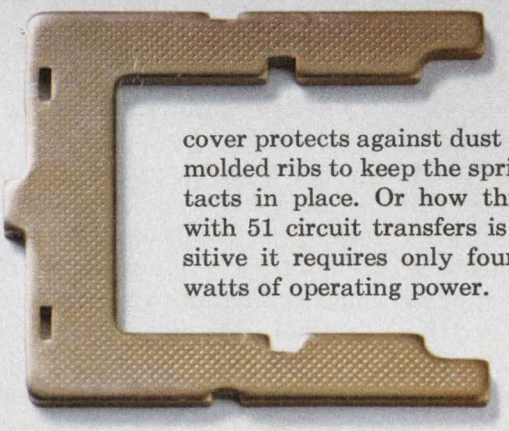
When we say flat, it's flat.

Each frame, banged out by a gigantic machine is extra thick and extra flat. Then they're planished. Planishing is another step we go through in forming the frame to add strength and stability by relieving surface strain.

We've made our spring-loaded pile-up clamp extra thick, too. Once it's tightened down, the whole pile-up is nice and tight, and stays tight.

There's more.

We could tell you a lot more about our Class W relays. Like how the tough high-temp molded



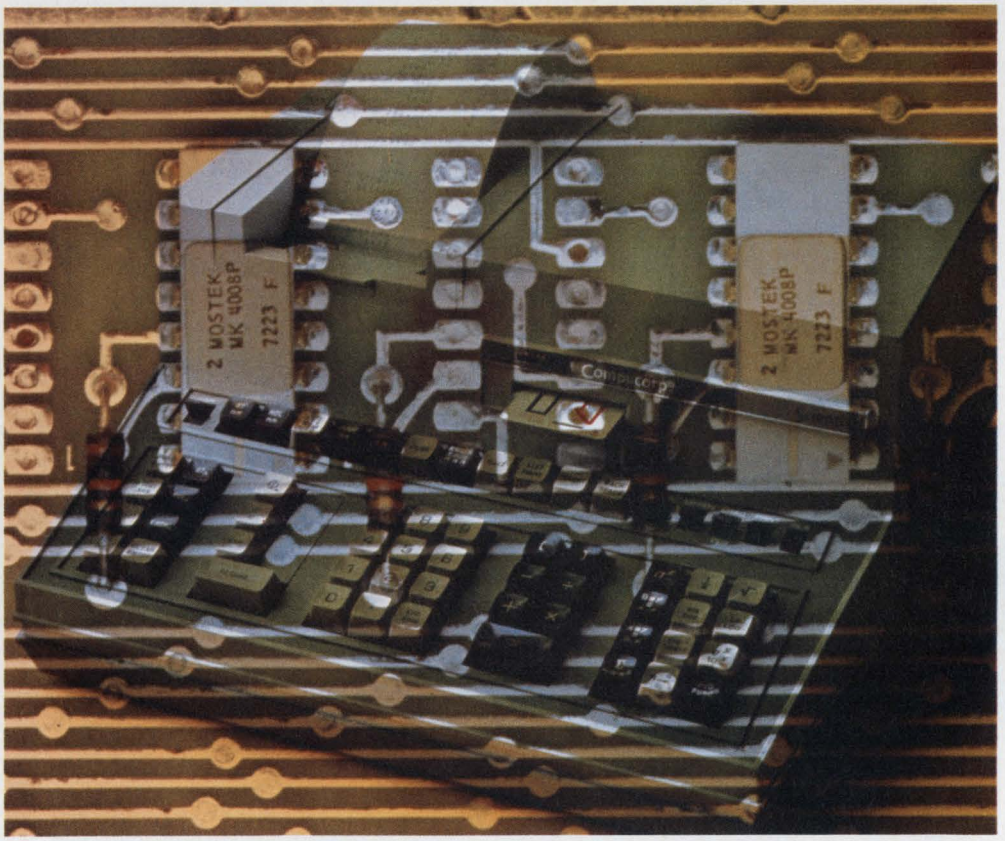
cover protects against dust and has molded ribs to keep the spring contacts in place. Or how this relay with 51 circuit transfers is so sensitive it requires only four to six watts of operating power.

But why don't you let us prove how much reliability we put into our Class W? We'll be waiting to hear from you. GTE Automatic Electric, Industrial Sales Division, Northlake, Ill. 60164.

GTE AUTOMATIC ELECTRIC

INFORMATION RETRIEVAL NUMBER 30

The calculator and the engineer



Programmable calculators, once rarely used in engineering, are rapidly becoming one of the most valuable tools that a design engineer or engineering manager has.

These calculators serve the engineer both at his desk and in the laboratory. At his desk, the machine provides rapid, easy solution of problems that otherwise wouldn't be attempted or that would require a small computer to solve. In the laboratory, the calculator can make speedy calculations between measurements or even acts as a central processing unit and controls an automated test system.

Programmable calculators are getting both smaller and larger. Hand-held machines are starting to intrude on the realm of the slide rule. Larger programmable calculators—with a full array of peripherals, such as printers, plotters, digitizers, expandable memory and the like—are beginning to fuzz the boundary line between calculators and minicomputers. The larger calculators have several hundred storage registers and can handle programs with several hundred steps.

Prices for programmable calculators range from less than $1000 to nearly $10,000. When you add peripherals, the costs can go much higher.

Engineers sometimes ask: "For my job, do I need a programmable calculator, a minicomputer or a time-shared terminal?" The answer comes from a thorough understanding of the capabilities and limitations of each. Many articles have been written about the capabilities and limitations of minicomputers and time-sharing. Not much has been said about programmable calculators.

ELECTRONIC DESIGN has put together three articles on the capabilities of the programmable calculator and possible applications. The first article gives a broad overview, explaining functional capability, programming and calculator structure in a general way. There is also a discussion of the use of a calculator as a system component.

The second article will consider the programming features of the calculators and their limitations. And the third article will discuss the expansion of a calculator system with peripherals.

Starting in this issue with the first article, the series will be continued in the next two issues of ELECTRONIC DESIGN.

David N. Kaye
Senior Western Editor

The Calculator and the Engineer -- Part 1

Try it on the calculator. If the design is too troublesome for manual analysis but not complex enough to justify use of a computer, try a programmable calculator.

Once mere adding machines, sometimes improved with a few special keys, calculators are now available as powerful, flexible, interactive systems that rival small computers. Still, today's programmable calculators—as machines with such expanded capability are called—are just as easy to use as their predecessors. They fill the gap between the slide rule and the computer, doing hundreds of odd jobs that don't quite fit the computer and simply would never get done by hand.

Consider these facts if you are a designer who has yet to investigate the value of these machines and how they operate.

- Programmable calculators come in two languages, keyboard and algebraic, and each has a wide choice of capabilities.
- Most of the peripherals available to computers can be used, including card readers, tape readers and punches, X-Y plotters, output printers, digitizing devices and general-purpose interfaces.
- Keyboards are used not only for entering data for on-the-spot calculations but also for entering programs, and separate keyboard sections are available for special functions. Most of the program language appears right on the keyboard.
- Displays show calculated results, input data and programs, and they range from a simple numerical presentation to a complete alphanumeric, real-time output. Often there's a built-in hard-copy printer, and usually there is a magnetic-card or cassette unit for storing and read-

Paul L. Asmus, Hewlett-Packard, Calculator Products Div., P.O. Box 301, Loveland, Colo. 80537

1. **A programmable keyboard-language calculator** is almost as easy to operate as the old adding machines. Built-in card readers, displays, printers and a program mode make it a powerful problem solver.

ing back data and programs.

- Editing, syntax-checking and error-detecting features are often built in.

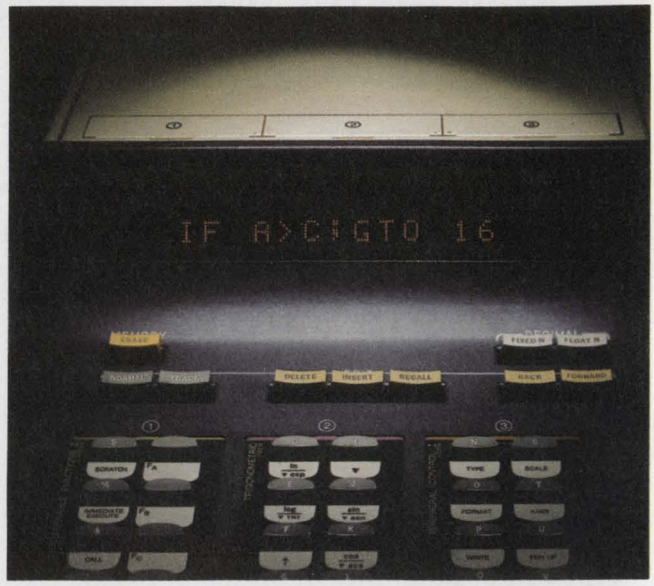
Shipped ready for instant use

Programmable calculators are ready to use right out of the shipping carton. On keyboard-language calculators (Fig. 1) complete operation —such as add, subtract or multiply—is normally defined by a single key. When the key is pressed in the operate mode the operation takes place immediately. Many functions that need several operations—such as storage, search, printing and many user-defined specials—can often be done with at most two key strokes.

Programming a keyboard-language calculator is done by switching it to its learn-program mode and pressing the keys in the same sequence that you would to make calculations directly. Thereafter the calculator can repeat a complex sequence automatically, stopping only to wait for new data at selected points or to take prestored data from the memory or registers.

Keyboard-language calculators are easy to master. With almost no experience in programming, you can operate a unit with fair efficiency almost immediately and program effectively in days.

The keyboard calculator is powerful. The simpler unit can execute sequentially about 500 programmed steps, and more advanced machines can handle several thousand steps. Each step is represented by a single-key operation. Most keyboard calculators can store about a hundred floating-point numbers, and they can easily solve 10 simultaneous linear equations. Almost all units operate internally with at least 12-digit precision, although the output may be rounded off to any lesser precision the user selects.



2. **A programmable algebraic-language calculator** accepts and displays equations almost as you would write them.

But a limitation of the keyboard calculator is that it is cumbersome to use to solve really long and complex problems. Although it has all the instructions to do the job, the long sequence becomes tedious.

Algebraic units solve complex equations

The algebraic programmable calculator (Fig. 2) is a better choice for solving complex equations. Its language and displays are very similar to a computer's. An engineer familiar with FORTRAN, BASIC or any other well-known programming language can use an algebraic calculator almost immediately. He enters the expression in the calculator with almost the same symbols he uses to write it on paper.

Each key represents the code of one function

Calculators offer more than just answers

Programmable calculators encourage engineers to try things they might not otherwise do. "I haven't time to mess with that" becomes, "Let's try that on the calculator."

A simple RC trigger circuit, for example, often gets designed by rule of thumb. Solving the few exponentials is conceptually simple, but it requires tables or a slide rule. In the time it takes to find the right set of tables, an engineer can punch a two or three-line program on a calculator and accomplish a lot more—find out how resistor tolerance affects delay time or what the linearity of the charge rate is.

Or consider the engineer making a field-strength plot for an antenna. The calculations involved aren't too complex, but they are time-consuming—there are sines and cosines to look up, lots of data to jot down. He can "write" a complete program on an algebraic calculator in the time it takes to calculate one point with a slide rule. With time to spare, he can make several plots—or change the length of the stub or the number of turns of the coupling coil and watch the results. Soon he sees that the back lobe widens or narrows, or that directivity increases. He's learning something about antennas —something important, something he might not have time to learn without his calculator.

3. **Programmable calculators that use a bus** architecture are easy to interface with almost all the peripherals available to minicomputers such as X-Y plotters and magnetic-tape cassette units.

of a program, even though in the display it may appear as a two or three-character mnemonic. A program statement like IF A > C; GTO 16 takes eight characters, since IF and GTO are only one character each. The expression appears on an alphanumeric display as it is entered.

At any time during the entry the expression may be backed up and edited. An error causes the calculator to display an error message. Errors in a line, such as failure to include a terminal parenthesis, prevent the calculator from executing or storing the line; instead the machine displays a diagnostic code. When the program is running, performance errors, such as an attempt to divide by zero or to take logs of a negative number, stop the calculator, and an error code is displayed along with an indication of the line in which the error occurred.

Once the expression is properly entered, pressing an "execute" key produces the calculated result. If a "store" key is pressed instead, the calculator assigns a number to the entered line of algebraic figures (as the user sees it on the display), and the machine stores both the line number and expression in its memory.

Calculators do have their limits

However, there is a limit to the size of problems that even an algebraic calculator can handle. Available memory capacity is the main limiting factor. Although peripherals like tape cassettes can substantially expand the memory, use of a calculator beyond a certain point is inefficient. A computer may be better here.

Unfortunately there is little agreement among calculator manufacturers and users on how best to measure capability. Some use the number of registers, others the number of program steps that can be handled. But different calculators may use different percentages of their memory for a particular step, and not all registers are the same size or can do the same things. Comparison is difficult, but not impossible. Let's examine some helpful guides.

Measuring capability

To use the number of registers as a measure of calculator capability, the engineer must first understand their purpose and the sizes they come in. In general, a register is a memory circuit that is big enough to store a 12-digit or longer floating-point number, its sign and a two-digit exponent with its sign. This is equivalent to four, 16-bit words. Therefore a common calculator with 100 registers has the equivalent of about 400, 16-bit words of memory.

In some calculators all registers can be used interchangeably for either program or data storage. Other calculators have registers set aside for data only, while different registers hold program information only. When used for program storage, a register holds from eight to 16 steps in keyboard machines, and about eight characters of program in an algebraic machine.

Thus, in judging calculator capability the number of registers alone is insufficient information. The size and allowed flexibility in using the registers must also be considered.

To use total program steps as an effective measure of calculator capability, you must know

how much calculating is done with each step. In most keyboard machines, arithmetic operations use one or at most two steps. Storage and recall operations and indirect arithmetic operations call for from two to six steps. Conditional transfer operations require two to five steps. And special functions, like trig or square root, usually need only one step.

A comparison of step-capacity numbers only, can be quite misleading. The types of problems that the user will be solving have a great effect on the meaning of this capacity number.

The calculator is easily interfaced

Programmable calculators with a bus architecture are easy to interface (Fig. 3) with digital devices that use standard codes. Digital voltmeters, counters, X-Y plotters and tape-cassette units are only a few of the peripherals that may be used. In fact, a variety of standard packages are available for interfacing calculators with peripherals that use BCD and ASCII codes. A calculator, an interface card set and a DVM make an inexpensive measuring, data-processing and logging system. The voltages measured automatically by the DVM are fed into the calculator, and they can be converted to other units of measurement, if desired. A complete statistical analysis can be done. And a printer, usually part of the calculator, makes the system a data logger.

Further, while serving in such dedicated systems, the calculator can still be used for its basic purpose—calculating. Built into its language is the ability to disconnect from the interface; there is no need to physically reconfigure the system in any way.

There are two main approaches to calculator interfacing: the dedicated interface and the general-purpose coupler. The dedicated interface connects a single peripheral device directly to the calculator's internal bus. As many as four interface cards are used. The calculator has full control over the bus, directing and routing data between itself and the peripheral.

The general-purpose coupler, however, provides its own external bus system, and couplers with as many as eight interface channels are available. Thus up to eight different devices can be simultaneously connected to a calculator.

By using a general-purpose coupler, with an ASCII input-output card, and a programmable power supply, you can make an automatic stimulus source for testing. Combine this with a DVM and a data scanner (often part of the DVM), and you have an automatic test system for circuit boards. The different functions of DVMs—such as ac or dc, volts or milliamperes, or ohms—and their ranges are also controlled by the calculator. The program for the tester is written in the same language used for normal calculator work.

4. **Automatic testing, data analysis and logging** can be done by coupling a programmable calculator to programmable signal sources and measuring instruments. A programmable frequency sweeper and tracking detector, when added to a calculator, becomes a versatile network analyzer that is simple to program.

By combining a programmable frequency sweeper and tracking detector with a calculator via a general-purpose interface card, you get a very versatile network analyzer (Fig. 4). The calculator controls the measurement cycle and then analyzes the results. Hi-go-lo testing, statistical analysis and even self-calibration can be done. And with a tape cassette added, the calculator can maintain a history of the test data for the quality-assurance department.

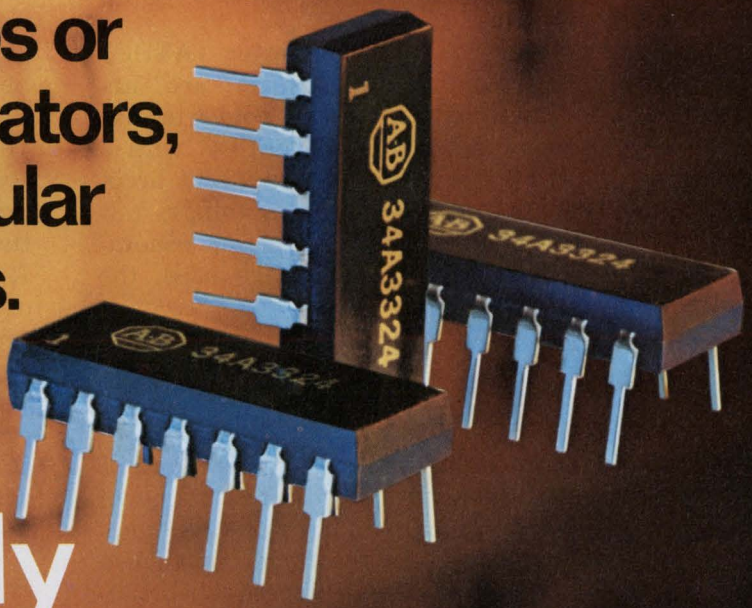
Such systems are nearly as powerful, but much less expensive, than minicomputer configurations. At the same time calculator testers are very easy to use, and they can be readily reconfigured for other jobs.

Speed, however, is an important limitation with calculators. A calculator-DVM combination can operate at 40 to 50 readings a second. A comparable minicomputer system can operate several magnitudes faster.

Another limitation is the relatively small on-line storage capability of calculators—generally only several hundred storage locations. This can be improved by using the usual 12-digit calculator register to hold two numbers of five digits each. However, this results in a sacrifice of speed. A further way of improving storage capacity, if speed is not important, is to store the data on a magnetic-tape, cassette or cartridge unit, or a magnetic disc. In this manner, very large amounts of data and programs can be handled.■■

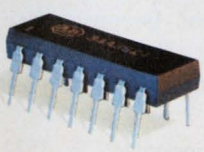
Quality resistor networks now available off-the-shelf.

Pull ups or terminators, in popular values.



If you're really serious about cost, be serious about quality.

Now our most popular thick-film resistor networks are ready and waiting, in quantity, at your A-B electronics distributor. Pull-up networks and terminator networks with tolerances of ±2% in popular values from 68 ohms to 22K ohms. All in compatible 14 lead .300 series DIP's. Or if you need something special we'll quickly custom design any circuit that'll fit into a 14 or 16 lead DIP. And we mean quickly. Overall specs include: absolute tolerances to ±.5%. Tracking ±50 ppm/°C (and lower). TCR to ±100 ppm/°C. Write for free technical publications 5850 and 5851. Allen-Bradley Electronics Division, 1201 South Second Street, Milwaukee, Wisconsin 53204. Export: Bloomfield, New Jersey 07003. Canada: Allen-Bradley Canada Limited, Galt, Ontario. United Kingdom: Morganite Resistors Limited, Jarrow, Durham.



Actual Size

Allen-Bradley
Milwaukee, Wisconsin 53204

INFORMATION RETRIEVAL NUMBER 31

Cut synchro-to-digital conversion costs

and improve performance with this simple converter. Extensive use of digital ICs simplifies its quantity production.

In spite of increasing synchro-to-digital conversion needs, present conversion techniques are complex and frequently shrouded with proprietary labels. The common approaches—using nonlinear function generators or interpolation techniques[1]—result in hardware that is difficult to mass-produce. Calibration, production-testing and repair are problems.

The arc synchro-to-digital converter (ASDC) avoids these shortcomings. (The term "arc" underscores the fact that the device converts arc-sine or arc-cosine functions). An ASDC with a peak error of ±5.4 arc minutes, or 12-bit accuracy, can be built for $130 in parts (single-unit prices). Since neither nonlinear function generation nor interpolation techniques are used, the ASDC can be mass-produced easily.

ASDC operation is simple

The basic ASDC encoding technique for converting a synchro input into a 0°-to-360° output is very simple, since it uses the best known waveshape—a sine function. This sinewave function is readily available in the form of synchro excitation voltage. The standard three-wire, 120-degree-spaced synchro input is converted into a sine and a cosine function with a Scott-T transformer (see box for brief explanation).

To understand the basic ASDC operation, suppose that we have two inputs: a dc signal $R \times \sin \theta$, varying in amplitude as a function of a shaft angle, θ, with the maximum possible positive value of R volts, and a sinewave $R \times \sin \omega t$, varying as a function of ωt, also with the maximum possible positive value of R volts. In addition suppose that we have available a squarewave, Ref_{so}, varying between 0 and +5 V, whose positive portion coincides in time with the positive half cycle of $R \times \sin \omega t$.

If we connect these signals (Fig. 1a), we obtain an output pulse train, with the pulsewidths proportional to θ. Mathematically,

$$R \times \sin \theta = R \times \sin \omega t, \quad (1)$$

or, canceling terms,

$$\theta = 2\pi \text{ ft}. \quad (2)$$

George S. Oshiro, Consulting Engineer, P.O. Box 90876, Los Angeles, Calif. 90009.

The comparator of Fig. 1a, ideally, can swing instantaneously between 0 and +5 V. In practice, however, as $R \times \sin \theta$ approaches the peak of $R \times \sin \omega t$, the finite gain of a "live" comparator will begin to show as jitter in the encoded pulsewidths. To solve this problem, the other output of the Scott-T transformer ($R \times \cos \theta$) is used. To understand how, assume that θ is in the first quadrant. As θ approaches 90°, $R \times \sin \theta$ will approach the peak value of $R \times \sin \omega t$ (R volts). Simultaneously $R \times \cos \theta$ will approach zero volts. At $\theta = 45°$, $R \times \sin \theta$ equals $R \times \cos \theta$. By detection of this equality, pulsewidths are generated, with $R \times \sin \theta$ used for angles of less than 45°. For angles of greater than 45°, $R \times \cos \theta$ is used as the input to the comparator of Fig. 1a. For effective encoding, dual comparators are required for detecting θ as it passes through all four quadrants.

This dual-mode comparison is summarized graphically in Fig. 2. It should be noted that the IC comparators must have these minimum characteristics to achieve the accuracy of ±5.4 arc minutes:

- Minimum gain of 200 V/mV.
- Response time of 100 ns or less.

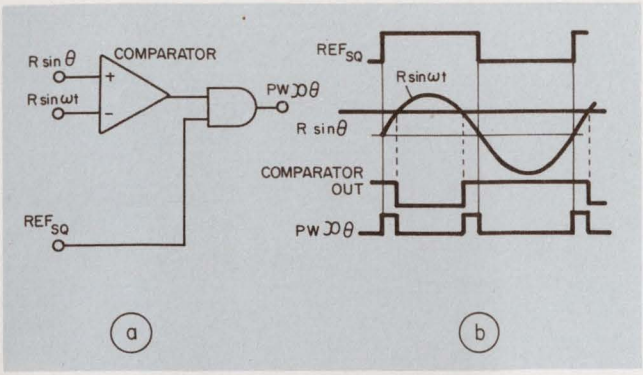
Understand ASDC timing

Basic to the operation of the ASDC is the use of a complete cycle of $R \times \sin \omega t$ for the peak detection (or sampling) process. This is done to avoid comparison of negative $R \times \sin \omega t$ voltages, thus reducing component count and logic complexity. Referring to Fig. 3, we see that the complete conversion cycle is:

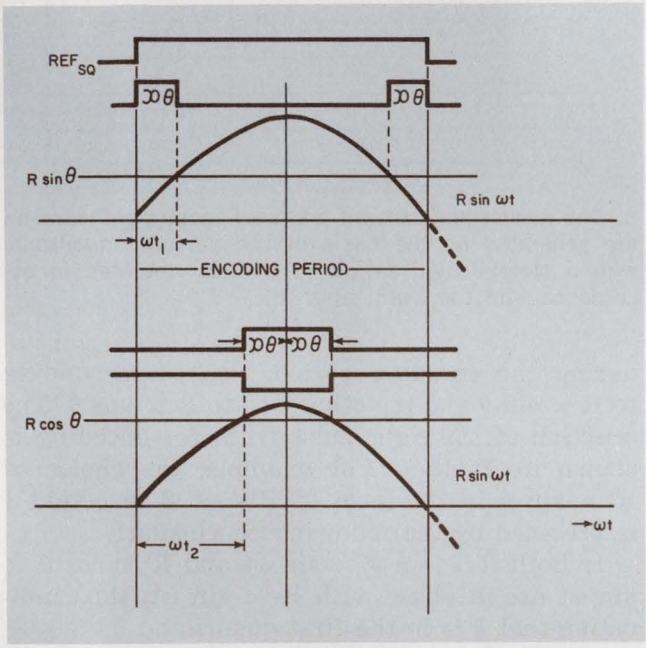
1. Peak and quadrant detection.
2. Encoding.
3. Reset function.

The presence of the $R \times \sin \theta < R \times \cos \theta$ comparator output throughout the encoding period provides the switching reference for the dual-mode comparison.

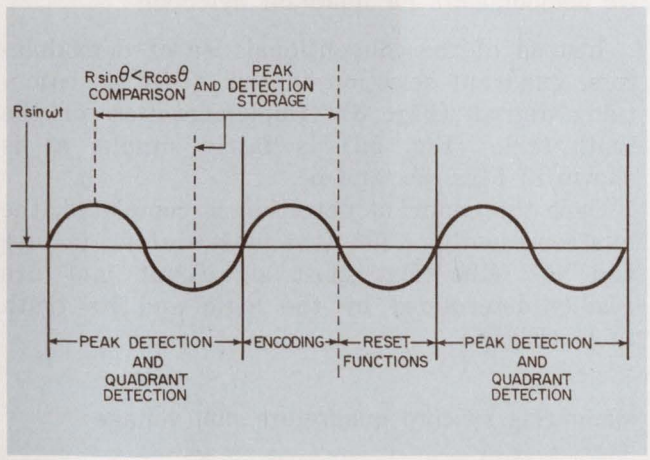
Before proceeding with octant-by-octant operation of the ASDC, note that the $R \times \sin \theta < R \times \cos \theta$ comparator need not be very accurate, since the pulsewidth jitter does not become significant until θ becomes about 70°. Furthermore the octant selection itself does not have to be



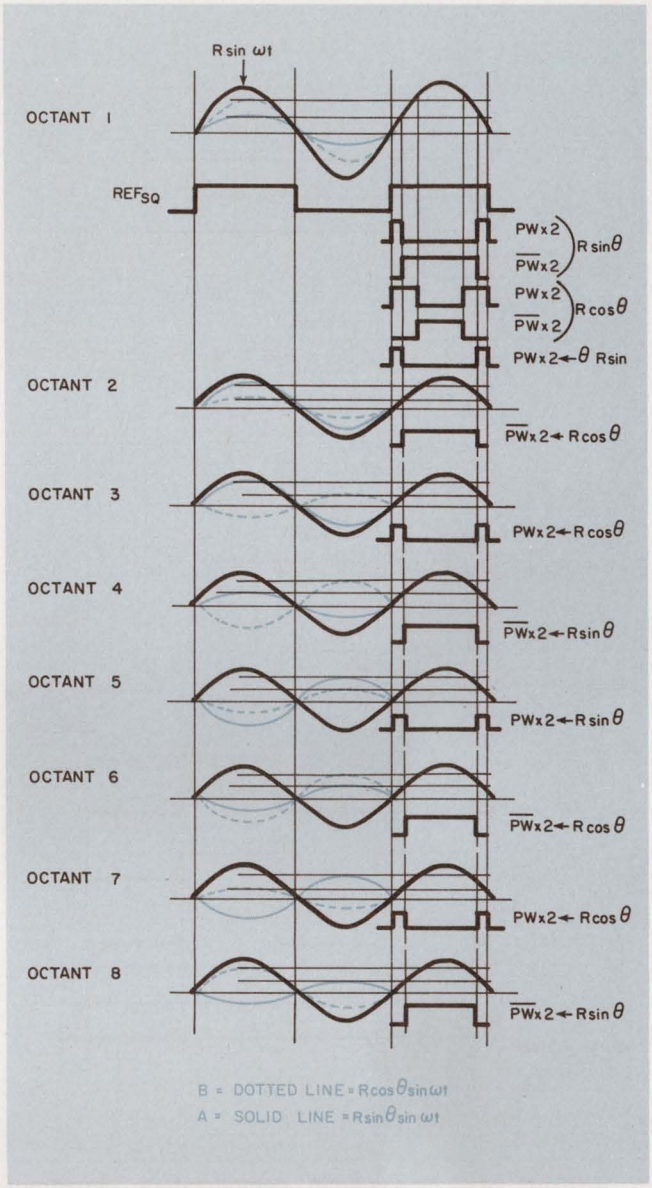
1. **Synchro-to-digital conversion is based** on generating pulsewidths (PW) proportional to the angle θ. The principle is illustrated in a simple circuit (a) and its waveshapes (b).



2. **To eliminate pulsewidth jitter at large angles,** both outputs of the Scott-T transformer (R × sin θ and R × cos θ) are used. The R × sin θ is used for angles of less than 45°, and R × cos θ is used for angles of more than 45°.



3. **Use of a complete cycle of the reference signal** (R × sin t) results in fewer components and simpler logic for timing various encoding events.



4. **Selection of the encoded angle's octant** is done after determining the corresponding quadrant (see Table 1) and then "looking" at the waveshapes shown above.

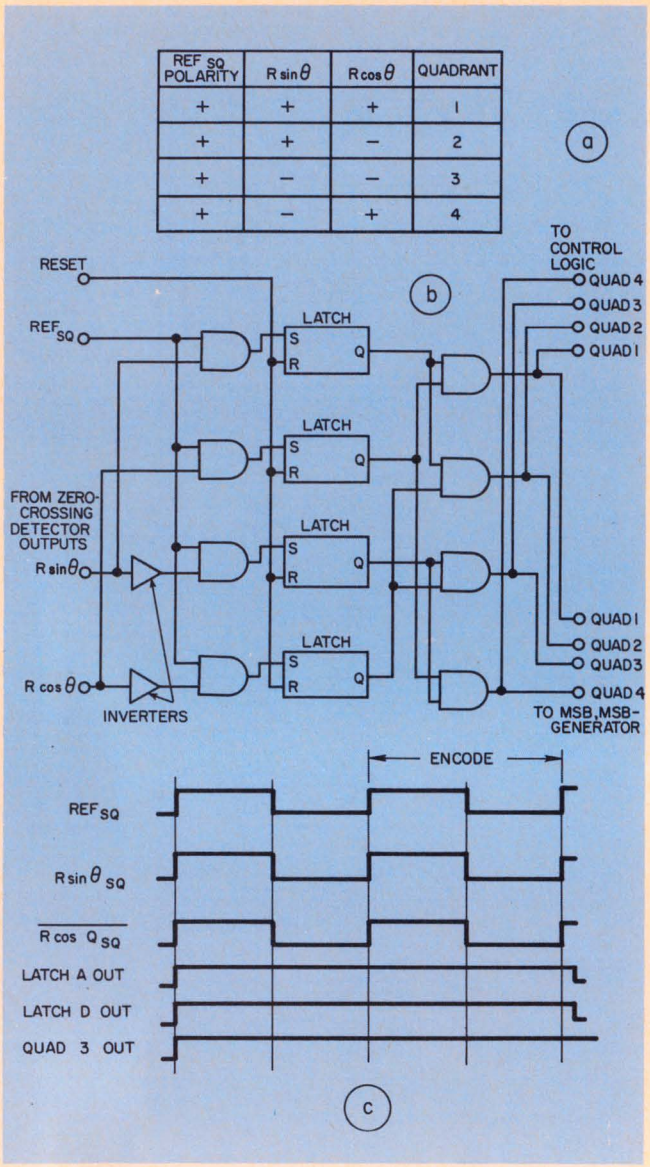
precise. Thus this comparator can have a sizable hysteresis without effect on ASDC accuracy. This is a significant advantage over existing synchro-to-digital converters that rely on octant selection for generating the third most significant bit in the digital angle output.

Selecting the octants

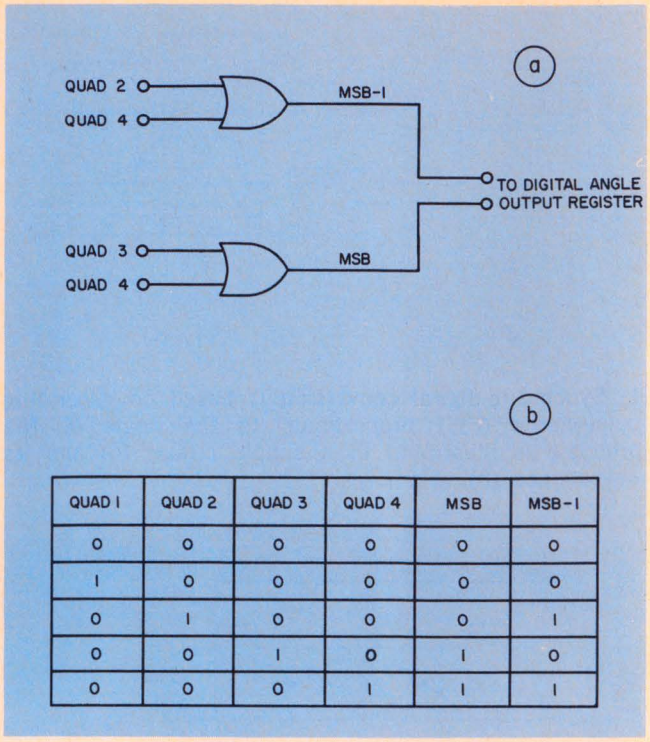
Octant selection is summarized in Table 1, with octant-by-octant waveforms sketched in Fig. 4.

Octant I is characterized by the fact that both R × sin θ × sin ωt and R × cos θ × sin ωt prior to peak detection are in phase with R × sin ωt. The reference squarewave, Ref_{SQ}, is obtained by squaring R × sin ωt, and it provides the master timing reference for the ASDC operation.

Note that a total of four pulse trains (marked PW × 2 or $\overline{PW}$ × 2 in Fig. 4) are provided



5. **Instead of conventional demodulators,** quadrant selection is essentially digital, in accordance with the truth table (a) and its implementation (b). The operation is detailed in "c."



QUAD 1	QUAD 2	QUAD 3	QUAD 4	MSB	MSB-1
0	0	0	0	0	0
1	0	0	0	0	0
0	1	0	0	0	1
0	0	1	0	1	0
0	0	0	1	1	1

6. **The most significant bit** and next most significant bit are generated on the basis of the detected quadrants with a simple logic circuit (a), which operates in accordance with the truth table (b).

Dual-mode comparison and encoding

R sin θ x R sin ωt POLARITY	R cos θ x R sin ωt POLARITY	QUADRANT	R sin θ < R cos θ	OCTANT	CHOOSE R sin θ IN FORM OF		CHOOSE R sin θ IN FORM OF	
					PW x 2	$\overline{PW}$ x 2	PW x 2	$\overline{PW}$ x 2
+	+	1	YES	1	X			
			NO	2				X
+	−	2	NO	3			X	
			YES	4		X		
−	−	3	YES	5	X			
			NO	6				X
−	+	4	NO	7			X	
			YES	8		X		

during the encoding period, two corresponding to R × sin θ and the other two to R × cos θ. The selection of the right pulse train for encoding is shown in Table 1. For example, the choice of R × sin θ in the form of PW × 2 in octant I is preceded by the following conclusion:

1. Both R × sin θ × sin ωt and R × cos θ × sin ωt are in phase with R × sin ωt, thus indicating that θ is in the first quadrant.
2. The peak-detected value of R × sin θ is less than the peak-detected value of R × cos θ.

The ASDC operation in other octants can be followed from Table 1 and Fig. 4.

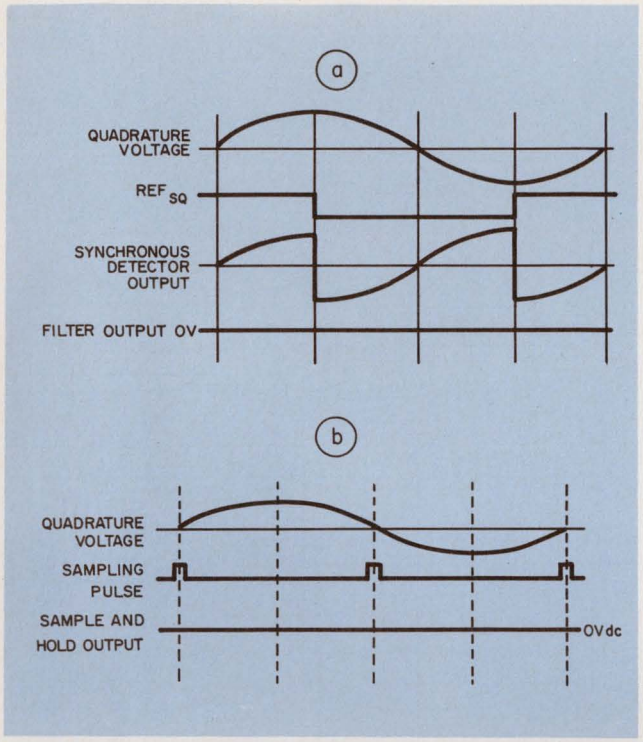
No demodulators for quadrant detection

Instead of the conventional use of demodulators, quadrant selection in the ASDC is essentially digital (Fig. 5). Implementation of the truth table (Fig. 5a) is fairly simple, as is shown in Figs. 5b, and 5c.

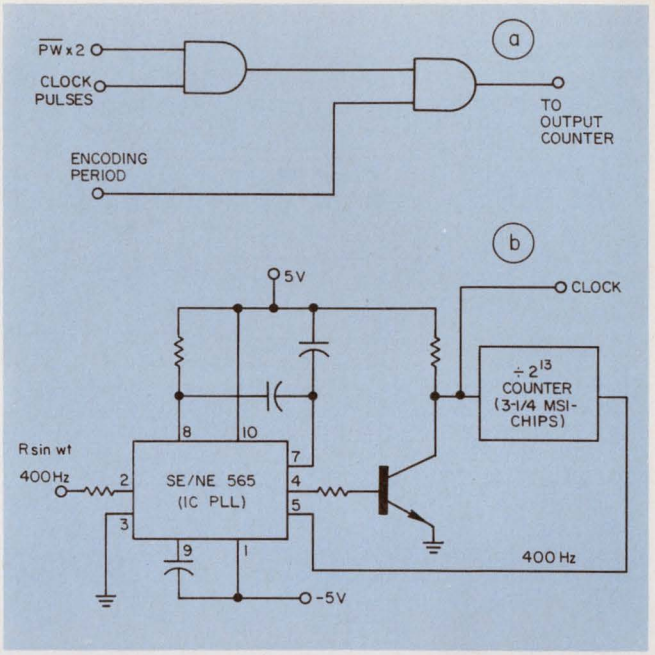
Once the quadrant detection is completed, the bits representing 180° (the most significant bit) and 90° (the next most significant bit) are readily determined by the logic and its truth table (Fig. 6).

Minimizing synchro quadrature null voltage

One of the most important features of the ASDC is its ability to reject the synchro quadrature voltage. To appreciate this, let's review very



7. **To improve the conventional quadrature voltage rejection technique** (a), the ASDC uses a specially designed peak sampler that rejects the quadrature voltage in accordance with "b."



8. **Pulsewidths are converted into digital data** by a single AND gate (a) that puts out the clock pulses during the pulsewidth ($\overline{PW} \times 2$). The second AND gate stops the output pulses to the output counter at the end of an encoding period. To eliminate the effects of the drift in the reference signal (synchro excitation voltage, R × sin t), the clock is slaved to the reference (b).

briefly the errors produced by the quadrature voltage and an existing technique for their elimination.

All synchros (and resolvers) exhibit a fundamental null voltage, along with harmonics (predominantly the third) when the synchro is positioned at its electrical zero. The harmonics can be filtered out, but the fundamental null voltage cannot, being of the same frequency as the synchro excitation voltage but with a quadrature (90°) phase shift.

The error caused by the quadrature null voltage can be substantial. For example, suppose that a quadrature voltage of 20 mV dc = R × sin θ exists after detection and filtering. If ratioing is used and the maximum value of R × cos θ is 10 Vdc,

$$(R \times \sin\theta)/(R \times \cos\theta) = \tan\theta,$$
$$(0.02)/(10.0) = \tan\theta,$$

so that

$$\theta = 7 \text{ arc minutes of error.}$$

Among the previously available techniques for rejecting quadrature voltage, there is only one worth mentioning. Referring to Fig. 7a, we see that synchronous detection of sin θ and cos θ (or synchronous detection of ac error voltages generated within the conversion process) is used to eliminate quadrature voltages. This technique is widely used in high-accuracy, closed-loop tracking converters[1].

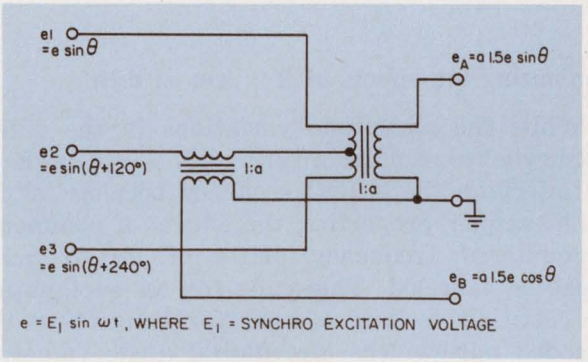
The method used in the ASDC consists of sampling the R × sin θ and R × cos θ voltages

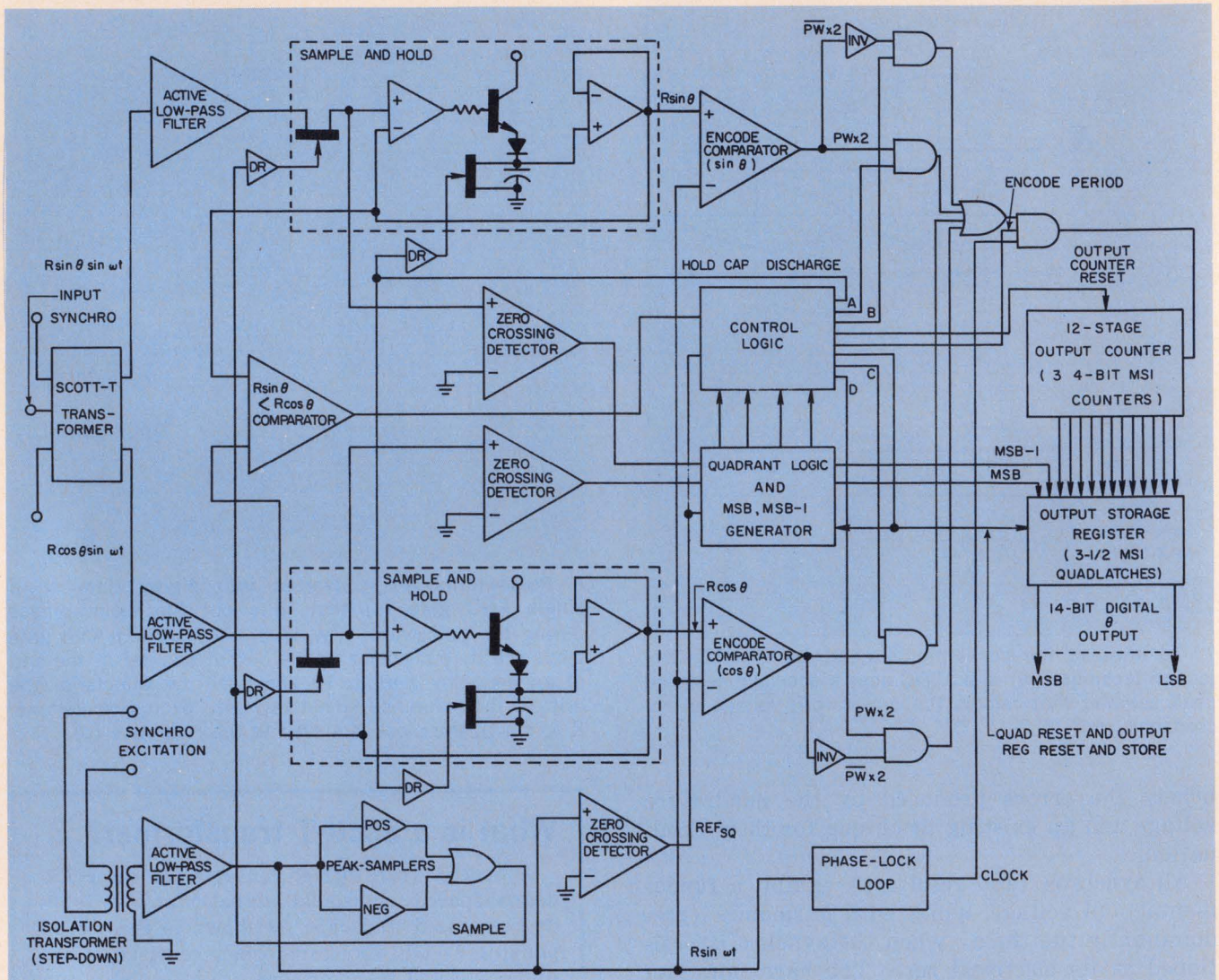
What is a Scott-T transformer?

A Scott-T transformer converts the three 120 degree-spaced sinusoidal signals into two 90-degree-spaced sinusoids. As shown in the accompanying sketch, the transformer consists of two interconnected transformers.

The information in the output and input signals of the transformer is in the form of amplitude modulation of the carrier, $e = E_1 \sin \omega t$, whose magnitude varies as a function of the synchro shaft angle. A step-down ratio, 1:a, is required to accommodate solid-state conversion circuits. Typical maximum outputs of a Scott-T transformer are 20 V peak-to-peak.

Highly accurate and compact transformers—2 × 1 × 1/2 inches, with errors as low as 45 arc sec—are commercially available at prices from $5 to $35.





9. **The functional simplicity of the ASDC is apparent** from its complete block diagram.

at the peaks of the reference carrier R × sin ωt to avoid quadrature (Fig. 7b). Since the sampling accuracy in Fig. 7b depends almost entirely on how narrow the sampling pulse is, a special peak sampler[2] was designed for the ASDC. It permits generation of pulses as narrow as 100 μs with a 400-Hz carrier. (The type of sample-and-hold circuit used to store the peak values of R × sin θ and R × cos θ is shown in the over-all functional schematic of the ASDC.)

Minimizing the effects of R × sin ωt drift

While the amplitude variations in the reference synchro excitation voltage, R × sin ωt, have no effect on the ASDC accuracy because of the peak-sampler properties, the effects of commonly encountered frequency drifts of up to ±5% must be canceled. This calls for an explanation of counting technique used for converting the encoded pulsewidths into digital angle values.

Assume that we are encoding a synchro shaft angle of 90° and that the frequency of the reference, R × sin ωt, is exactly 400 Hz. At 90° the selected encoded pulsewidth is $\overline{PW} \times 2$ (Fig. 4). This turns out to be a squarewave that is exactly coincident with Ref_{SQ}. Since the ASDC is a 14-bit device and the most significant bit and next most significant bit are generated as a result of quadrant detection, the remaining 12 bits must be derived from the $\overline{PW} \times 2$ product corresponding to 90°. This is done by counting clock pulses that occur during the pulsewidth, $\overline{PW} \times 2$, with

$$\text{Clock frequency} = 2 \times 400 \times 2^n \text{ Hz/sec},$$

where n is the number of least significant bits (LSB) remaining. Since in this case n = 12, the clock frequency becomes 3,276,800 Hz.

And since 90° is represented by 12 binary bits, this means that

$$\text{LSB} = 90°/2^{12} = 90°/4096 = 1.3 \text{ arc minutes}.$$

Thus, for the output digital angle to represent 90°, a counter must count a total of 4096 clock pulses in 1/800th of a second. The conversion of the $\overline{PW} \times 2$ pulsewidth into a digital output is

carried out by two AND gates (Fig. 8a).

In this scheme if the synchro-excitation-voltage frequency changes and the clock period remains the same, there will be an error in the digital output that is proportional to the frequency change.

To prevent this error, the clock is slaved to the synchro-excitation frequency by a phase-locked loop (Fig. 8b). While the phase-locked-loop circuit is designed with higher-than-usual gain (to keep the phase-locked loop error contribution below ±LSB (±1.3 arc minutes), the circuit will be stable, since it has to track over frequency deviations of only ±5%.

How to encode an angle

Having covered the major design points of the ASDC, we can now go over its operation. Referring to Fig. 9, a complete functional schematic of the ASDC, let's follow the encoding of, say, a 30° angle.

The active low-pass filters attenuate harmonics and any high-frequency pickup is also filtered out.

The filter outputs are sampled at the positive and negative peaks of the reference sinewave, $R \times \sin \omega t$. Quadrant selection takes place as soon as the sampled peak voltages are available to the zero-crossing detectors. The stored peak voltages correspond to $R \times \sin 30°$ and $R \times \cos 30°$ in dc form. The $R \times \sin \theta < R \times \cos \theta$ comparator decides that $R \times \sin 30°$ is less than $R \times \cos 30°$, so that PW × 2 output of the encoding comparator is selected from the $\sin \theta$ channel. The PW × 2 pulses are gated with the clock pulses, which are derived from the phase-locked loop. The gated clock pulses are counted by a 12-stage binary counter, with the maximum count of 4096 for a 90° angle. Since our angle is only 30°, the output of the counter is

$$(30°/90°) \times 4096 = 1365.333,$$

or, since the counter cannot count fractions, 1365.

As soon as the encoding period ends, the leading edge of the QUAD RESET & OUTPUT REG. RESET & STORE pulse resets the quadrant storage latches and the output register, while the trailing edge transfers the counter contents into the output register. The transfer takes place in parallel in only 100 ns. This completes the operation of the ASDC.

The ASDC, because of its sampling nature, has an inherent time-division multiplexing capability. It also can be used in conjunction with absolute-shaft-angle encoders that use resolvers. ■■

References

1. Hermann Schmid, "An ELECTRONIC DESIGN Practical Guide for Synchro-to-Digital Converters," first part appearing in ED 6, March 15, 1970, p. 178.
2. George S. Oshiro, "Generate Noise-Free Timing Pulses," ED 10, May 11, 1972, p. 56.

Announcing a remarkable for 3-year-old

There's a whole group of us at Digital whose only job is supporting people who already have our computers.

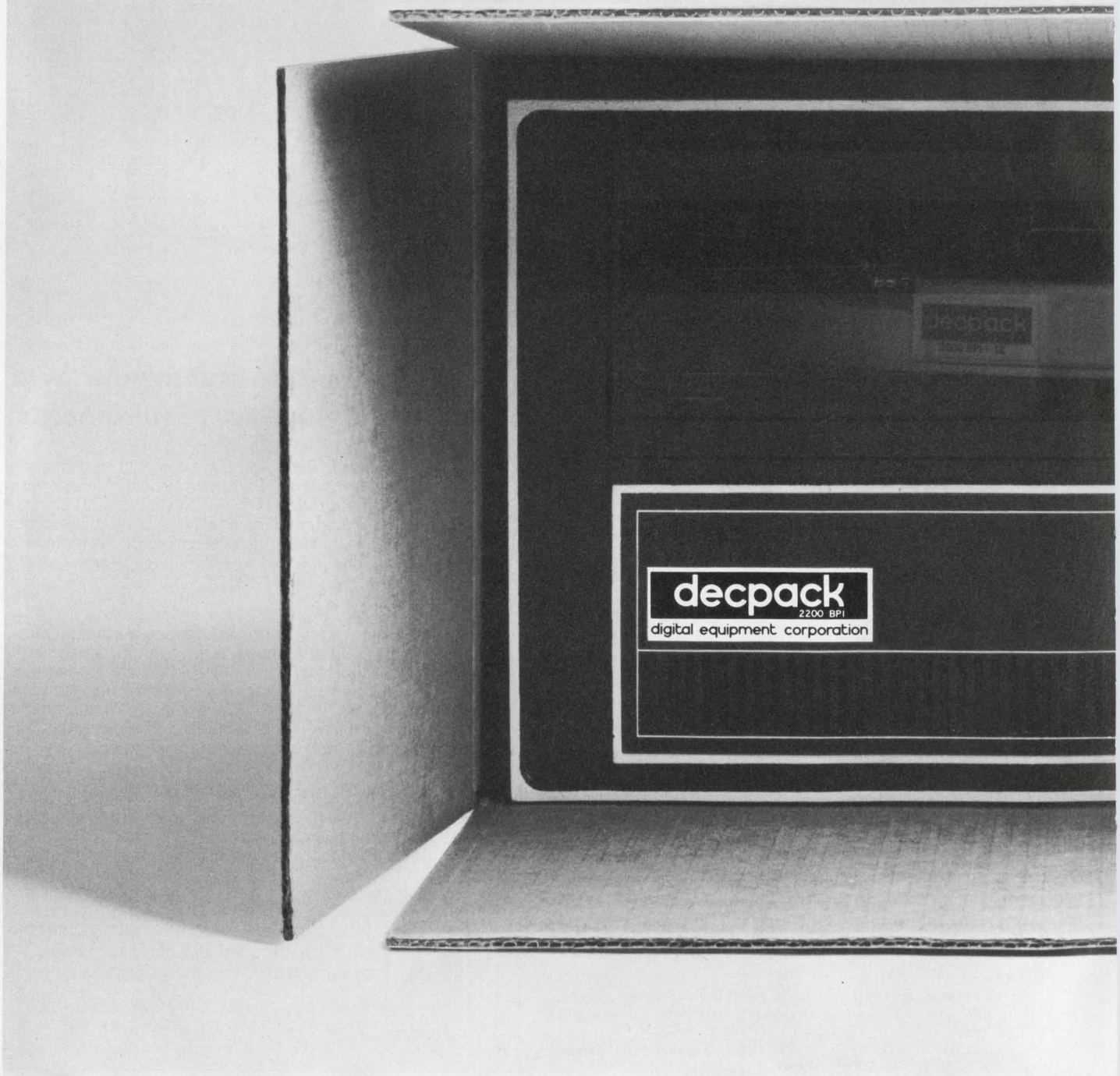
We couldn't help but notice how many people with our PDP-8's, 8/I's, and 8/L's really wanted to do more.

So we thought about all those sixty beautiful peripherals that had been made for the PDP-8/E. Discs. Magtape units. Line printers. Paper tape punch/readers. Communications equipment, A/D converters, cassettes, DECwriters, CRT displays, and on and on and on and on.

And their new low prices, many as much as 50% less than before.

So we've come up with a way to get everybody together. A $1500 interface that'll turn PDP-8's, 8/I's and 8/L's into 8/E's. It's called DW8E.

It makes them act just like they had



new source of peripherals PDP-8's: Digital.

an OMNIBUS[SM]. Which means that almost all those PDP-8/E peripherals will just plug in.

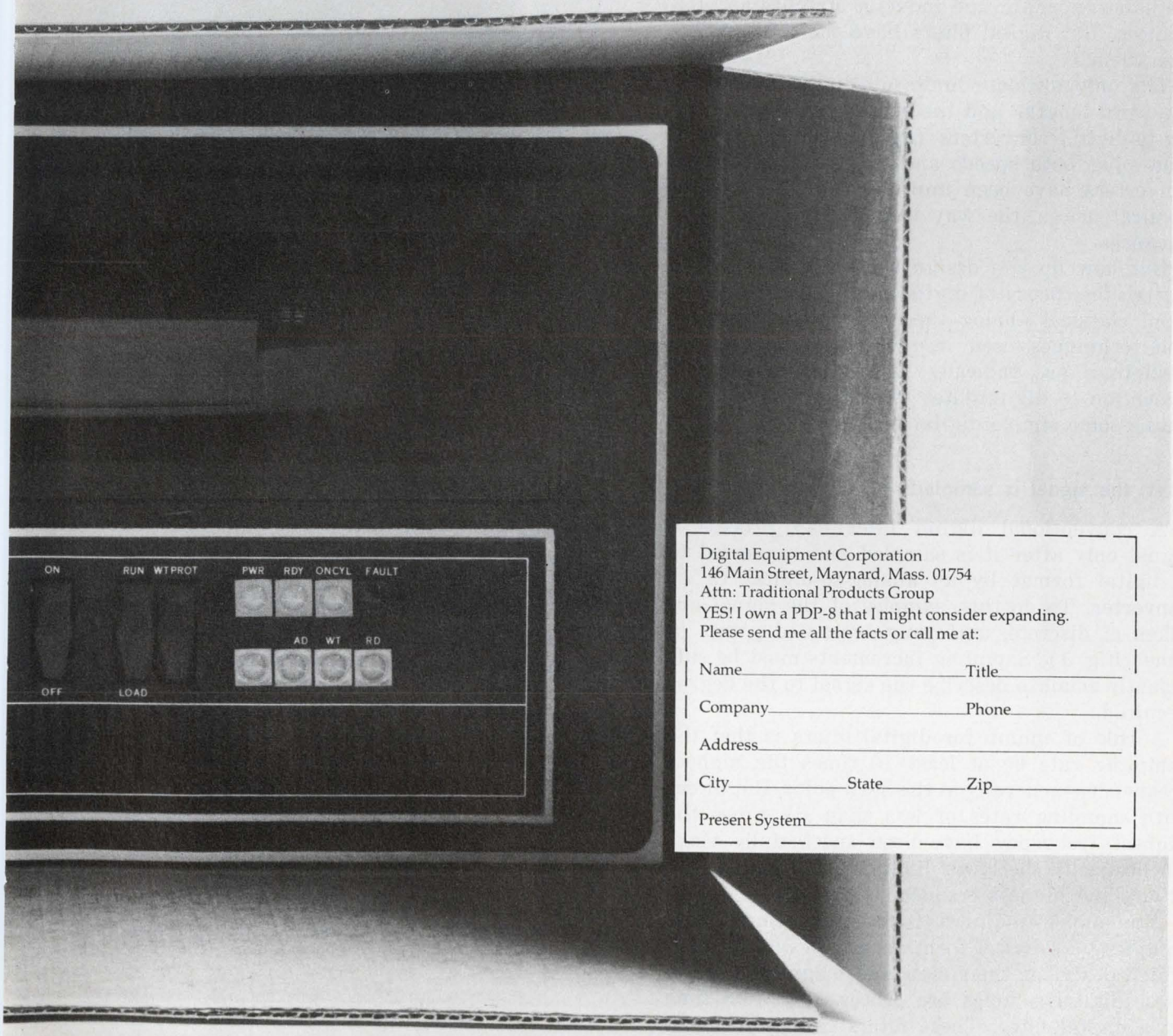
And we'll furnish all the power supplies, cables, modules, prints, bits and pieces you need.

And don't worry about delivery, support, installation and warranty, because you'll get the same good service that brought you to Digital in the first place.

Return this coupon or call us at (617) 897-5111, Ext. 2787 or 2058, and ask for Bob Reed.

Digital Equipment Corporation, 146 Main Street, Maynard, Mass. 01754. European headquarters: 81 route de l'Aire, 1211 Geneva 26. Tel: 42 79 50.

digital



Digital Equipment Corporation
146 Main Street, Maynard, Mass. 01754
Attn: Traditional Products Group
YES! I own a PDP-8 that I might consider expanding.
Please send me all the facts or call me at:

Name_____ Title_____

Company_____ Phone_____

Address_____

City_____ State_____ Zip_____

Present System_____

INFORMATION RETRIEVAL NUMBER 33

Switch to digital-filter design and let numbers replace voltages. Stable shift registers, adders and gates eliminate drift-prone capacitors and inductors.

The design of analog filters has reached the point where further improvement is limited by available capacitor and inductor stability and tolerances. But digital filters have their future before them.

The only ultimate limits on digital filters are the word lengths and the speed with which analog-to-digital converters (a/d) can handle them. And since both speeds and word lengths of a/d converters have been improving rapidly at economical prices, the way is wide open for great advances.

But how do you design a digital filter? Even though the theory of digital filters can be derived from classical analog theory[1,2], the terminology and techniques used in the digital and analog disciplines are radically different. To ease the transition to digital-filter technology[3,4,5], let's examine some simple digital filters.

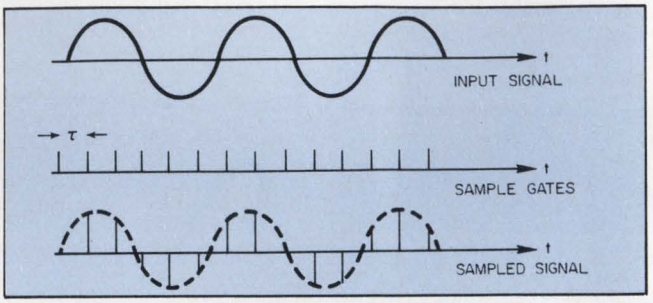
First, the signal is sampled

A conventional digital filter can process a signal only after it is sampled and converted to a digital format by an analog-to-digital (a/d) converter. To do this, samples of the signal are taken at discrete, uniformly separated points in time (Fig. 1). Sampling increments must be sufficiently small to describe the signal to the degree required.

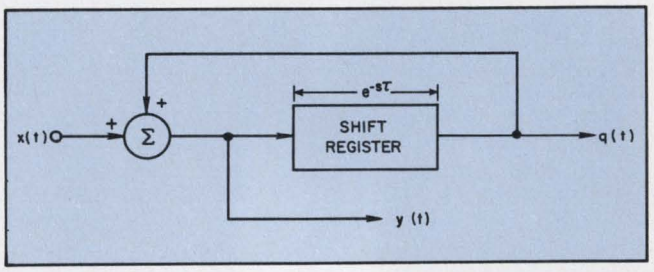
A rule of thumb for digital filters is that the sampling rate be at least 10 times the highest frequency—generally at the 3-dB point. But filters with sampling rates of less than six times the highest frequency have been successfully used. Theoretically the lower limit is the Nyquist rate (twice the highest frequency).

The analog-to-digital function converts these samples to a digital form, usually a binary code, which describes their sign and magnitude. Then these digital samples are processed in real time by a digital filter. These filters can perform all the functions of analog types. After processing, the signals may be left in digital form or converted back to analog, as required.

Harry C. Brown, Manager, Westinghouse Electric Corp., Systems Development Div., Baltimore, Md. 21203.



1. **Sampling and converting to digital signals** is the first step in implementing a digital filter.



2. **A digital integrator** is formed by combining a shift register with an adding circuit.

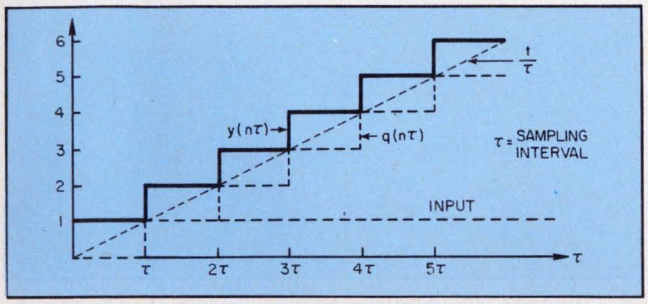
The shift register (Fig. 2) is the heart of the digital filter. It functions as a delay element to compare data sampled at a particular instant of time with data sampled at prior instants of time. Thus an output $q(t)$ is equal to the input $x(t)$ present τ seconds before; $q(t) = x(t-\tau)$. In most digital filters $\tau = \frac{1}{f_s}$, where f_s is a constant sampling rate.

Even though the data are only significant at instants $t = \tau$, we may nevertheless represent this delay process in the S domain by the Laplace delay operator $\epsilon^{-s\tau}$, which can be approximated as follows:

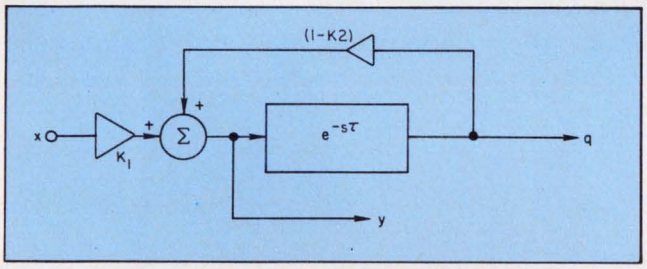
$$\epsilon^{s\tau} = 1 + s\tau \frac{(s\tau)^2}{2!} + \frac{(s\tau)^3}{3!} + \cdots$$

$$\simeq 1 + s\tau \text{ where } s\tau << 1, \text{ thus } \epsilon^{-s\tau} \simeq \frac{1}{1 + s\tau}$$

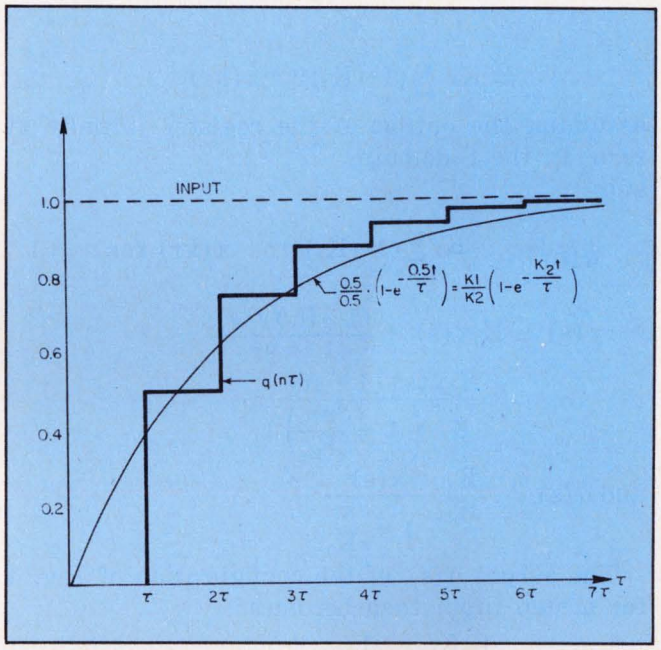
This approximation increases in accuracy as the sampling rate, f_s, becomes much greater than the highest frequency of interest.



3. **The response of the circuit in Fig. 2** to a step input shows that it behaves as an integrator.



4. **By digitally including the scaling factor,** the integrator becomes a digital low-pass filter.



5. **A good comparison is obtained** between the unit-step input response of a low-pass filter and the approximation derived from the S-domain calculation.

Figure 2 is used to explain the application of this S-domain approximation to digital filters. The delay element is connected to an adder circuit. At any sampling instant $(n\tau)$, the input to the register is the data at that instant plus all previous sampled data:

$$y(n\tau) = \sum_{k=o}^{n} x(k\tau) = x(o) + x(\tau) + x(2\tau) + \cdots + x(n\tau).$$

The resulting output for a unit-step input is a stepped approximation to a ramp function as shown in Fig. 3. For simplicity, it's assumed that both the input and output are constant in the interval between samples. The inputs may in fact be continuous or pulsed, but this simplification does not affect the final conclusions.

A delay and an adder make an integrator

To show that the configuration of Fig. 2 is an integrator, let $q(s) = y(s)\ \epsilon^{-s\tau} = \frac{y(s)}{1 + s\tau}$

where $y(s) = x(s) + q(s) = x(s) + \frac{y(s)}{1 + s\tau}$

solving for $y(s)$ results in

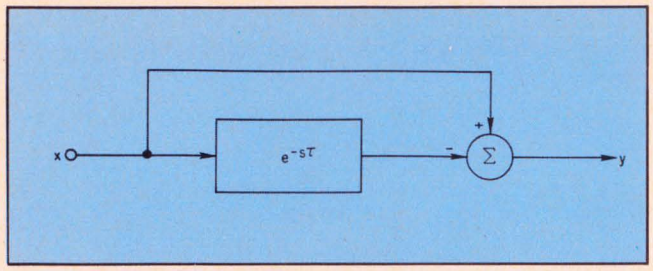
$$y(s) = \frac{(1 + s\tau)x(s)}{s\tau}.$$

Since $s\tau << 1$, $y(s) \simeq \frac{x(s)}{s\tau}$. Applying the Laplace transform for $x(s)$, which is a unit step, then $y(t) = \frac{t}{\tau}$, a ramp represented by the dotted line of Fig. 3. This is the behavior of an integrator to a step input.

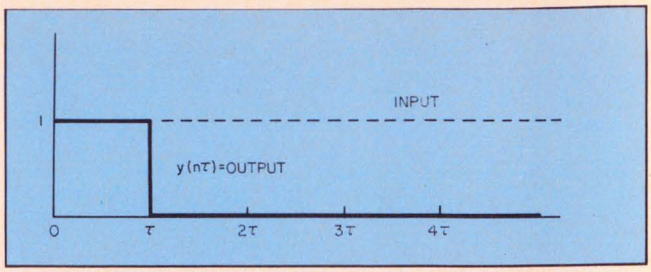
Adding scaling factors forms a low-pass filter

The integrator configuration of Fig. 2 becomes a low-pass filter with the addition of the scaler K_1 to the input and the scaler $(1-K_2)$ to the feedback connection (Fig. 4). In that case,

$$y(n\tau) = K_1x(n\tau) + (1-K_2)y[(n-1)\tau]$$
$$= K_1x(n\tau) + (1-K_2)K_1x[(n-1)\tau] +$$



6. **A digital differentiator** is formed by using a subtractor with a shift register.



7. **The response of the circuit in Fig. 6** to a step input shows that it behaves as a differentiator.

$$(1-K_2)^2K_1x[(n-2)\tau] + (1-K_2)^3K_1x[(n-3)\tau] + \cdots$$

$$= K_1\sum_{k=o}^{n}(1-K_2)^{(n-k)}x(k\tau)$$

assuming the output of the register initially at zero. In the S-domain,
and

$$q(n\tau) = \begin{cases} K_1\sum_{k=o}^{n}(1-K_2)^{(n-k-1)}\,x(k\tau) & \text{for } n \geq 1 \\ o \text{ for } n = o \end{cases}$$

$$y(s) \simeq K_1x(s) + \frac{(1-K_2)\,y(s)}{1+s\tau}$$

$$= \frac{K_1x(s)\,(1+s\tau)}{K_2\left(1+\frac{s\tau}{K_2}\right)}$$

$$\text{and } q(s) = \frac{K_1}{K_2}\,\frac{x(s)}{1+\frac{s\tau}{K_2}}$$

The output $q(s)$ of the configuration of Fig. 4 for a step input then becomes:

$$q(s) = \frac{1}{s}\,\frac{K_1}{K_2}\,\frac{1}{1+\frac{s\tau}{K_2}}$$

Let's check the accuracy of response $q(s)$ by transforming it to the time domain:

$$q(t) = \frac{K_1}{K_2}\,(1-\epsilon^{-K_2\frac{t}{\tau}})\,.$$

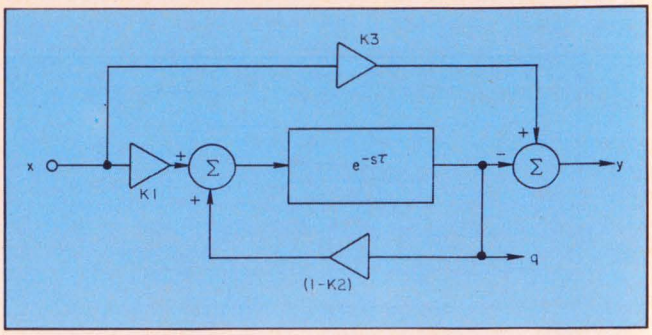
The actual time response $q(n\tau)$ is

$$q(n\tau) = \begin{cases} \sum_{k=o}^{n-1}(1-K_2)^{(n-k-1)} & \text{for } n \geq 1 \\ o \text{ for } n=o \end{cases}$$

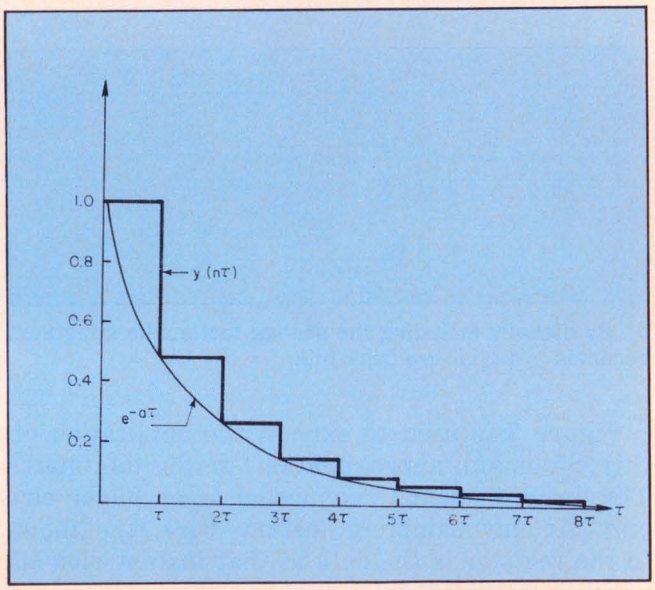
These two functions are compared in Fig. 5 for $K_1=K_2=0.5$. The curve of $q(n\tau)$ is characteristic of the response of a low-pass filter (to a step function input) whose passband gain is K_1/K_2 and cutoff frequency (in radians) at the 3 dB point is K_2/τ. The output at "y" is that of "q" but ahead in time by τ. The ratio of the sampling frequency to the cutoff frequency for $K_2 = 0.5$ is

$$\frac{f_s}{f_{3dB}}\,\frac{f_s}{K_2/2\pi\tau} = \frac{2\pi}{0.5} = 4\pi.$$

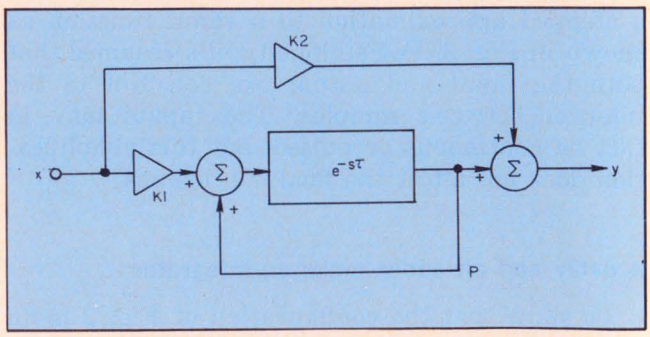
With $K_2 = 0.2$, the S-domain approximation is more accurate near the 3 dB cutoff frequency and a time response plot as in Fig. 5 would show a closer approximation to the exponential



8. **Digitally including the scaling factors,** K_1, K_2 and K_3 converts the differentiator to a digital high-pass filter.



9. **The step response of the digital high-pass filter** as derived by the S-domain approximation is compared to its theoretical value.



10. **The response of a feedback system** is digitally synthesized using a combination low-pass-high-pass circuit.

function. This is because the sampling rate would be 2.5 greater.

To build a high-pass filter, a differentiator instead of an integrator is used (Fig. 6). The delayed information in this case is subtracted from the current information, so that

$$y(n\tau) = x(n\tau) - x(n\tau - \tau).$$

This is plotted in Fig. 7 for a step input.

In the S domain,

$$y(s) \simeq x(s)\left(1 - \frac{1}{1 + s\tau}\right) = \frac{s\tau}{1 + s\tau}\, x(s)$$

when $s\tau << 1$, $y(s) \simeq s\tau \cdot x(s)$, and a differentiator is obtained.

A differentiator becomes a high-pass filter

The differentiator becomes a high-pass filter with the addition of scaling factors and another adder (Fig. 8). Then

$$q(n\tau) = 0, \text{ for } n = 0$$

$$q(n\tau) = K_1 \sum_{k=o}^{n-1} (1 - K_2)^{(n-k-1)} x(k\tau), \text{ for } n \geq 1$$

$$y(n\tau) = \begin{cases} K_3 x(n\tau) - K_1 \sum_{k=o}^{n-1} (1 - K_2)^{(n-k-1)} x(k\tau), \\ \qquad\qquad\qquad\qquad \text{for } n \geq 1 \\ x(n\tau), \; n = o \end{cases}$$

The response to a step function is shown in Fig. 9.

In the S-plane,

$$q(s) = \frac{\frac{K_1}{K_2}\, x(s)}{1 + \frac{s\tau}{K_2}}$$

$$y(s) = \frac{x(s)\left[K_3\left(1 + \frac{s\tau}{K_2}\right) - \frac{K_1}{K_2}\right]}{1 + \frac{s\tau}{K_2}}$$

Setting $K_3 = \frac{K_1}{K_2}$

$$y(s) = x(s)\, \frac{1}{K_2}\, \frac{s\tau}{1 + \frac{s\tau}{K_2}}\, \frac{K_1}{K_2}$$

This is the response of a high-pass filter of passband gain $\frac{K_1}{K_2}$ and a cutoff frequency at $\omega_{3\,dB} = K_2/\tau$.

Feedback control is a practical example

It is possible to synthesize a variety of filter structures by combining low-pass and high-pass configurations. The general procedure is to calculate the constants and sampling rates needed to obtain the response and gain. As an example, consider the problem of digitally synthesizing the response

$$G(s) = 2\, \frac{\left(1 + \frac{s}{1.5}\right)}{s} = \frac{KV\left(1 + \frac{s}{\omega_1}\right)}{s}$$

This form of response occurs frequently in feedback control work and may be synthesized by a configuration similar to Fig. 8 but with $K_2 = 0$, and noting that $y = K_2 x + q$ as shown in Fig. 10.

Accordingly, $y(s) = K_2 x(s) + P(s)$, and

$$P(s) = \frac{K_1 x(s) + P(s)}{1 + s\tau}.$$

Solving for $P(s)$ gives

$$P(s) = \frac{K_1 x(s)}{s\tau},$$

Since $y(s) = x(s)\,(K_2 + K_1/s\tau)$.

Rearranging terms results in

$$\frac{y(s)}{x(s)} = \frac{(K_1/\tau)\,(1 + s\,K_2\,\tau/K_1)}{s}$$

The desired response can then be synthesized by setting

$$\frac{K_1}{\tau} = K_V = 2, \quad \frac{K_1}{K_2/\tau} = \omega_1 = 1.5 \text{ radians.}$$

For a frequency range up to two octaves, above ω_1, use $s\tau(\max) = 0.1$ and

$$f_s \text{ (sampling frequency)} = \frac{1}{\tau}$$

$$= 10 \times 4 \times 1.5 = 60 \text{ Hz.}$$

Choosing instead $f_s = 66.6$ Hz, for numerical convenience, you get $\tau = 15$ ms and $s\tau = 6 \times .015 = 0.090$ at 6 radians—two octaves above 1.5 radians. Solving for the remaining constants results in

$$K_1 = K_V\,\tau = 2 \times 15 \times 10^{-3} = 0.03$$

$$K_2 = \frac{K_1}{\omega_1\,\tau} = \frac{0.03}{15 \times 10^{-3} \times 1.5} = 1.33.$$

Implementing the scalars

The scalars (such as K_1 and K_2) can often be implemented by means of simple binary shift and add operations. Scalars equal to numbers that are powers of 2 or 1/2—like 2, 4, 8; or 1/2, 1/4, 1/8—can be obtained by simply shifting the binary input to the left (which multiplies by two) or right (divides by two).

When these shifts do not adequately approximate the required scalar, it can be more closely approximated by a combination of shifting and adding. For example:

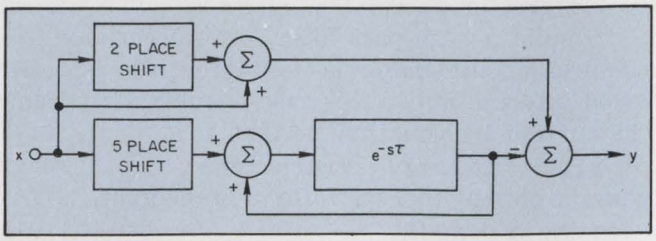
$K_2 = 1.33 \simeq 1.25 = 1 + 1/4$ and

$K_1 = .03 \simeq .0313 = 1/32$

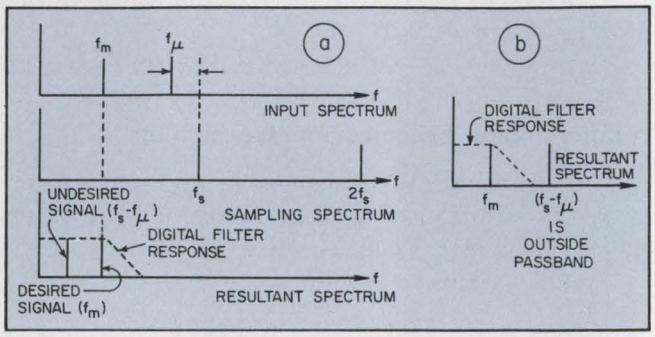
Then K_1 can be obtained with a five place shift to the right, and K_2, with a two place shift to the right and summation with the original input as in Fig. 11.

There are shortcomings too

The mixing (or beating as in a superheterodyne receiver) of the input signal with the sampling frequency, f_s, results in not only the desired spectral line, f_m, falling within the filter's passband, but also an undesired or "aliased" line at



11. **The scalers** are implemented digitally.



12. **Aliasing of undesired signals** into the passband is a serious problem in digital filters. Raising the sampling frequency helps reduce this problem.

frequency f_u, is mixed into the passband at $(f_s - f_u)$, as in Fig. 12a. In general, frequencies near a spectral line of the sampling frequency will "beat" down to the pass region of the filter.

As in Fig. 12b, this undesired energy, can be removed by increasing the sampling frequency so that $(f_s - f_u)$ lies above the cutoff frequency of the digital filter. When a broad band of unwanted frequencies (such as noise) exists, though, this is not possible, and an analog low-pass filter may have to be placed ahead of the a/d converter.

In the particular case where the input signal is in pulse form, it is most efficient when the sampling signal's frequency and phase coincide with the input signal. This eliminates the need to place sampling points so close that no pulse is missed. Signal information is lost by missing a pulse. ■■

References

1. Rader, C.M. and Gold, B., Digital Processing of Signals, McGraw-Hill, N.Y., 1969 (numerous references are contained in this book).

2. Rader, C.M. and Gold, B., "Digital Filter Design Techniques in the Frequency Domain," *Proc. IEEE, 55;* 1967, pp. 149-171.

3. Jackson, L.B., Kaiser, J.F. and McDonald, H.S., "An Approach to the Implementation of Digital Filters," *IEEE Trans. on Audio and Electroacoustics, Vol. AU-16, No. 3,* Sept., 1968, pp. 413-31.

4. Jackson, B., "Round off Noise Analysis for Fixed-Point Digital Filters Realized in Cascade or Parallel Form," *IEEE Trans. on Audio and Electroacoustics, Vol. AU-18, No. 2,* June, 1970.

5. Weinstein, C.J., "Quantization Effects in Digital Filters," *M.I.T. Lincoln Laboratory Tech., Report 468,* Nov., 1969.

Chip

off the old breadboard.

RCA put 1,238 devices on a 150 mil COS/MOS chip. What are your LSI requirements?

The move is toward LSI. And RCA is ready now to develop custom COS/MOS circuits to your most demanding requirements.

For example, the 149 x 150 mil timing circuit above was integrated from a breadboard containing 1,238 discrete devices. Just one of many custom chips designed with RCA's unique silicon interconnect process to provide high packaging density.

RCA maintains a staff of systems engineers who are experienced in the development of complex micropower arrays. They are backed by extensive facilities to speed the process of IC design and development.

These facilities consist of computers for logic simulation, artwork digitizer-plotter systems that can cut turnaround time by 33% in typical circuits, Mann Pattern Generator facilities to speed mask preparation, and Teradyne Model J-283 digital IC systems which functionally evaluate complex arrays.

Put RCA's COS/MOS team to work to help reduce package count, cut assembly costs, and achieve excellent cost effectiveness in your systems.

When it comes to COS/MOS LSI, come to RCA.

Contact your local RCA Representative or RCA Distributor, or write RCA Solid State Division, Section 571-28, Box 3200, Somerville, New Jersey 08876.

RCA Solid State

products that make products pay off

International: RCA, Sunbury-on-Thames, U. K., or Fuji Building, 7-4 Kasumigaseki, 3-Chome, Chiyoda-Ku, Tokyo, Japan. In Canada: RCA Limited, Ste. Anne de Bellevue 810, Canada.

INFORMATION RETRIEVAL NUMBER 35

Use the wired-AND and implied-OR configurations to simplify logic circuitry. They require fewer gates and inputs than a conventional Boolean implementation.

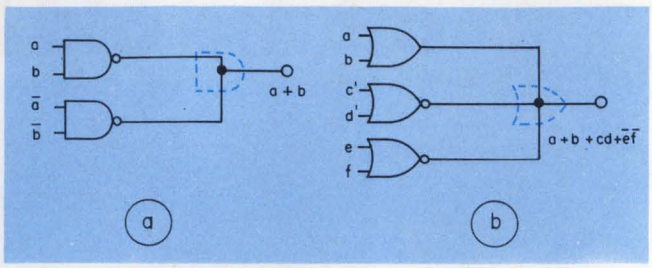
If you want to realize logic functions that will reduce circuitry, the wired-AND or implied-OR configurations have a lot going for them:

- They tend to minimize the conventional logic required.
- They call for algorithmic methods to obtain functions, thereby lending themselves to straightforward implementation by computer program.
- They can eliminate static hazards, or glitches.

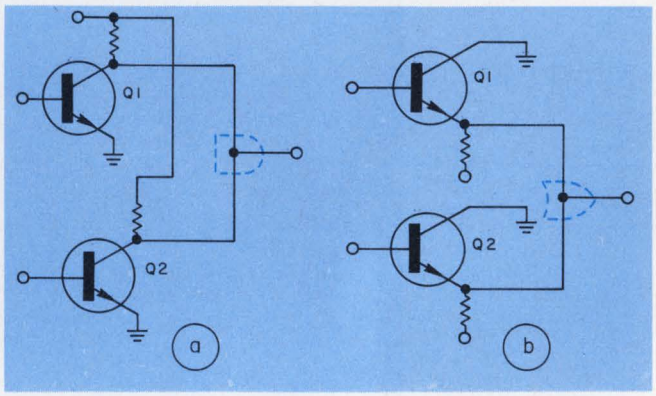
In the wired-AND configuration, gate outputs are tied together to obtain the AND function (Fig. 1a); in the implied-OR, gates are tied together to obtain the OR function (Fig. 1b). Note that it is the common connection that yields the logical function at the outputs.

With gate drivers connected as shown in Fig. 2a, the output is high (positive level) when transistors Q_1 and Q_2 are off, giving the AND condition. With emitter-follower drivers as shown in Fig. 2b, the output is high if either transistor Q_1 or Q_2 is on, giving the OR condition.

In other words, if the gates that are wired together have an emitter-follower driver, then the common connection forms an OR. This is generally the case for emitter-coupled logic. Note that for the AND case, the gates are usually connected at the output of an amplifying stage.



1. **The wired-AND is formed by** connecting the outputs of individual gates (a). The implied-OR is similarly obtained (b).



2. **Actual wired-AND (a) and implied-OR (b).** Output is high or the wired-AND when both transistors are cut off. Output is high for the implied-OR when either transistor is conducting.

Synthesis is easy

The implied-OR can easily be synthesized with the aid of a Karnaugh map. The map yields a sum-of-products expression, which is then modified for implied-OR realization with DeMorgan's Theorem. The terms of the expression may then be implemented with individual NOR gates and OR-gates, for the single-product terms. For example, consider the logic function of Fig. 3a. A minimum sum-of-products expression for this function is:

$$f = a + b + c\bar{d}.$$

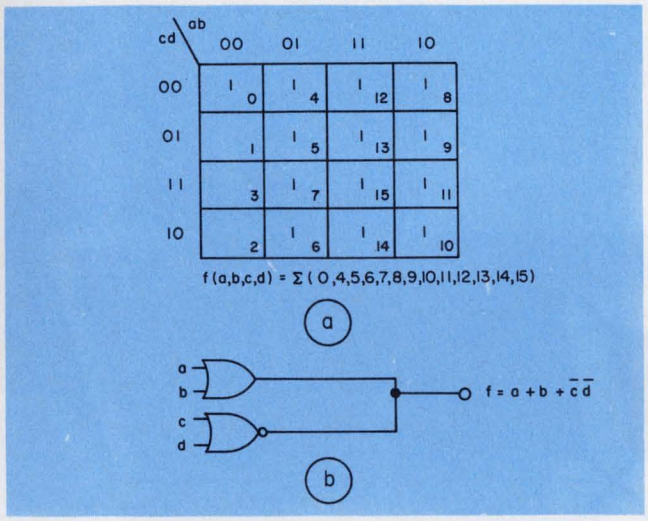
Using DeMorgan's Theorem, we get an equivalent expression:

$$f = a + b + (c + d).$$

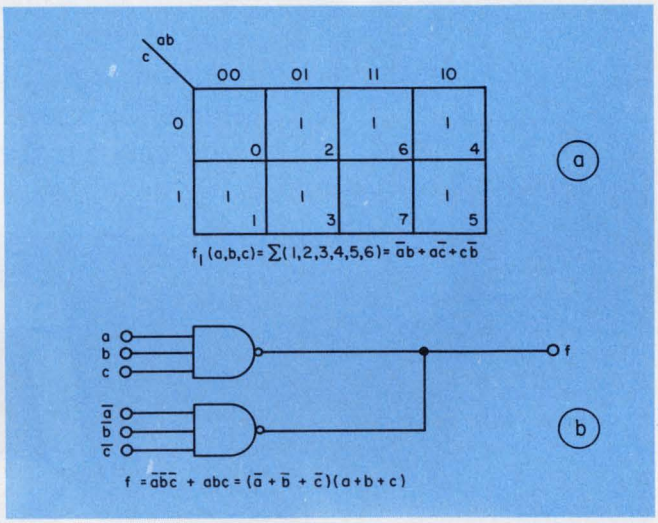
The implied-OR realization for this function is shown in Fig. 3b.

While the implied-OR configuration is easy to implement directly from the Karnaugh map, this is not true for the wired-AND. For example, though TTL provides the AND function when hard-wire connected, the totem-pole output structure of the TTL gates can cause problems. This is because, with a totem-pole arrangement, a single output stage may be required to sink current from the active pull-up transistors of the other gates. In addition to degradation of the logic-ZERO voltage level, there exists the possibility of high-current damage to the output-stage transistors. This is because the totem-pole structure can source as much as 55 mA, while a typical gate output is usually guaranteed to sink only 16 mA.

Dwight H. Sawin III, Instructor, University of Idaho, Moscow, Idaho 83843



3. **Function plotted on Karnaugh map (a)** is realized in implied-OR form (b). DeMorgan's theorem is used to re-arrange the function to the implied-OR form.



4. **Three-variable function** derived from Karnaugh map (a) is realized by wired-AND circuit shown in (b). Only two gates are required.

The problem is avoided by use of open-collector gates, of which up to 10 can be wired together with no adverse effects.

The algorithm for obtaining the logic expression for the wired-AND consists of three steps:

Step 1: Obtain a sum-of-products expression for the function.

Step 2: Complement the expression obtained in Step 1.

Step 3: Take the dual of the expression obtained in Step 2.

For example, consider the logic function shown in Fig. 4a. To realize this function, you would need four gates with nine inputs. However, by complementing the expression and then taking the dual, you can reduce it to a form that requires only two gates with a total of six inputs (Fig. 4b).

This technique can be more easily implemented, of course, by reading the ZEROES of the Karnaugh map and then taking the dual of the resulting expression. Further, as the number of variables in the function increases, the savings in logic for the wired-AND configuration increases.

A rule of thumb: If a large number of ONEs are contained in the function, then the wired-AND will generally be the simplest solution. If a large number of ZEROES are present, the implied-OR often yields the best realization.

Solution is glitch-free

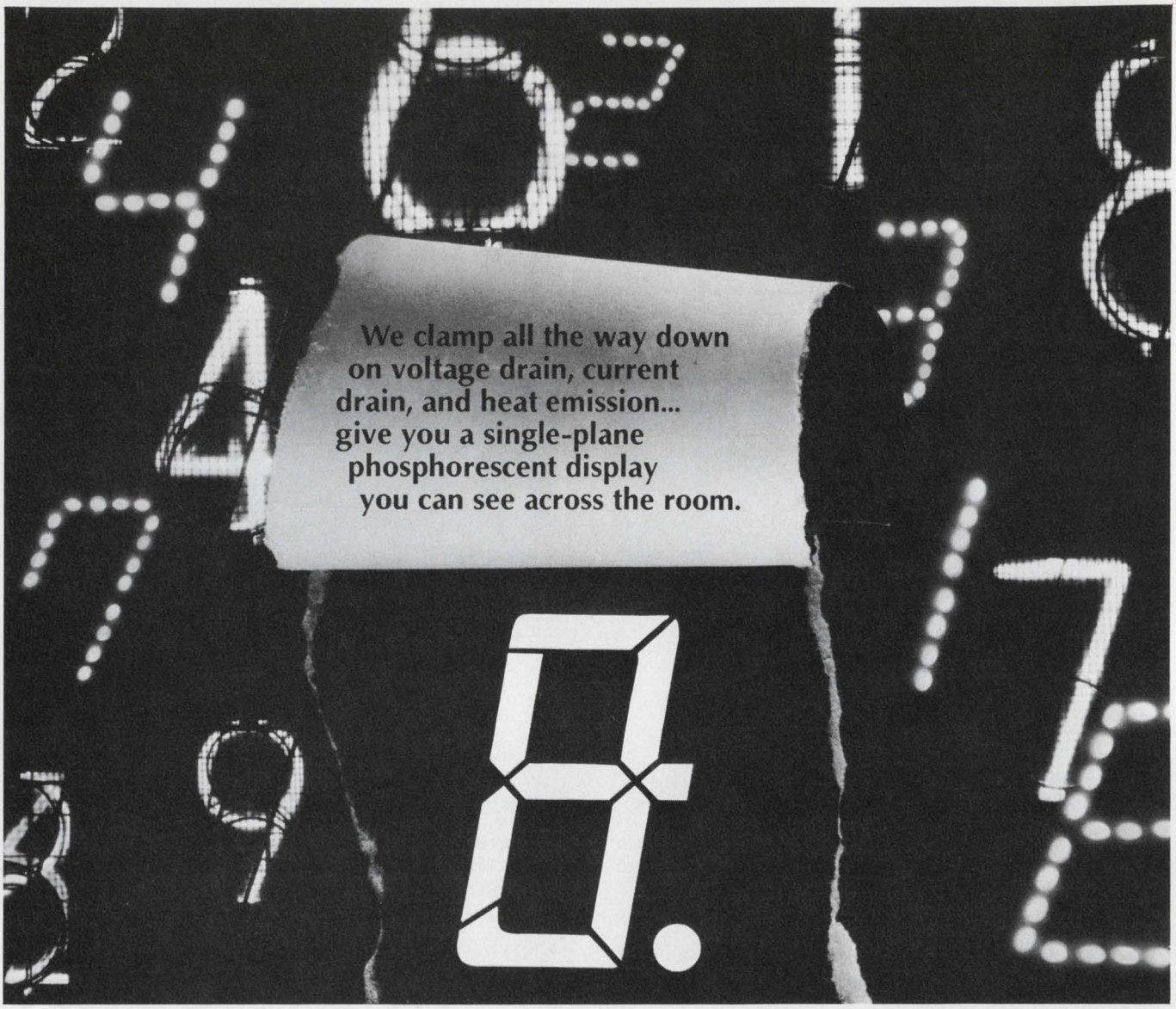
Both the wired-AND and implied-OR solutions are free of static hazards, if the original sum-of-products expression, obtained from the Karnaugh map is hazard-free.

A static hazard is the momentary output change that occurs when an input switches between two states that, individually, produce the same output state. These glitches, as they are often called, may or may not be tolerable in a given logic circuit.

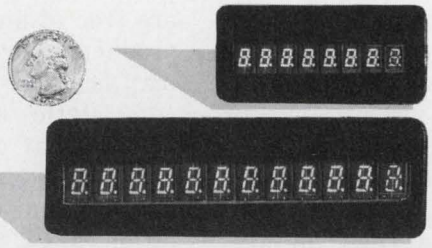
If a sum-of-products expression contains no static hazards, then the final expression, obtained with the algorithmic methods given here, will also be free of hazards. For example, the function of Fig. 4b must be rearranged to the following form to be hazard free:

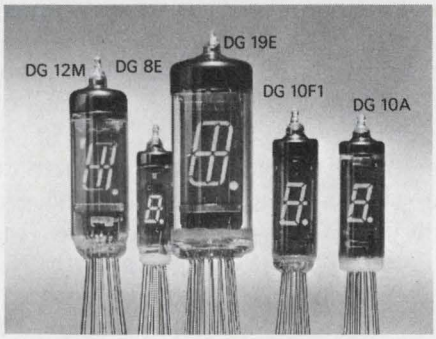
$$f = \bar{a}c + \bar{a}b + b\bar{c} + a\bar{c} + a\bar{b} + \bar{b}c.$$

To realize this function, you would need seven gates with 18 inputs. However, the wired-AND realization is also hazard free, and it requires only six gate inputs—a significant savings. ■■



We clamp down fully
on the disadvantages of other displays.
Our digital readouts,
including the extremely lightweight,
mini-size Multi-Numerical Indicator
with 8, 10, and 12 digit readout,
offer low-voltage,
low-current drain,
and stability advantages over
conventional displays.
All have eye-easy phosphorescent
segments with digits on a single-plane
for optimal visibility
under ambient light.
It's a natural green glow,
so soft and clear you can see
it across the room.
But the best comes last:
They're competively priced
for all modern applications
in calculators,
digital clocks, voltmeters and counters,
and a host of others.
Count on us.





The Brighter Side of Electronics

ISE ELECTRONICS CORP.
P.O. Box 46 Ise City, Mie, Japan Tel: 05963-5-2121

International Div.
ISE INTERNATIONAL CORP.
No.7-7-2, Shigashi Shinbashi Minato-ku, Tokyo
Tel: 433-6618 Cable: Iseworldrep
Telex: J26546 Iseinter

USA Sole Distributor
LEGI ELECTRONICS CORP.
1472 West 178th Street, Gardena California 90248
Tel: (213) 532-0470, 0471

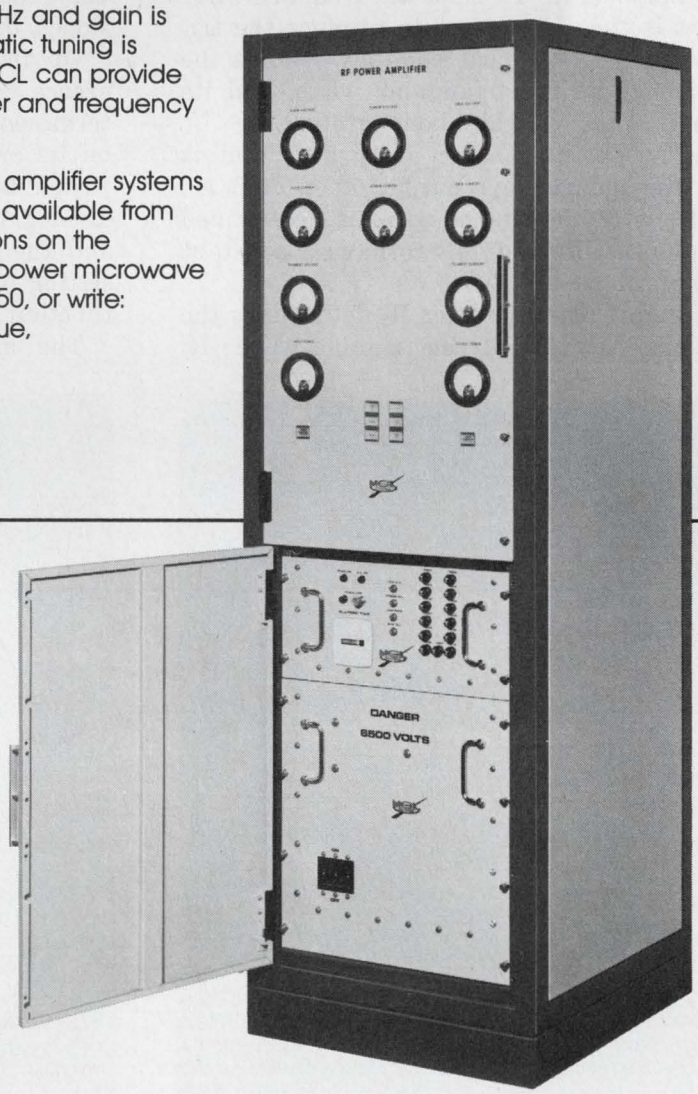
INFORMATION RETRIEVAL NUMBER 85

high power linear amplifiers from MCL

Reliability in linear amplifiers begins with cavity amplifier design. MCL combines today's most advanced cavity designs with regulated power supplies, metering and cabinetry for total system dependability.

For example, MCL Model 10581 linear amplifier system covers a frequency range of 200 to 400 MHz for dependable command communications. Bandwidth at 3 db is 4 MHz and gain is 13 db. Servo controlled automatic tuning is available as an option. And MCL can provide this amplifier in the exact power and frequency configuration you require.

A wide range of high-reliability amplifier systems in addition to Model 10581 are available from MCL. For complete specifications on the amplifier that meets your high power microwave requirements, call (312) 354-4350, or write: MCL, Inc., 10 North Beach Avenue, La Grange, Illinois 60525.



Opportunities developing now for RF engineers at MCL, Inc.—an equal opportunity employer.

INFORMATION RETRIEVAL NUMBER 86

Triangle-wave generator keeps slopes constant as amplitude changes

A function generator maintains constant positive and negative slopes of a triangular-wave output during amplitude variations. In addition the slopes may be independently controlled. And the triangle-wave output may be offset from circuit common without changing the shape of the waveform.

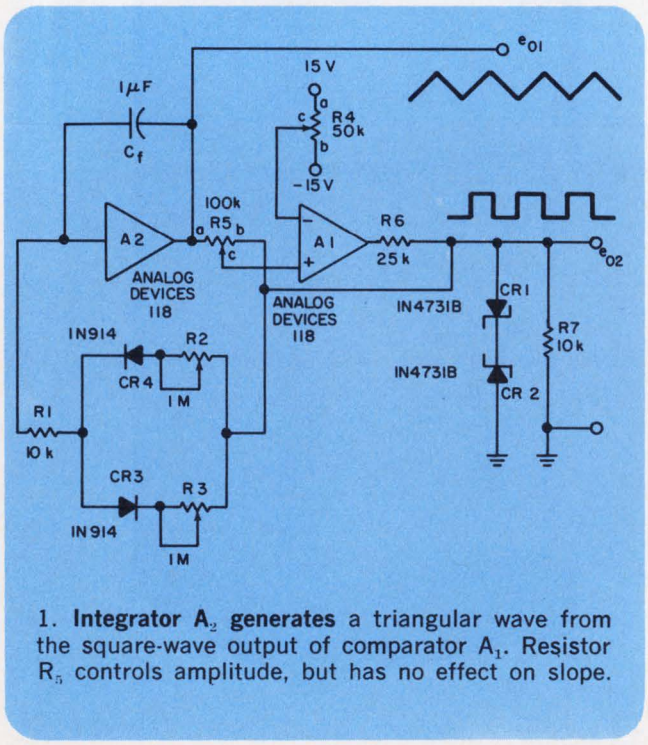
Two op amps (Fig. 1) generate a square-wave output that is then integrated to produce the triangular output. The square wave always has the same frequency as the triangular wave, and its amplitude is symmetrical about ground.

Op amp A_2 operates as an integrator that is driven by the square-wave output of op amp A_1. The amplitude of the square wave is determined by zener diodes CR_1 and CR_2 to have a constant amplitude of ±5 V.

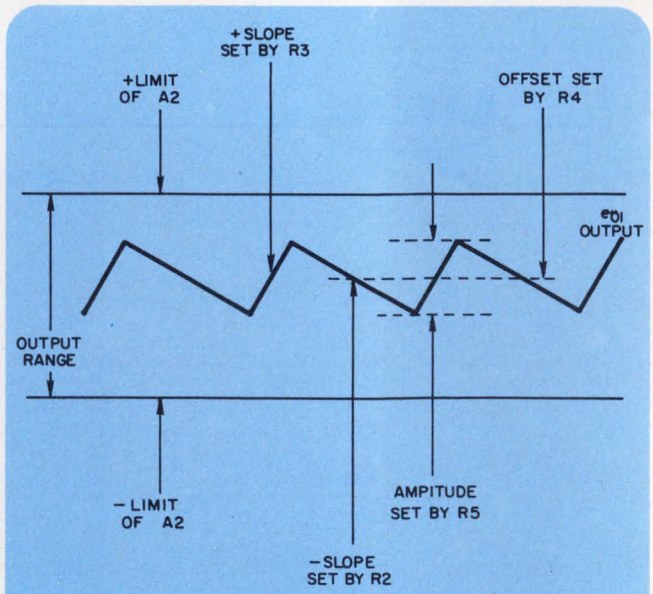
The setting of potentiometer R_3 determines the positive slope (Fig. 2) of the triangle wave; R_2 governs the negative slope. Amplitude of the triangle is determined by the setting of R_5. If only equal positive and negative slopes are desired, CR_3, CR_4 and R_2 may be omitted. Diode CR_3 switches resistor R_3 out of the circuit during the negative slope, and CR_4 switches R_2 out during the positive slope. Of course, resistors R_2 and R_3 vary the output frequency when they vary the slopes, but they have no effect on the amplitude.

Op amp A_1 operates as a comparator. The reference voltage provided by the setting of R_4 determines the offset of the output but has no effect on its amplitude or slope. The amplitude is adjusted by R_5, which acts as a variable voltage divider between the output of the comparator and the varying output of the integrator. The setting of R_5 has no interaction with any circuit function except amplitude.

The maximum positive or negative slope is



1. **Integrator A_2 generates** a triangular wave from the square-wave output of comparator A_1. Resistor R_5 controls amplitude, but has no effect on slope.



2. **Triangular-wave output** has positive and negative slopes, which may be varied independently of amplitude by potentiometers R_3 and R_2.

What if mercury contacts are too much, and dry reeds won't do?

Clare's new 861 Mercury Reed Relay is the answer.

Up to now, you've had only two kinds of relays to choose from when interfacing parts of your system: expensive ones, or inexpensive ones. You've had to pay a lot or take a chance.

That's why Clare developed the 861 Mercury Reed Relay. It fits right between our fast, extremely long-lived Mercury-Wetted Contact relays and our shorter-lived Dry Reed Relays.

Like the more sophisticated mercury-wetted relay, the new 861 Mercury Reed Relay has bounce-free contact and consistant low-level resistance. And though it doesn't give you the almost endless life of the mercury contact, it does have higher standard voltage ratings (up to 1,000 v) and greater load switching capacity (50 VA) than the simpler dry reed relay. And it comes in a small package—only 1.135 x .460 x .350 for a 1 form A.

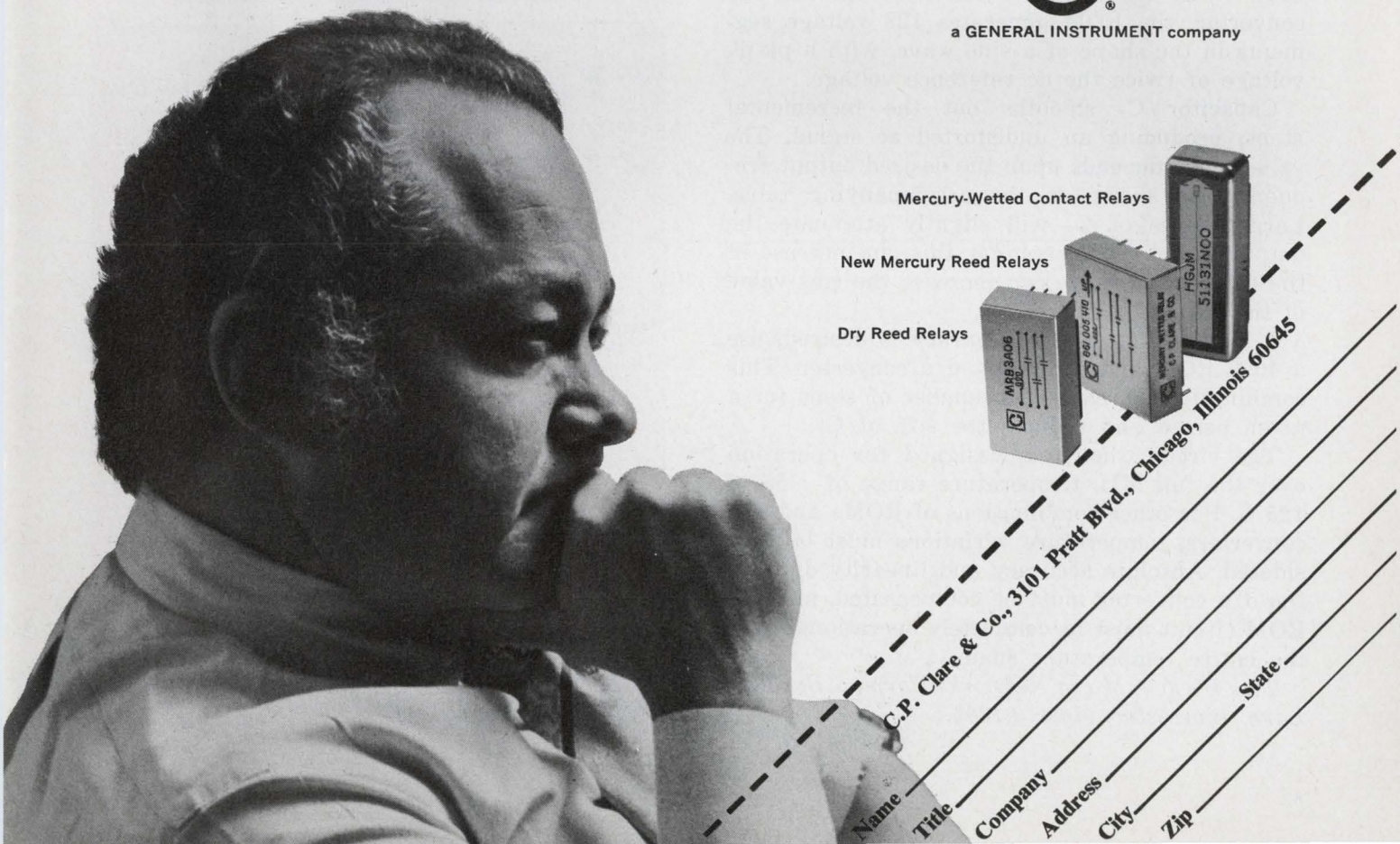
This new 861 Mercury Reed Relay means we have the complete range of relays immediately available. They make it possible for you to match whatever level of cost and confidence you need. And we have the engineering experience to help you decide what's most appropriate, if there's any question.

In other words, we don't have an ax to grind. It depends entirely on what you need.

For immediate technical information on the new Clare 861 Mercury Reed Relay, Contact your Clare Representative directly. Or use the coupon below. WE'LL SEND YOU A FREE COPY OF OUR BOOKLET ON RELAY INTERFACE APPLICATIONS. Six minutes of ideas that may trigger some thoughts for you.

CLARE®

a GENERAL INSTRUMENT company



Design Equations

Triangle-wave Amplitude $E_{01} = E_{02}\left(\frac{R5_{ac}}{R5_{cb}}\right)$

Square-wave Amplitude $E_{02} = \pm 5$ V as determined by limit diodes CR_1 and CR_2

Positive Slope (V/s) $= -E_{02}\left(\frac{-C_f}{R1 + R2}\right)$

Negative Slope (V/s) $= +E_{02}\left(\frac{-C_f}{R1 + R3}\right)$

Output Voltage Offset $= (-30)\left(\frac{R4_{ac}}{R4_{ab}}\right)$

500 V/s; the minimum is ±5 V/s, with the ± rates adjustable independently. Offset is variable over a ±10-V range, but the output is also limited to ±10 V and clipping may occur when either the output amplitude or the offset is large.

Limiting factors include slew rate and current capability of the op amps and switching speeds of the diodes. For other rates, use integrating components that allow A_2 to integrate faster or slower, depending on need. The use of only one set of integrating components also restricts the integration rate.

David G. Larsen, Instructor, Virginia Polytechnic Institute and State University, Dept. of Chemistry, Blacksburg, Va. 24061

CIRCLE No. 311

Ac reference achieves 0.01% accuracy with ROM-d/a converter combination

By adding a 1024-bit ROM to an eight-bit d/a converter, you can build an ac reference source that has an amplitude error of less than 0.01%. The circuit's frequency stability is determined by the stability of the clocked input.

In the circuit shown, two 5493 counters act as a seven-bit counter that drives the 1024-bit (128 × 8) ROM. In conjunction with the d/a converter, the ROM generates 128 voltage segments in the shape of a sine wave, with a pk-pk voltage of twice the dc reference voltage.

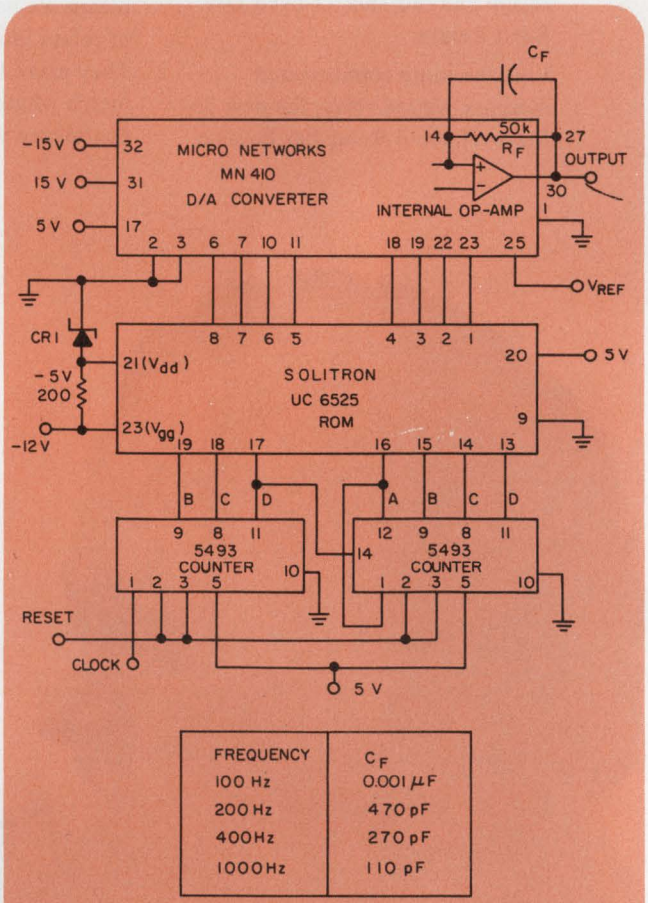
Capacitor C_F smooths out the incremental steps, producing an undistorted ac signal. The value of C_F depends upon the desired output frequency, as shown in the accompanying table. Large values of C_F will slightly attenuate the output signal. To correct for this, an increase in the reference voltage can increase the rms value of the output.

If better than 0.01% accuracy is desired, use a 4096 ROM and a nine-bit d/a converter. This combination increases the number of steps for a given period and reduces the size of C_F.

The circuit shown is designed for operation over the full MIL temperature range of −55 to 125 C. For other combinations of ROMs and d/a converters, temperature variations must be considered. Absolute accuracy and linearity drift of the d/a converter must be compensated, and the ROM circuit must be completely operational over the entire temperature span.

Tim Hickey, Micro Networks Corp., 5 Barbara Lane, Worcester, Mass. 01604.

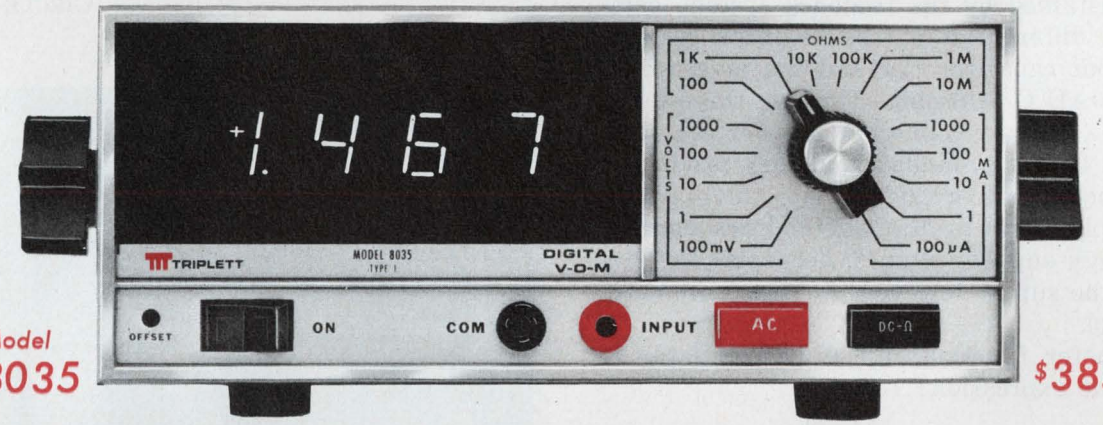
CIRCLE No. 312



FREQUENCY	C_F
100 Hz	0.001 μF
200 Hz	470 pF
400 Hz	270 pF
1000 Hz	110 pF

Capacitor C_F smooths the output waveform of the MN 410 d/a converter in this ac reference circuit. Optimum values for the capacitor are indicated in the table.

If you need a high quality 3½-digit V-O-M at your price . . . buy Triplett's new 8035



Model 8035

$385

1. **EASY OPERATION** — Single polarized plug for test leads eliminates switching leads when changing functions.

2. **LOW POWER CONSUMPTION** — Less internal heating for greater stability and reliability.

3. **LOW CIRCUIT LOADING** — Greater measurement accuracy with 10 megohm input resistance for all AC and DC voltage ranges.

Designed for R&D, production, quality control, maintenance and classroom use, Triplett's new Model 8035 Digital V-O-M features an automatic polarity display, 100% overrange capability, out-of-range display blanking and high input resistance to make it nearly foolproof.

With 26 ranges, the Model 8035 boasts accuracies from ± 0.1% to ± 0.7% of reading ± 1 digit . . . ranking it among the best on the market. Its green, polarized window and its single-plane, seven-bar, fluorescent display combine to insure bright, reflection-free readability from virtually any viewing angle.

Hardware for rack mounting is available.

See the Model 8035, priced at $385, at your local distributor. For more information, or for a free demonstration of the convenience and accuracy of the 8035, call him or your Triplett representative. Triplett Corporation, Bluffton, Ohio 45817.

TRIPLETT

The World's most complete line of V-O-M's choose the one that's just right for you

INFORMATION RETRIEVAL NUMBER 38

Clock oscillator for telemetry systems uses CMOS chip to minimize power drain

An inexpensive and stable oscillator built around a CMOS IC chip and a piezoelectric resonator has a total power consumption of less than 100 μW. Frequency stability is better than 0.0015%/C over a 0 to 50 C temperature range.

The stability is sufficient for telemetry systems, which often require a master clock oscillator to control various operations, such as channel sampling and bit synchronization. The low power drain is particularly important in battery-powered systems, since the master oscillator usually remains on continuously.

Oscillations are generated by an adjustable piezoelectric resonator (VBA1-R in the diagram) and are sustained by the feedback system, composed of a differentiator (the feedback resistor R_2 and input capacitor C_3) and the inverter on the CD4000AE CMOS chip. The two three-input gates on the chip are connected as inverters, with the unused inputs grounded, and they produce a buffered square-wave signal at the output. Power-supply network R_1-C_1-C_2 reduces current drain at high supply voltages, decouples the circuit from the supply line and provides automatic gain control.

The transfer function of the differentiator is given by the expression:

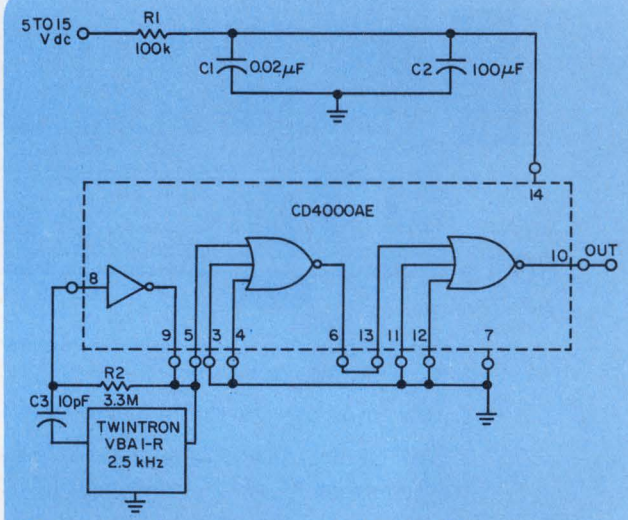
$$\frac{V_m}{V_o} = -j\omega R_2 C_3 \frac{A}{1 + A + j\omega R_2 C_3},$$

where A is the gain of the inverter (approximately 10). At resonance, the phase shift of the resonator is approximately 90 degrees, and the losses are negligible. The circuit will thus oscillate at the resonant frequency of the crystal, provided the R_2-C_3 time constant is chosen to obtain a greater than unity open-loop gain. Capacitor C_3 should be kept as small as possible—but larger than the 5-pF input capacitance of the inverter—because this type of resonator operates best with a high impedance load.

Circuit operation has been optimized with the component values shown for 2.5-kHz operation. The power-supply voltage may range from 4.2 to 15 V without deterioration in circuit performance, and the total current drain then varies between 17 μA at 5 V to 106 μA at 15 V. With a 5-V supply, the output signals are 3.3-V pk-pk, with rise-time of 1.5 μs.

Dr. Sam Ben-Yaakov, Associate Research Engineer, and P. Greene, Dept. of Geology, UCLA, Los Angeles, Calif. 90024

CIRCLE No. 313



Piezoelectric resonator and CMOS chip generate a stable clock while consuming only 17 μA from a 5-V supply.

IFD Winner of May 25, 1972

T. J. Steen, Pres. Kennedylaan 36, Roosendaal, The Netherlands. His idea "Three-LED circuit indicates ac or dc and polarity" has been voted the Most Valuable of Issue award.

Vote for the Best Idea in this Issue

SEND US YOUR IDEAS FOR DESIGN. You may win a grand total of $1050 (cash)! Here's how. Submit your IFD describing a new or important circuit or design technique, the clever use of a new component or test equipment, packaging tips, cost-saving ideas to our Ideas for Design editor. Ideas can only be considered for publication if they are submitted exclusively to ELECTRONIC DESIGN. You will receive $20 for each published idea, $30 more if it is voted best of issue by our readers. The best-of-issue winners become eligible for the Idea of the Year award of $1000.

The things we can do with small lamps should interest you.

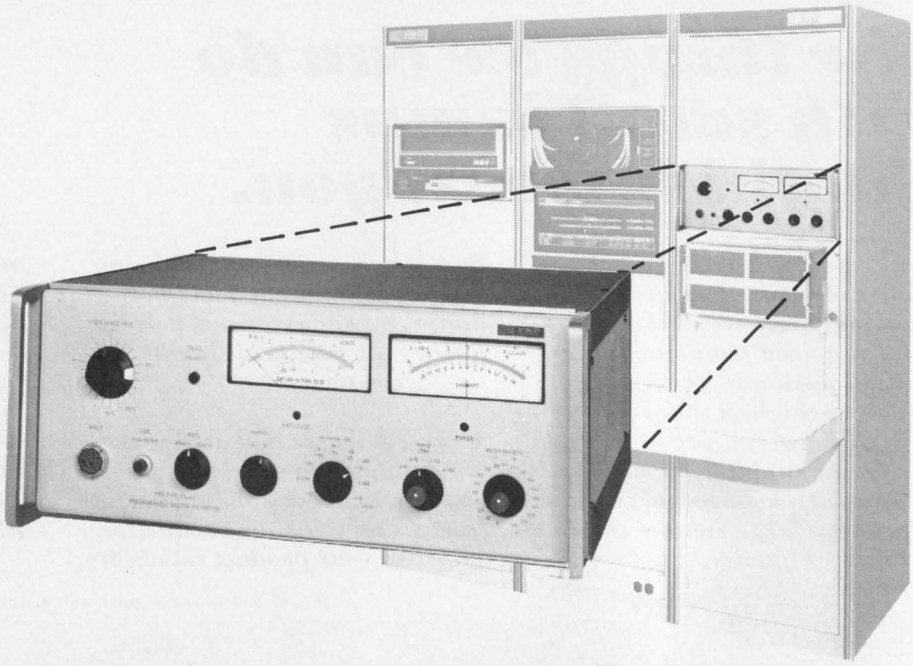
One reason to buy Tung-Sol lamps is because you can get all the miniature and subminiature types you need from one source. More importantly, the quality will be the highest that 75 years of experience can produce. And as a major supplier for original equipment, we have learned how to produce large volume without sacrifice of quality.

But, if you really want value in your application of Tung-Sol lamps, let our engineers help you while your product is in the prototype stage.

Tung-Sol lamps that are specially encapsulated to eliminate the conventional base and socket, might simplify your production, improve your product reliability, or even just plain save you money. For more specific information, write, describing your requirements.

Lamp Sales
WAGNER ELECTRIC CORPORATION
630 W. Mt. Pleasant Avenue
Livingston, N.J. 07039
TWX: 710-944-4865
Phone: (201) 992-1100
(212) 732-5426

HARRIS
Communications and Information Handling



NOW... A programmable Vector Voltmeter

...in addition to the standard

When we introduced our standard 2020 Vector Voltmeter its wide frequency range and 50 ohm coaxial inputs (no probes) lead to wide acceptance by the industry.

Now we're producing a programmable version . . . the P2020. It retains all the features of the standard model and also meets the requirements of automatic testing.

Its control functions can all be programmed through a single rear panel connector by standard TTL logic levels. Phase locking the P2020 is even simpler . . . its automatic over the entire frequency range of the instrument, thereby minimizing your programming efforts and simplifying operation in the manual mode.

If you plan to automate your RF and microwave testing (either by computer or hard-wire programming), but have found the cost to be prohibitive, consider our Programmable Vector Voltmeter . . . it's the cost effective answer. Write or phone PRD for the complete story on the *only* Programmable Vector Voltmeter, the P2020.

Specifications: □ 1.5 MHz to 2.4 GHz Frequency Range □ ±1° Phase Accuracy to 1 GHz □ 70 dB Dynamic Range □ Matched 50 ohm Inputs

PRD ELECTRONICS, INC. | HARRIS

PRD ELECTRONICS DIVISION, Harris-Intertype Corp.
1200 Prospect Avenue, Westbury, L. I., N. Y. 11590
Telephone: 516-334-7810

INFORMATION RETRIEVAL NUMBER 40

new products

4-½-digit pocket multimeter slashes size, price and power consumption

Data Precision Corp., Audubon Rd., Wakefield, Mass. 01880. (617) 246-1600. $295; stock.

The smallest 4-1/2-digit multimeter is also the least expensive. At $295, Data Precision's Model 245 is priced with many 3-1/2-digit meters and far below all but one 4-1/2-digit unit—the $329.95 Anaconic Model 390.

With a volume of 468 cubic inches (5 H × 8-1/2 W × 11 D), Anaconic's unit is a bit bigger than Data Precision's, with 31 cubic inches (1-3/4 × 5 × 3-1/2). The Anaconic is for line operation only, while the Data Precision (which weighs only 14 oz. and can fit in a jacket pocket) works from internal, rechargeable batteries or from the line.

Anaconic's unit has 29 ranges against Data Precision's 21, but the Anaconic is not always characterized as thoroughly as one might wish and some ranges may be less than convenient to use.

For example, to measure 1, 10 or 100 mA dc, you apply the leads (not furnished) to the terminals marked "VOLTS-MA," which is what you'd expect, though "the 1-mA range is extremely influenced by external ac fields and is provided as a convenience only," according to the manufacturer.

Measuring dc microamperes, however, is less straightforward. For the 100-μA range, you apply the leads to the "LOW" jacks of the terminals marked "VOLTS-MA" and "OHMS-CAP." Then you turn the range and function switches to 100 V dc. For the 10-μA range, you switch to 10 V dc, keep the leads where they were and short the "VOLTS-MA" jacks.

Despite such inconveniences, the Anaconic's versatility is impressive. It offers measurements of capacitance and frequency (to 2 MHz) as well as the usual resistance, dc and ac voltage, and dc current (though frequency measurements may require application of some arithmetic). The instrument counts events and provides four time-base signals (1 to 1000 ms).

For some measurements, the meter's accuracy could have been provided by a 3 or even 2-digit instrument. The basic accuracy of the two ac ranges, for example, is 5% f.s. ±200 mV or "typically" 5% rdg ±300 mV, depending on whether you read the data sheet or some accompanying notes.

In contrast, Data Precision's unit is designed for simplicity of operation and is rather thoroughly characterized in terms of accuracy for each range and (unlike the Anaconic) short- and long-term drift and temperature coefficient. On the ac-current (which the Anaconic lacks) and dc-current ranges, Data Precision blanks out the least-significant digit, admitting that it can't get good enough shunts.

The Data Precision includes ranges from 1 to 1000 V dc and ac (though the 1000 V ac range, like that in the Anaconic, is limited to 500 V ac), 1 to 1000 mA dc and ac, and 1 to 10,000 kΩ. All Data Precision functions permit 100% overrange, while the Anaconic has only 20% except for the frequency and count, which go to 19999.

For ac operation and simultaneous battery charging, the Data Precision works with a small, plastic-cased charger at the far end of the line cord (to keep raw ac out of the instrument) or with an optional bench stand with charger (at about $50). Internal batteries are included in the price of the instrument, as are the line-cord charger, the carrying strap, probes and carrying case.

Both meters use gas-ionization displays. The Anaconic uses conventional tube types and the Data Precision uses the Sperry planar display to conserve power. The entire unit consumes only 0.75 W. For more information:

From Anaconic **CIRCLE NO. 250**
From Data Precision **CIRCLE NO. 251**

8-digit frequency counter operates to 120 MHz

Heath Company, Hilltop Avenue, St. Joseph, Mich. 49085. (616) 983-3961. $349.95 (mail order).

The IB-1102 Frequency Counter Kit features eight cold-cathode display tubes, an overrange lamp, gate lamp, and two range-indicator lamps. Over-all accuracy is assured by the use of a pre-built, temperature-compensated, crystal-oscillator (TCXO) clock. The unit has a sensitivity of 50 mV to 100 MHz and 125 mV to 120 MHz. It accepts inputs up to 120 V rms from 1 Hz to 150 Hz, 50 V at 40 MHz, and 3 V at 120 MHz without damage to the instrument. The IB-1102 uses ECL plug-in ICs and circuit boards to speed and simplify assembly and service. The counter can be wired for either 120 or 240 V ac operation.

CIRCLE NO. 252

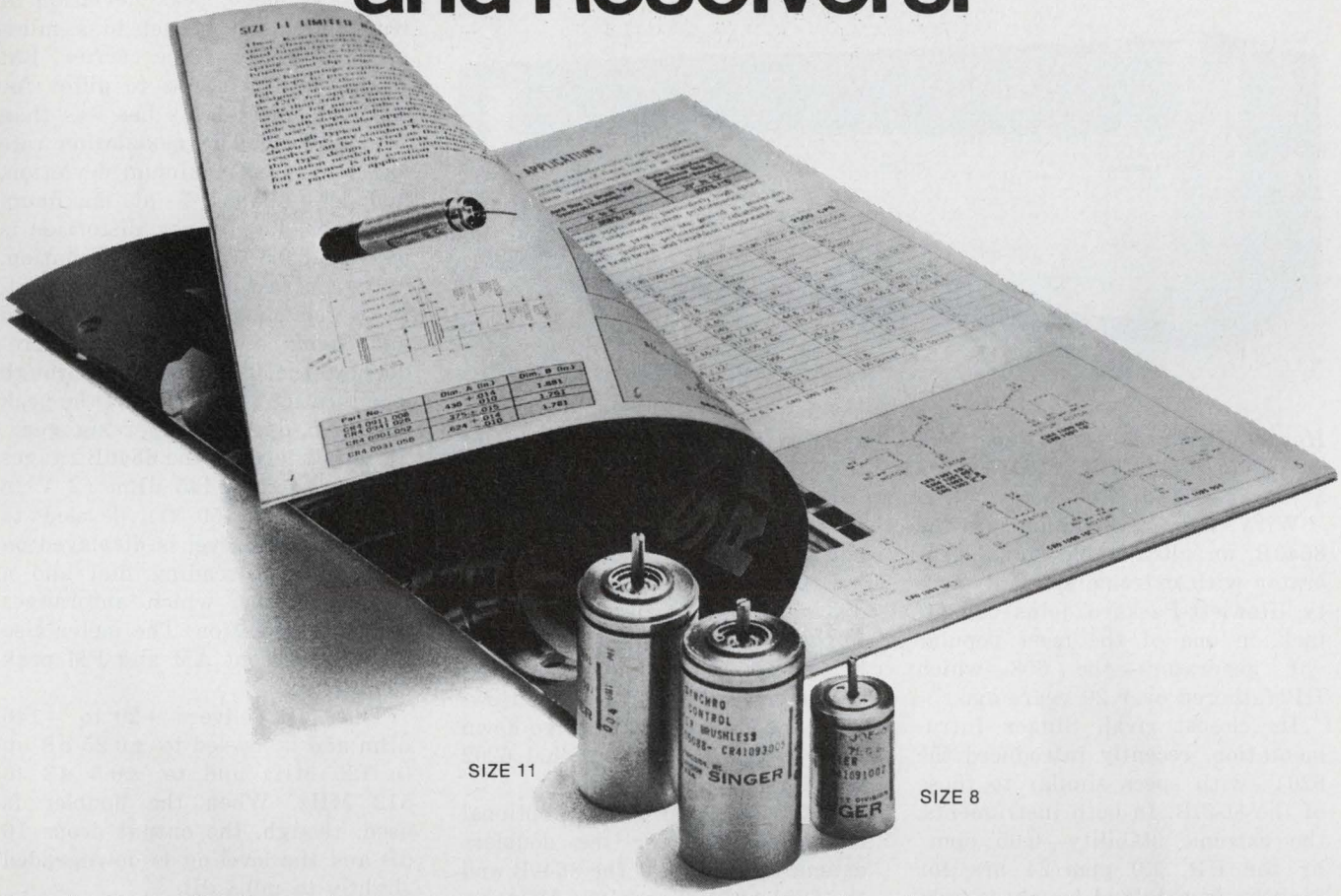
Drop-proofed VOM costs just $132.50

Weston Instruments Div., 614 Frelinghuysen Ave., Newark, N.J. 07114. (201) 243-4700. $132.50; stock.

The Model 666 is the latest addition to the company's line of "drop-proofed" VOMs. For current measurements, the Model 666 offers twelve ranges with a lowest full-scale range of 1 μA; eighteen voltage ranges, from 100 mV full scale through 1000 V and fourteen ohms ranges, featuring seven low-power-ohms ranges for "in circuit" measurements of semiconductors. Other features include a differential FET-input circuit providing 10 MΩ impedance. This design eliminates frequent battery replacement, assuring 400 continuous hours of operation.

CIRCLE NO. 253

Send for our brushup course on Brushless Synchros and Resolvers.



Faced with applications where synchros and resolvers have to be driven at extremely high speeds? Or where brush wiping contact can't be permitted?

Kearfott Brushless Components provide system performance advantages. (Instead of standard brushes and slip rings, rotary transformers couple power into the synchro motor.) And extra-wide bearings give you increased reliability and load-carrying capacity.

Our Brushless Synchros offer you a number of other benefits, too. Longer life, since there's nothing to wear but the bearings. No spurious signals from high-speed brush bounce which Digital Computers can interpret as a command input. Elimination of brush friction for Indicators that require the ultimate in minimum loading. And an end to RFI noise.

Kearfott Brushless Synchros and Resolvers also serve as excellent low cost Brushless Encoders when used in combination with Kearfott TRIGAC I S/D converter cards.

Like to know more? Write for our 36-page brochure on Synchros and Resolvers. It's packed with facts and figures on Brushless Synchros for limited and continuous rotation applications—plus our full line of Synchros and Resolvers. The Singer Company, Kearfott Division, 1150 McBride Avenue, Little Falls, New Jersey 07424.

SINGER

AEROSPACE & MARINE SYSTEMS

The Singer Company, Kearfott Division
1150 McBride Avenue
Little Falls, New Jersey 07424

Gentlemen:

☐ I want to know more about Brushless Synchros. Rush me your 36-page booklet on Synchros and Resolvers.

☐ I have an application for Brushless Synchros. Have a company representative call.

Name_____

Title_____

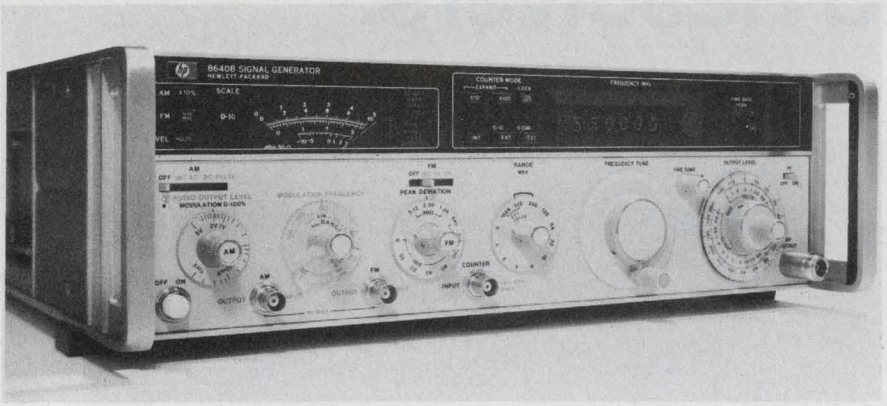
Company_____

Address_____

City_____ State_____ Zip_____

INFORMATION RETRIEVAL NUMBER 42

Phase-locked signal generators yield ultra-stable frequencies



Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. 94304. (213) 877-1282. $4450; 90 days.

With the introduction of the 8640B, an ultra-stable signal generator with extreme spectral purity, Hewlett-Packard joins the attack on one of the most popular vhf generators—the 608—which HP fathered over 20 years ago.

Its closest rival, Singer Intrumentation, recently introduced the 6201—with specs similar to those of the 8640B. In both instruments, the extreme stability—0.05 ppm/hr for HP, 1.0 ppm/24 hrs for Singer—is obtained by phase-locking the output to a crystal reference.

Temperature drift for the 8640B is a low 0.05 ppm/°C—at room temperature—and less than 1 ppm/°C over the 15-30 C range. The 6201's drift is listed as less than 0.5 ppm/°C.

Spectral purity is where the solid-state HP unit really shines: It delivers low-noise signals that, till now, could be attained only with vacuum-tube generators. Nonharmonic and sub-harmonic outputs are more than 100-dB down. Close-in noise, important for adjacent-channel selectivity tests, is spec'd at 130-dB below the carrier.

Though it's difficult to compare noise specs—since they are measured and presented differently—the Singer generator appears to run neck-and-neck with HP's, with a listed broadband noise of better than 130-dB below the carrier.

Harmonics of both units are better than 30-dB down across the entire frequency range.

Both units have a six-digit LED display of output frequency which, in the HP, covers the range of 450 kHz to 550 MHz and, in the Singer, covers 7.75 to 512 MHz. However, the Singer 6201 can go down to 61 kHz with the optional 6202 plug-in.

Both units also offer an optional frequency doubler; the doublers extend the range of the 8640B and the 6201 to 1100 and 1024 MHz, respectively. But, when using the doubler option with the Singer instrument, the frequency output is twice the indicated frequency. In contrast, the HP always displays the actual output frequency.

Additionally, both generators can measure external frequencies with their built-in counters. In this mode, the 8640B handles frequencies to 550 MHz, while the 6201 measures to 10 MHz.

Modulating characteristics of both the 8640B and the 6201 match their precision CW performance. Both units provide AM, FM and pulse modulation. AM, in both units, can be varied from zero to 100%. Distortion, in the HP, (at 1-kHz rate) is less than 1.5% to 50% AM, and less than 2% to 90% AM. For the Singer, distortion is less than 2% for 30% AM.

In FM mode, peak deviation of both units can be set to a minimum of 0.5% of the carrier. But FM distortion seems to differ for the two units: HP's has less than 1% up to 25-kHz modulation rate and to 1/4 of maximum deviation, and less than 3% at maximum deviation. For Singer, distortion is less than 0.5% at 0.1% deviation.

In contrast with the HP unit, in which deviation is calibrated and remains constant with frequency, the user must go through a calibration process to set the peak deviation on the Singer sig gen.

Output level of the 8640B ranges from +19 to −145 dBm (2 V to 0.01 μV into 50 Ω), leveled to ±0.5 dB. The level is displayed on both a direct-reading dial and a built-in meter, which autoranges for best resolution. The meter also displays percent AM and FM peak deviation.

The 6201 delivers +20 to −146 dBm and is leveled to ±0.25 dB up to 125 MHz and to ±0.5 dB to 512 MHz. When the doubler is used, though, the output drops 16 dB and the leveling is downgraded slightly to ±0.8 dB.

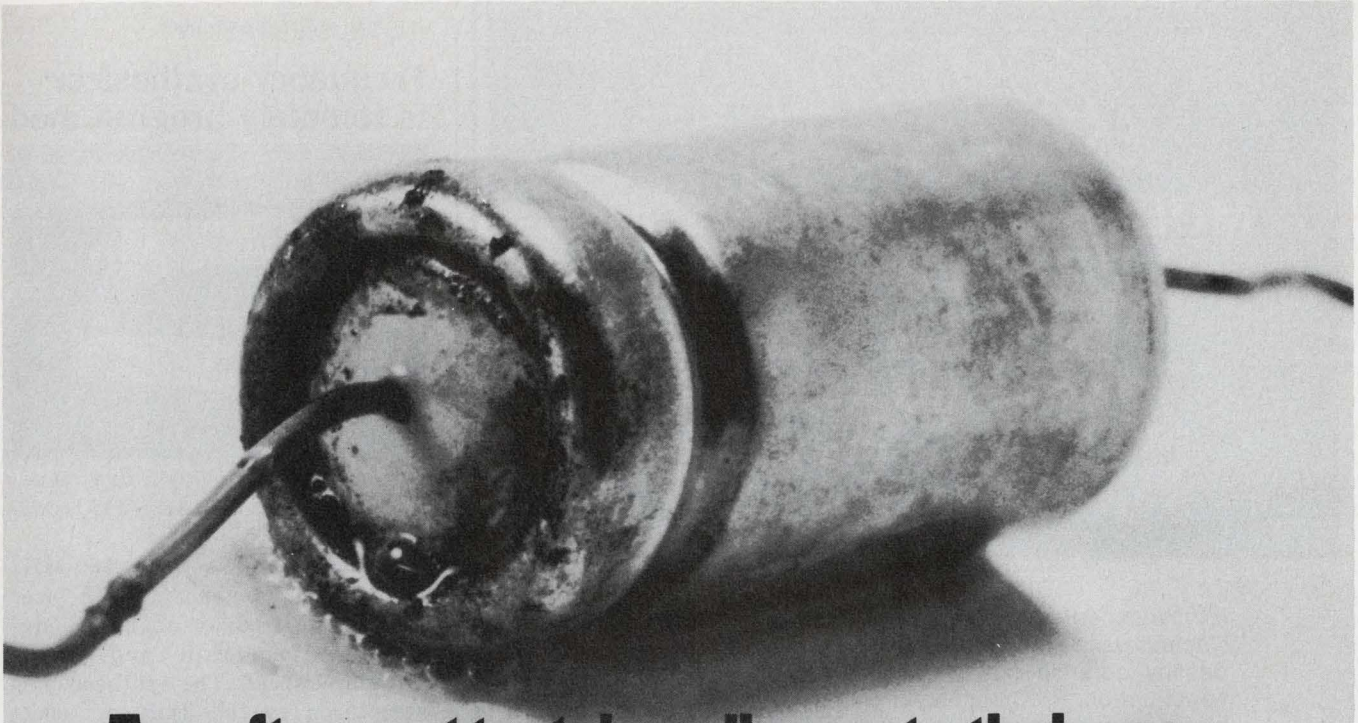
Finally, the HP 8640B offers a number of operating conveniences and options which complement its fine performance. An optional, built-in 20 Hz-to-600 kHz oscillator can be used as the modulating source, or independently to provide calibrated output levels. This $150 option extends the usable cw frequency of the 8640B down to 20 Hz.

Other features include: lighted annunciators that indicate when output levels or modulation limits have been exceeded; a flashing of the LED display to indicate that the phase-lock has been broken; and a vernier that allows fine tuning of the rf in the locked mode of at least ±20 ppm.

For more information from:

Hewlett-Packard: **CIRCLE NO. 254**

Singer: **CIRCLE NO. 255**



Too often, wet tantalums live up to their name.

They leak.

Which is a pretty good reason to switch to a tantalum that won't.

Our KEMET® T242 tantalum.

It's a true hermetic sealed, extended range, solid state tantalum capacitor. Which means it contains no electrolyte to freeze, dry, drip or ooze.

Now recognized by the military as CSR23, it's available in L,M, and P failure rates. In standard MIL A,B,C and D case sizes. And with a capacitance range of 1.8—1000uF—6 to 50 volts.

What's more, the T242 has much better low temperature electrical characteristics than wets. For example, ΔC and D.F. for a 560uF T242 at -55° C is ±10% and 10% respectively, versus -64% and 128% for the CLR65.

If DC leakage is bothering you, ask us. We can beat the CSR23 specs by a large margin, and often beat the wets too. At a price less than half that of a hermetic sealed wet.

So if you're using wet tantalums, you now have a choice. Ask your KEMET representative about switching. Or contact us direct. Union Carbide Components Department, Box 5928, Greenville, S.C. 29606. Phone: (803) 963-7421. TWX: 810-287-2536.

After all, you need a capacitor that won't run out on you.

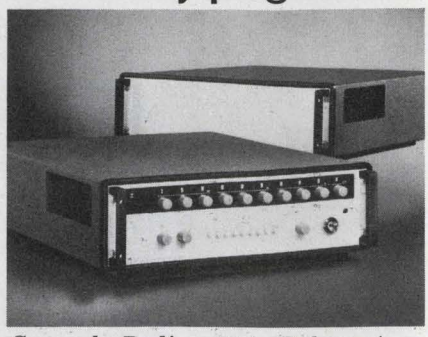
UNION CARBIDE COMPONENTS DEPARTMENT

Available through your KEMET distributor.

INFORMATION RETRIEVAL NUMBER 43

INSTRUMENTATION

Frequency synthesizer is remotely programmed



General Radio, 300 Baker Ave., Concord, Mass. 01742. (617) 369-4400. $4700.

General Radio's new 160-MHz Model 1061 Frequency Synthesizer is characterized by an 80-dB signal-to-spurious ratio and 100-μs switching speed. The synthesizer is structured so the user can select options for a level of performance and degree of frequency resolution commensurate with his needs. The basic unit provides a leveled output of 0 dBM to +20 dBM into 50 Ω from 400 kHz to 160 MHz with 10-kHz (5-digit) resolution. Both frequency and output level can be remotely programmed and a search-sweep mode provides additional resolution to 100 Hz. A separate output covers a frequency range of dc to 10 MHz and is standard on all units. The search-sweep mode allows any decade, with 1-MHz steps or less, to be varied by a continuous control with overlapping coverage.

CIRCLE NO. 256

Autoranging DPMs offer 100 MΩ input

Digitan Systems Co., 5001 16th Ave., Brooklyn, N.Y. 11204. (212) 853-2793. $99 (200); 4-6 wks.

A new line of digital panel meters offer an auto-expand feature: when the reading gets to 10% of full scale, a scale expansion by a factor of 10 takes place. Thus the meter, when used to replace a conventional 3-1/2-digit panel meter, enhances the overall system capability. The DPMs feature seven-segment fluorescent readouts, 100 MΩ input impedance, 5 V power supply, 100% overrange, and input readings up to 20 V.

CIRCLE NO. 257

Angle indicator resolves 0.1 degrees

Transmagnetics, Inc., 210 Adams Blvd., Farmingdale, N.Y. 11735. (516) 293-3100. $645; stock.

The Model 2623EC2 is a compact, solid-state angle indicator having a digital readout. The unit will accept the full range of synchro or resolver inputs and will display the mechanical input angle from 0 to 359.9 degrees on a four-digit, seven-segment display. The instrument will display a 180-degree change in input angle within 2.5 ms. The four-decade unit has 14-bit resolution with an absolute accuracy and resolution of 0.1 degrees. The incandescent digital character height is 3/8 inches. Size is 4-1/2 × 1-3/4 × 5 inches. Power supply requirements are +5 V dc and ±15 V dc.

CIRCLE NO. 258

Waveform generator lets user set exact shape

Princeton Applied Research Corp., Box 2565, Princeton, N.J. 08540. (609) 452-2111. $1650; 60 days.

The Model 175 waveform generator/programmer permits the user to independently select all the individual parameters whose values determine the exact shape of the final waveform. Instead of providing the usual frequency, amplitude and offset controls, the Universal Programmer allows the independent selection of up to four inflection points and two values of either time (in pulse mode) or slope (in sweep mode) so that complex waveforms of up to four variable-length segments can be generated either singly or repetitively. Front panel and parallel external controls permit instant reset, hold and reverse of the generated waveform at any point.

CIRCLE NO. 259

Photometer/Radiometer has digital readout

Tektronix Inc., P.O. Box 500, Beaverton, Ore. 97005. (503) 644-0161. $600 w/o probe; 6 wks.

The J16 Digital Photometer/Radiometer is a portable unit capable of making a wide variety of light measurements. It measures only 2.4 × 4.6 × 8 inches, and weighs 3-1/4 lb, including the internal rechargeable batteries. The 2-1/2-digit LED display can be easily read in low-ambient light conditions. All probes use silicon sensors (1 cm^2) for maximum stability. The J6501 Probe measures illuminance in footcandles. The J6502 Probe measures irradiance in $\mu W/cm^2$ within the spectral range of 450 to 1000 nanometers. The J6503 Probe measures luminance in foot Lamberts. The J6504 Probe has no correction filter so that the spectral response characteristics of the silicon detector may be used directly. The J6505 Probe measures illuminance of sources having spectral outputs in the red region (LEDs).

CIRCLE NO. 260

Rb frequency standard is inexpensive

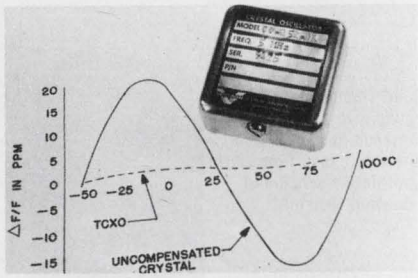
Tracor, Inc., 6500 Tracor Lane, Austin, Tex. 78721. (512) 926-2800. $5900.

The Model 308-A rubidium frequency standard has been introduced by Tracor, Inc. Designed for applications in astronomy, navigation, metrology, communications and other situations where a precise and stable time base is required, the 308-A has all the advantages of atomic stability at near-crystal prices. Standard output is 5 MHz with others optional.

CIRCLE NO. 261

MODULES & SUBASSEMBLIES

Crystal oscillator offers $\pm 10^{-7}$ stability



Vectron Laboratories, Inc., 121 Water St., Norwalk, Conn. 06854. (203) 853-4433. Stock.

The Model CO-252-3A TCXO (temperature-compensated crystal oscillator) uses computer compensation techniques to achieve a stability of $\pm 1 \times 10^{-7}$ over the 0 to 50C temperature range. This stability is achieved without the use of an oven, resulting in low (5-10 mA) power drain, small size and instantaneous "on-frequency" operation. Long term stability (aging) is better than 1×10^{-8} per day and 1×10^{-6} per year. A broad temperature range unit, Model CO-252-4A, provides $\pm 1 \times 10^{-6}$ stability over the −55 to +85 C temperature range. These oscillators provide sine, TTL or CMOS output in the 1 to 20-MHz range; models are available covering frequencies from 60 Hz through 80 MHz.

CIRCLE NO. 262

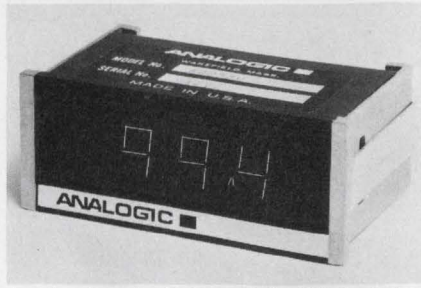
Power modules feature automatic crossover

Kepco, Inc., 131-38 Sanford Ave., Flushing, N.Y. 11352. (212) 461-7000. $225.

Kepco, Inc. introduces the PTR power supply module, an automatic-crossover voltage/current stabilizer in modular form for the OEM. PTRs feature integrated front ends in both the voltage and current-control channels. They function in OEM environments from −20 to +71C (with no need to derate the output) and can be programmed digitally (with the Kepco "SN Programmer") or with analog instructions. A built-in overvoltage crowbar, available as an option, protects sensitive loads. PTR modules offer the OEM a selection of six power units ranging from 0-7 V at 5.5 A to 0-100 V at 0.6 A.

CIRCLE NO. 263

DPM uses external scaling resistors to set FS



Analogic, Audubon Rd., Wakefield, Mass. 01880. (617) 246-0300. $47.00 (100s).

Analogic's AN 2530 is a 3-decimal digital panel meter that can be inventoried as a single basic measurement block for almost any system measuring and display application. All that is necessary is to select an appropriate feedback resistor and to pin select the desired display increment. The universal DPM is available in two mechanical configurations.

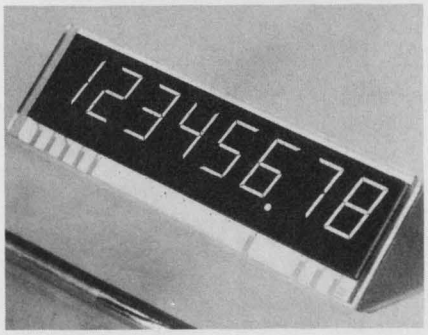
The unit measures positive or negative inputs in the presence of up to ±300 V common mode (dc or ac peak) with respect to digital logic ground. The isolated input is powered from a floating analog source developed by a built-in dc/dc converter. The analog count circuit is transformer-coupled to the counter-display circuit.

Externally-selected input scaling is accomplished with simple resistor connections. Full scale voltage is ±20 mV to ±2.0 V with current ranges from 2 μA upwards as determined by a selected shunt. External jumper connections of counter-circuit terminals provide a least-count resolution of 1, 2, 5 or 10 units.

Other specs include: 0.2% resolution; guaranteed monotonicity; independent decimal point selection; linearity and relative accuracy of ±0.2% FS ±1 count; input bias current of 10 nA (nominal); tempco of Zero: 1 count per 20 C or 20 μV/°C (whichever is greater); tempco of F.S. range: 1 count per 20 C or 250 ppm/°C (whichever is greater); a conversion rate of 1.5 per second (nominal); a CMRR of 120 dB for dc (nominal) and 100 dB for ac (nominal at 60 Hz) input. Input power is 3.0 W, and size is 3.187 × 1.375 × 1.800 inches (behind bezel).

CIRCLE NO. 264

Panel display features eight 0.7-inch digits



Burroughs Electronic Components Div., Box 1226, Plainfield, N.J. 07061. (201) 757-5000. Approx. $2/digit (quantity); 1st quarter of 1973.

The BR08751 PANAPLEX II panel display with eight 0.7-inch characters (compared to previously announced 0.25 and 0.4-inch characters) can be comfortably viewed from distances of up to 35 feet. The character format is seven-segment, 0.37 inches wide, and is displayed against a black, nonreflective background. The BR08751 panel contains eight digits of display interconnected within a common envelope. Only 24 connections are required to address the eight character positions and decimal point. The connection scheme permits a wide variety of vertical, horizontal, and angled mounting configurations. The unit is 5.4 inches wide, 1.6 inches high, and only 0.25 inches thick (not including tubulation). The BR08751 operates at low power and is compatible with standard TTL and DTL integrated circuits.

CIRCLE NO. 265

Crystal oscillator gives 12 frequencies

Connor-Winfield Corp., Winfield, Ill. 60190. (312) 231-5270. 2-3 wks.

A crystal, multiple-frequency clock oscillator provides up to 12 fixed, square-wave frequencies that are multiples of up to 2 different frequencies from 1 Hz to 30 MHz (±0.001%, 0 to +50 C, or ± 0.005%, −25 to +75 C). Each frequency can drive 10 TTL gates. Supply voltage is 5 V dc ±5%. Case size is 0.78 × 0.49 × 0.57 inch.

CIRCLE NO. 310

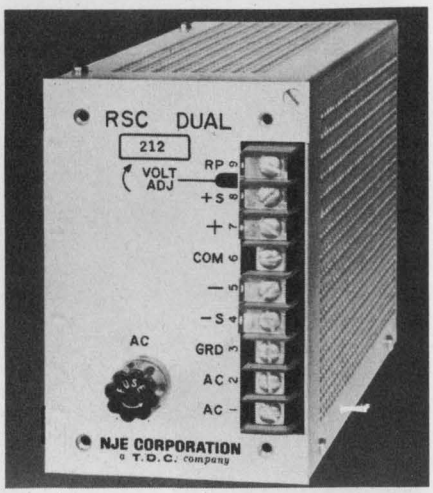
Narrow-band rf amp has 3-dB NF, weighs 2.5 oz.

Optimax Inc., P.O. Box 105, Advance Lane, Colmor, Pa. 18915 (215) 822-1311. AL-1007: $305; AL-1005: $345; AL-1006: $285.

The Model AL-1007 narrow-band rf amplifier weighs only 2.5 ounces, has a noise figure of 3 dB, maximum and a frequency range of 10 to 110 MHz. Hybrid thick-film techniques are used to reduce weight and size, which is 2.5 × 1 × 0.6 inches. The amplifier has a nominal gain of 35 dB and a gain-control range of ±5 dB. The VSWR in/out is 1.5:1, maximum and the IM product-intercept point is +15 dBM. Two other narrow-band rf amplifiers are available in this series: Model AL-1005 with a 380 to 500-MHz BW; and Model AL-1006 with a 40 to 80-MHz BW. Both of these units have the same noise figure as the Model AL-1007.

CIRCLE NO. 266

Power supply offers ±15 V at 2.4 A



NJE Corp., Culver Rd., Dayton, N.J. 08810. (201) 329-4616. $145; stock.

NJE now offers a high-current op amp OEM modular power supply, Model RSB-212, with a dual output adjustable from ±12 to ±15 V at 2.4 A (at 40 C). Physical size is 3.17 × 4.45 × 9.37 inches. The unit is fourth in a new series of op-amp type supplies by NJE. Input on all models in the series is 105-132 V, 47-440 Hz. Load regulation for all models in the series is 0.1% for a no-load to full-load change in output current within rating of the supply. Ripple and noise do not exceed 3 mV pk-pk, 1.0 mV rms (dc to 10 MHz). Stability is less than 0.1% total drift for eight hours. Transient recovery time is less than 50 μs within ±1.0% for line changes of ±10% around nominal, or ±50% load changes around nominal.

CIRCLE NO. 267

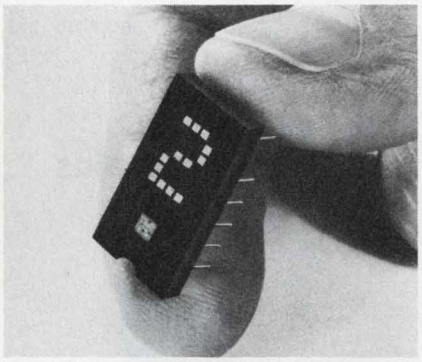
10-bit d/a converter has 0.01 Ω output impedance

Sprague Electric Co., 87 Marshall Street, N. Adams, Mass. 01247. (413) 664-4411.

The Series UHM-500 consists of complete 8 and 10-bit d/a converters in DIP-compatible plastic cases for operation over the temperature range of −55 to +125 C. Conversion accuracy is specified as better than ±1/2 LSB between −25 and +85 C. The type UHM-503 is a 10-bit converter with an absolute accuracy of better than ±0.048% and a conversion time of, typically, 2.5 μs. The Type UHM-506 is similar but includes an operational amplifier with feedback resistors for an output impedance of only 0.01 Ω. The Type UHM-523 is an eight-bit converter with an absolute accuracy of better than ±0.195% and a conversion time of, typically, 2.0 μs.

CIRCLE NO. 268

Hexadecimal display has integral TTL chip

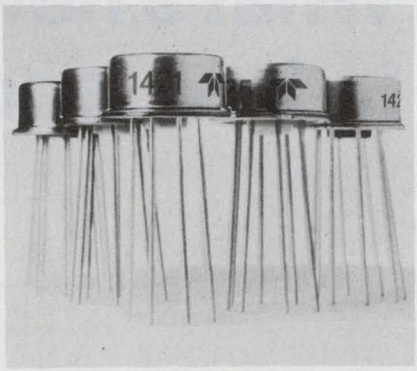


Dialight Corp., 60 Stewart Ave., Brooklyn, N.Y. 11237. (212) 497-7600. $10 ea. (1000) 4-6 wks.

Dialight announces its new 0.27-inch LED hexadecimal readout with integral TTL circuit that accepts, stores and displays four-bit binary data. The display and TTL MSI chip are mounted on a lead-frame assembly that is then cast within a red, electrically nonconductive, transparent plastic compound. Multiple displays may be mounted on 0.450-inch centers. The display also has left and right decimals, single-plane wide-angle visibility, and high brightness due to the gallium arsenide phosphide used for the LEDs. These readouts can be used with separate LED and logic 5-and-6-V power supplies.

CIRCLE NO. 269

FET op amp line extended



Teledyne Philbrick, Allied Dr. at Route 128, Dedham, Mass. 02026. (617) 329-1600. Stock.

Six devices are added to the company's 1400 series, a line of FET op amps. The new units include the following: the 1422—a 5-MHz GBW amp with 8 V/μs minimum slew rate; 1424—a low-cost version; 1425—an internally trimmed device with 1 mV max initial offset voltage and 5 pA maximum bias current; 1426—a low-drift unit with 1 mV max initial E_{os} and 5 μV/°C drift; 1428—a low-cost replacement, and the 1429, with bias currents under 0.25 pA and internal trimming to 1-mV max initial offset voltage.

CIRCLE NO. 270

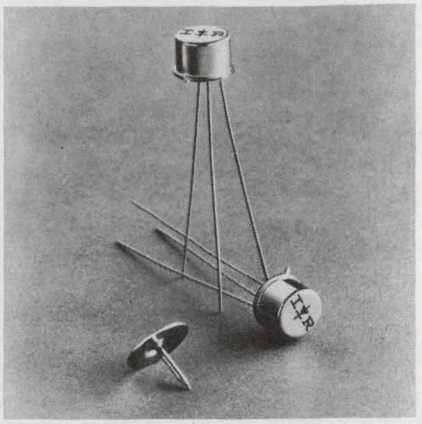
Hybrid op amp boosts slew rate to 2000 V/μs

M. S. Kennedy Corp., 168 Pickard Bldg., E. Molloy Rd., Syracuse, N.Y. 13211. (315) 437-5616. $89 (10-24); stock.

The Model 780 hybrid op amp boasts a slew rate of 2000 V/μs with an output current rating of 80 mA. Bandwidth is 120 MHz. The 780 comes in an 8-pin TO-3 package and operates over the full MIL temperature range.

CIRCLE NO. 271

Low power SCR line extended

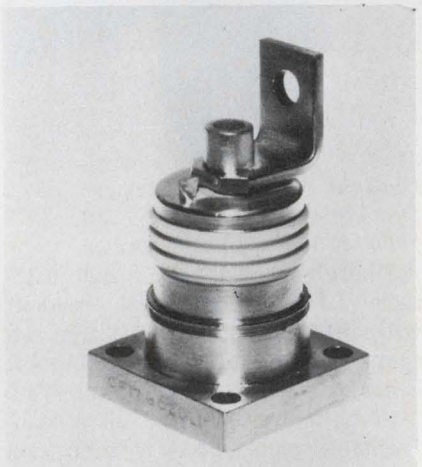


International Rectifier Corp., 233 Kansas St., El Segundo, Calif. 90245. (213) 678-6281.

Six series of SCRs in TO-5 cans provide an alternate source of these units while further expanding the company's line of low-power SCRs. The new series are the 2N2322, 2N4212, IR5 and IR6. All are available in versions with rated voltages of 25 to 400 V; and the 2N1595 and 2N1595A, with rated voltages of 50 to 400 V.

CIRCLE NO. 272

SCRs and diodes rated at 1000 V plus



Westcode Semiconductors, 282 Belfield Rd., Rexdale 605 Ontario, Canada. (416) 677-5881.

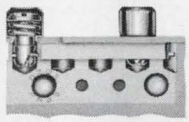
A series of SCRs and diodes operate from voltages above 1000 V. Transient voltage ratings are up to 5.5 kV, and repetitive voltage ratings go to 3750 V. The average current range is from 200 A to 625 A, with double-sided cooling.

CIRCLE NO. 273

Quick Fastening Devices for the Electronics Field.

Dzus Fastener Co. Inc., who invented the ¼-turn fastener in 1932 for use in the aircraft field, also produces a wide variety of specialized fastening devices for the electronics field which carry through the original Dzus concept of quality fastening at low installed cost.

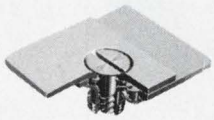
Panel Line



Spiral Cam ¼-Turn Self Locking Fasteners

Ideal for securing instruments, modules and chassis to racks. Panel strips are available in various lengths and configurations to conform to any application.

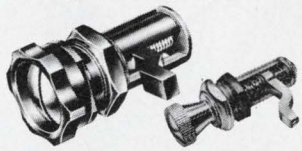
Standard Line



The Original and Most Versatile ¼-Turn Fastener

For use on any structural material in a wide variety of applications. Available in a variety of lengths and head styles.

Adjustable Pawl Latches



Standard and Miniature Sizes for Doors, Drawers and Panels

For compartment doors, sliding drawers or instrument covers. Wide, variable grip adjusts to fit varying metal thicknesses.

Toggle Latches

Low Cost, Low Profile Models with Choice of Strikes

For container fastening, control boxes, instrument cases and other uses where pull-up is required

DZUS® means quick fastening

Dzus Fastener Co. Inc.

425 Union Boulevard, West Islip, New York 11795 516/669-0494/TWX 96-1454 Dzus Fast Wslip
West Coast: 910 S. Brookhurst, Anaheim, California 92804 714/535-6915

INFORMATION RETRIEVAL NUMBER 57

FAST, ACCURATE

computer plotted printed circuit conversion

computer aided layout design

digitizing

computer controlled plotter

film processing

prototype fabrication

production

Com-Cir-Tek system converts basic electric logic into highly accurate artwork, prototypes and production run circuit boards in a matter of days. Minimizes time and expense. Accuracies to ±0.0005 are routine. Laborious manual designs, changes and corrections are eliminated. Flexible Com-Cir-Tek capability easily adapts to your requirements. Free bulletin gives full details. Write:

COM·CIR·TEK Inc.
210 FRENCH ROAD, GARDENVILLE, NEW YORK 14227
PHONE 716 675-3800

INFORMATION RETRIEVAL NUMBER 58

TEST CLIPS
After 100,000 wire insertions and removals contact resistance registered less than .001 ohms.

BI-PIN LAMP SOCKETS
Features 4 point PC mount for stability.

TRANSISTOR SOCKETS
Minimum insulation resistance of 500,000 megohms at 100 VDC.

BINDING POSTS
Caps won't melt at soldering temperature.

Even hardware can be different

Grayhill is in termination hardware because our customers wanted something different.

And products and features shown above reveal only part of the picture.

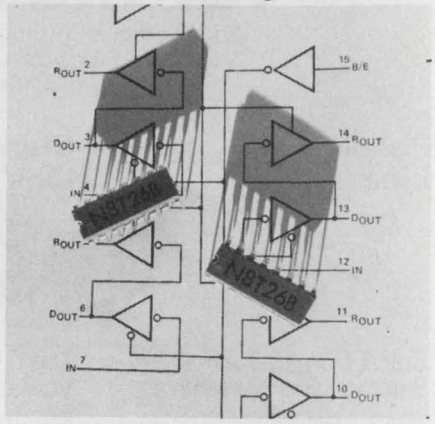
Grayhill makes 100 other items of termination hardware —developed for superior insulation, dielectric strength, minimum contact resistance. And if what you need isn't in our line now, we can design and make it for you.

For our latest Engineering Catalog write or phone:
Grayhill, Inc., 565 Hillgrove Ave.,
La Grange, Illinois 60525.
(312) 354-1040.

Grayhill INC.

INFORMATION RETRIEVAL NUMBER 59

Quad bus drvr/rcvr lists 17-ns delay



Signetics, 811 E. Arques Ave., Sunnyvale, Calif. 94086. (408) 739-7700. N8T26B: $3.90 (100 up); stock.

The 8T26, Schottky-TTL IC consisting of four driver/receivers, features a propagation delay of less than 17 ns and a power consumption of 250 mW. Each driver can sink 40 mA, while a receiver can handle 16 mA. The quad transceiver is suitable for routing data in bus-oriented systems, including small minicomputers and memory systems.

CIRCLE NO. 274

Dual op amps, comparators introduced

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. (408) 732-5000. LH2301AD: $6.95; LH2308-D: $8.95; LH2310D: $10; LH-24250CD: $8.95; LH2311D: $8 (100 up); stock.

A series of dual op amps and dual voltage comparators are offered. These include the LH2101A/LH2301A high performance amps, LH2108/LH2308 precision amps, LH2110/LH2310 high-speed voltage followers, LH24250/LH24250C programmable op amps and the LH2111/LH2311 voltage comparators. These ICs embody all of the features and specifications of the popular single LM101A, LM108, LM110, LM4250 and LM111, respectively. The new circuits offer lower weight, reduced insertion cost, reduced space requirements and closer thermal tracking.

CIRCLE NO. 275

The Answer Fan.
Low-profile installation? It's a mere 3⅝" sq., 1½" deep.
High output vs back pressure? It packs a 46 cfm cooling wallop.
We call it, "The Mini Boxer."

MiniBoxer fights the damaging effects of heat in rack panels, tape decks, main frames and similar space-critical applications.

10 high performance models, ball or new Grand Prix sleeve bearing types, provide 10 or more years normal operating life. Also available in rugged Mil Spec versions.

Other airmovers? Of course!

Send for our full-line catalog No. ND4r. It's free, and contains performance data, electrical and mechanical specifications on more than 100 units.

And valuable application information too.

For immediate service, contact us at **IMC Magnetics Corp., New Hampshire Division,** Route 16B, Rochester, N.H. 03867, tel. 603-332-5300. Or the IMC stocking distributor in your area. There are more than 50 nationwide and overseas.

imc

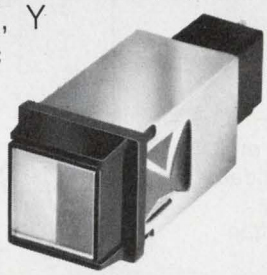
IMC New Hampshire Division Airmovers are available at the following locations:

Colo., Denver/Denver-Walker Electronics, 300 Bryant St. 80219/(303) 935-2406
Colo., Denver/Newark-Denver Elec., 2170 S. Grape St. 80222/(303) 757-3351
Conn., Norwalk/Harvey-Conn., 112 Main St. 06852/(203) 853-1515
Ga., Atlanta/Ack Radio Supply Co., 554 Deering Rd., N.W. 30309/(404) 351-6340
Mass., Boston/Demambro Electronics, 1095 Commonwealth Av. 02215/(617) 787-1200
Mass., Dedham/Gerber Electronics, 852 Providence Hwy. 02026/(617) 329-2400
Mo., St. Louis/Olive Industrial Elec., 6662 Olive Blvd. 63130/(314) 863-7800
N.C., Greensboro/Hammond Electronics, 838 Huffman St. 27405/(919) 275-6391
N.J., Haddonfield/Mid-Atlantic Electronics, 140 Haddon Ave. 08033/(609) 428-8286
N.Y., Binghamton/Stack Industrial Elec., 45 Washington St. 13901/(607) 723-6326
N.Y., Schenectady/Adirondack Electronics, 2469 Albany St. 12304/(518) 316-4717
Penn., Scranton/Consolidated Distributing, 115 Capouse Ave 18500/(717) 346-3831
Tex., Houston/Texas Inst. Supply, 3939 Ann Arbor Dr. 77042/(713) 785-4800
Utah, Salt Lake City/Standard Supply, 225 East 6th St. So. 84110/(801) 355-3971
W. Va., Beckley/Halley Electronics Co., 713 S. Oakwood Ave. 25801/304) 253-2151

Send for the complete IMC Distributor Directory.

INFORMATION RETRIEVAL NUMBER 61

Versatile lighted pushbuttons. Our Series 3 answers your need for a versatile medium-priced line of lighted pushbuttons. ☐ There's a choice of matrix, individual or strip mounting. Each with uniform panel appearance. ☐ As well as a choice of momentary or two-level alternate actions. ☐ There's even a choice of 5 amp power switches with Form X, Y and Z or electronic duty Form A reed switches. Matching indicators are available for both. ☐ Typical applications include transportation control systems, reproduction equipment, data processing and business machines, numeric control panels and communications gear. ☐ Call your MICRO SWITCH Branch Office or Authorized Distributor (Yellow Pages, "Switches, Electric"). Or write for our Series 3 product sheet.



MICRO SWITCH
FREEPORT, ILLINOIS 61032
A DIVISION OF HONEYWELL

INFORMATION RETRIEVAL NUMBER 62

Now we have two sides to our Pin Bar story.

Now you can pick up every pin with a single new Lear Siegler Pin Bar™. The new design utilizes both sides of the bar to pick up adjacent pins. Your installation time and production costs therefore are significantly reduced. Unlike most common connection methods, no soldering is required so making terminal connections has never been easier or less expensive.

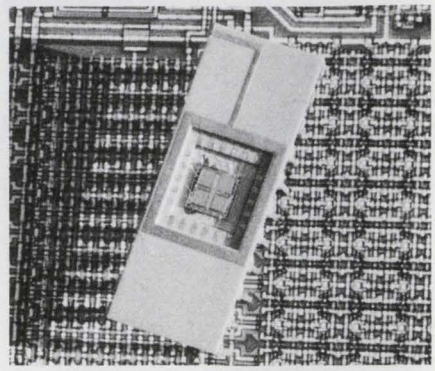
So if you'd like to simplify your bussing operation for as low as 2 or 3 cents per terminal, pin us down for details and a free sample.

LEAR SIEGLER, INC. / ELECTRONIC INSTRUMENTATION DIVISION
714 NORTH BROOKHURST ST.
ANAHEIM, CALIFORNIA 92803
PHONE (714) 774-1010

INFORMATION RETRIEVAL NUMBER 63

ICs & SEMICONDUCTORS

2048-bit dynamic RAM offers 300 ns access

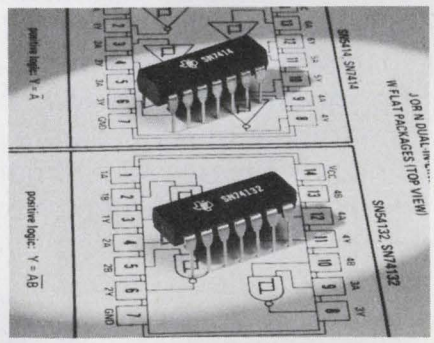


Signetics, 811 E. Arques Ave., Sunnyvale, Calif. 94086. (408) 739-7700.

A 2048 × 1 dynamic RAM, termed the 2548, uses enhancement-mode p-channel devices on a single chip to obtain a read access time of 300 ns (max) and cycle time of 615 ns (max). Power dissipation is only 80 μW/bit. The memory is fully decoded and contains built-in refresh amplifiers. All input data and control lines are directly TTL compatible.

CIRCLE NO. 276

Schmitt trigger ICs ease interface woes



Texas Instruments Inc., P.O. Box 5012, M/S 308, Dallas, Tex. 75222. (214) 238-3741. SN7414N: $4.19, 3 wks.; SN74132N: $3.02, stock.

A TTL hex and TTL quad Schmitt-trigger interface ICs offer a solution to unsuitable input waveforms and TTL inputs. The hex circuit, termed SN54/7414, and the quad IC, termed the SN54/74132, feature over 800 mV hysteresis typically and are guaranteed to provide a total of 800 mV additional noise margin. That's 300 mV for logic ZERO and 500 mV for logic ONE inputs.

CIRCLE NO. 277

Binary data converted to five-digit angle display

Computer Conversions Corp., 6 Dunton Court, E. Northport, N.Y. 11731. (516) 261-3300. $395 up; 4 wks.

The BAC 100 series of low-cost, 5-digit angle indicators operate on 16 bits of binary input data. The indicators have an accuracy of ±.01°. Their BCD readouts and digital displays can also be scaled to indicate other inputs such as range data, weight, pressure, temperature, etc. The units are available in a 9-1/2 × 1-3/4 × 12-in. case or on a 4.5 × 6.5-in. PC card.

CIRCLE NO. 278

Cassette runs 3 hours; claimed to be a first

TDK Electronics Corp., 23-73 48th St., Long Island City, N.Y. 11103. (212) 721-6881. $6.75 (unit qty).

A three-hour low-noise cassette, the TDK C-180LN claims a first in the audio cassette industry; it is 50% longer than any other. It uses an ultra-thin tape with a thickness of 0.025 mils. TDK says that it has solved thin-tape problems with its high-density magnetic coating, special tape backing material and binder system. TDK recommends using the cassette on its "jam-proof" cassette mechanism.

CIRCLE NO. 279

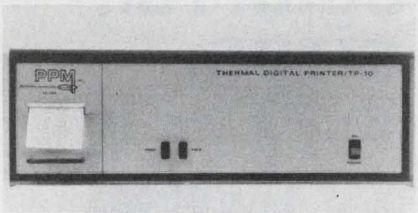
Bell offers 4800 b/s self-equalizing modem

American Telephone & Telegraph Co., 680 Fifth Ave., New York, N.Y. 10019. (212) 393-2101.

Data-Phone 4800 is the Bell System's new high-speed (4800 b/s) phase shift keyed data modem. The solid state unit features a 50-ms turnaround time. Automatic equalization corrects for delay or amplitude variations that may occur on the recommended four-wire, private-line, type-3002 telephone channel. A three-position test switch and status lamps on the front panel aid the analysis of the set's operation.

CIRCLE NO. 280

Quiet thermal printer stores input data



PPM, Inc., Subsidiary of Torq Engineered Products, Inc., 32 W. Monroe St., Bedford, Ohio 44146. (216) 232-1880.

Quiet in operation, the Model TP-10 prints on thermal paper using a thermal print head. The printer is available with 4, 8 or 12-column capacity. Print speed is 5 lines/sec continuous, or 10 lines/sec in bursts of 1000 lines. The TP-10 accepts parallel BCD codes for numeric characters at DTL/TTL levels. Data storage is provided, thus the data source need hold data for only the duration of the print command (5 μsec min), plus the previous print cycle, (100 msec).

CIRCLE NO. 281

design aids

Alumina package chart

A 24-in. by 33-in. wall chart features documented test data, suggested use data and specifications as well as a broad representation of alumina/glass package dimensional outline drawings. Packages covered in the chart range from 14 to 40-leads and offer all standard varieties of lead spacing, row centers, dielectric or F-15 alloy base materials. Thermal resistance case to ambient in °C/Watt is specified. Plessey Veritron, Inc.

CIRCLE NO. 300

Microwave transistors

Power vs frequency rating charts are available for molded and hermetic-sealed Power Tower microwave transistor packages. The charts (Bulletins 205 and 206) present, in graphic form, the power capabilities of National Beryllia Corp.'s Cermetrol Div. discrete device packages at various frequencies from 100 MHz to 3 GHz. With the inherent thermal conductivity characteristics of Berlox, the fundamental substrate of all Power Tower packages, higher power semiconductors can be electrically isolated and packaged in smaller sizes. National Beryllia Corp., Cermetrol Div.

CIRCLE NO. 301

ABS resins chart

A simplified, handy chart compares the cost—in cents per cubic inch regardless of price fluctuations—of Cycolac ABS resins and Cycoloy alloys with other engineering thermoplastics and metals. The revised chart—"Marbon Quick Reference File 9A"—gives an easily applied formula utilizing the specific gravity and pounds/cubic inch values of light and dense materials for computing and comparing the cents/cubic inch and cents/pound costs of Cycolac ABS resins and Cycoloy alloys versus those of 11 other plastics and five metals. Borg-Warner Corp., Marbon Div.

CIRCLE NO. 302

evaluation samples

Temperature templates

A modular approach to temperature monitor systems is highlighted in a template which features full-size photographs of Thermo's self-contained Mini Monitor and Six Point Indicator. It is designed so that the user may cut out the component pictures in order to prepare his own full-size panel layout. In contrast to scanning monitors, the modular approach of the Mini Monitor System provides continuous monitoring of each critical thermocouple point. Operation is simple. The user simply sets the high (or low) temperature limit of his process. When the setpoint is reached, an alarm lamp lights while rear connections can activate an audible alarm, shut down his process, and/or trigger peripheral equipment. Alarm sensitivity is to 1 F, with 1/4% repeatability and 1% setpoint accuracy. Thermo Electric.

CIRCLE NO. 303

Solder sleeves

A solder sleeve termination system for attaching coaxial cables to printed circuit cards is designed to prevent center conductor breakage while allowing closer spacing for more wires attached to the card. The Paddlecard Solder Sleeve contains a prefluxed solder preform and ground connecting device in a transparent, heat-shrinkable sleeve. Raychem, Devices Div.

CIRCLE NO. 304

Fuse clips

Fuse clip #798 features easy-mount legs and reduced costs. Two legs are the innovating feature of the new fuse clip design—they insert quickly into a printed circuit board for easy mounting. Since need for a separate fuse block is eliminated, the new fuse clip also effects a reduction in over-all user cost. Zierick Manufacturing Corp.

CIRCLE NO. 305

EVALUATION SAMPLES

Pushbutton switches

A multi-function pushbutton switch features immediate, continuous recognition of "in" and "out" positions without lamps or indicators. Non-illuminated DVR (dual visual recognition) switches visually present a black color band behind a color recognition cap to indicate the "out" position. When pushbutton is depressed ("in" position) black band disappears, leaving only the bright colored Recognition Cap showing, which readily signals that switch is set to "in" position. There is no possibility of a false identification caused by a malfunctioning lamp. Prices for the new components range from $1.50 (1-C) to $2.50 (4-C). Recognition Cap Kits (25 Caps per kit) are $2.50. Switchcraft Inc.

CIRCLE NO. 338

Molded plastic plugs

A line of molded plastic slides, buttons, plugs and bumpers provides hundreds of configurations and sizes. These molded plastic components need no lubrication and work in absorbing shock, in sealing, in reducing vibration and noise, and in providing a low friction bearing surface. All are electrical insulating, low in heat conduction, have good mechanical properties, and easy to install. Materials to choose from include nylon, polyethylene and cellulose acetate butyrate. Product Components Corp.

CIRCLE NO. 339

Cable ties

WRAP-IT cable ties are available in standard designs to meet military specifications and in screw mounted designs. Standard ties are offered in nine lengths from 3-3/4 to 21-1/4 in. for tying bundles from 1/16 to 6 inch in diameter. Screw-mounted ties come in six lengths from 5-13/16 to 15-5/8 in. for tying bundles with diameters from 1/16 to 4 in. A free LOCK N' SNIP tension-fastening gun accompanies initial orders for 25,000 ties. Richlok Corp.

CIRCLE NO. 340

PC card guides

Electro-Flex nylon guides for 1/16-inch PC boards have an exclusive bow feature which exerts tension, top and bottom, for improved card retention. A unique slot mounting pattern permits sufficient movement of the bowed guide to compensate for tolerance variations from card to card and thus control rack "spreading." Molded of UL-approved, Type 6/6 nylon, the guides come in 3, 4, 6 and 8-1/2-inch lengths. Electro-Space Fabricators, Inc.

CIRCLE NO. 306

DIP sockets

Dual-in-line sockets feature positive closed-entry insulators which prevent damage to socket contacts during IC insertion. Specifications of the 14 and 16-pin sockets include insulation resistance of 10^6 MΩ, breakdown voltage between adjacent contacts of 1150 V, contact resistance average—initial 8.3 MΩ and after 100 insertions 10 MΩ (with electrotin contact finish). JOLO Industries.

CIRCLE NO. 307

Syntactic-foam epoxy

A syntactic-foam epoxy system is designed for honeycomb edge-fill, radome repair, and other electronic and aerospace applications requiring low density and high strength. Tra-Bond 2125 is a completely unicellular material composed of micron-sized glass spheres in a high-performance epoxy binder. It cures at room temperature, has a dielectric strength of 375 V/mil and a compressive strength of 13,000 psi. Tra-Con, Inc.

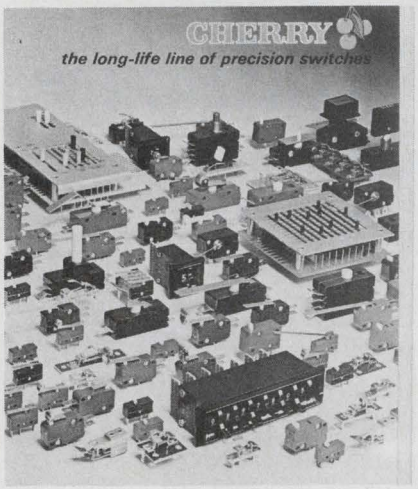
CIRCLE NO. 308

Plastic toggles

The Tinnerman wallboard toggle offers all-plastic, one-piece design providing positive retention in a front-mounting, re-usable assembly. The Tinnerman toggle can be used on standard wallboard thicknesses, from 3/8 in. to 1/2 in. No special tools are needed for assembly. The toggle is simply folded and inserted into a 5/16-in. panel hole. Eaton Corp., Engineered Fasteners Div.

CIRCLE NO. 309

new literature



Switches

Engineering drawings, specifications terms and operating characteristics are part of a catalog of switches. Over 200 standard types of snap-action switches, matrix selector switches, thumbwheel switches and keyboard switches plus everything you need to know in order to specify or order them are contained in this literature. Cherry Electrical Products Corp., Waukegan, Ill.

CIRCLE NO. 320

'72 Wescon papers

The 1972 Wescon technical session preprint can be ordered at nominal cost—most for about $2.00 per session (average: four papers for each of the 28 sessions) plus $1 mailing charge per complete order. The offer is good until December 1, 1972. For order form,

CIRCLE NO. 321

Microwave tubes

Characteristics of 136 microwave tubes and devices are presented in a catalog. New developments of traveling wave tubes, magnetrons, circulators, isolators, filters and mixers are listed together with a comprehensive equivalents list and a translation of terms into French, German, Italian and Spanish. The M-O Valve Co. Ltd. London, England.

CIRCLE NO. 322

Industrial controls

A 154-page Catalog No. 0200 contains description, application information and specifications for over 70 varied industrial event control products. Precision analog indicating and control tachometers, digital process monitors, speed-sensing transducers (magnetic pickups), instrumentation amplifiers, switches, relays, transmitters, dc transducers, meters, converters, SCR power controllers and temperature controls and alarms are included. Airpax Electronics/ Controls Div., Fort Lauderdale, Fla.

CIRCLE NO. 323

Fast-switching thyristors

Full-frequency rating information for six different designs of the fast switching di/namic gate family of silicon-controlled rectifiers used in high-frequency applications and in inverter and dc chopper equipment is presented in a 130-page booklet. The booklet explains the difference between conventional thyristors and the dinamic gate device, whose lower switching losses and higher allowable peak currents make possible higher frequency ratings. It also explains the concurrent testing method used to verify high-frequency thyristor ratings. A special section tells how to use the high-frequency rating data matrices supplied for the six different device designs. Westinghouse Electric Corp., Semiconductor Div., Youngwood, Pa.

CIRCLE NO. 324

Modems

A brochure describes a complete line of low-speed, Bell-compatible data modems. Designated the 4080 series, the modems are available in a variety of configurations, featuring TTY, EIA or TLT interfacing; loop-back testing and visual diagnostics; and dedicated or dial-line operation. Pulsecom, Falls Church, Va.

CIRCLE NO. 325

Limit switches

A super-sensitive limit switch for rotary and oscillating applications is the subject of a two-page data sheet. The fully illustrated data sheet furnishes complete product information on the Series EA150, a limit switch sensitive to torques as low as 1.5 oz. in. Namco Controls, Cleveland, Ohio.

CIRCLE NO. 326

Trimmer, counter catalog

A 160-page T-100 line catalog covers all the in-production time, count, program and step controls and accessories. The catalog includes a selection guide, a glossary of timer and counter terms used in the catalog and an index for quickly locating all models by number. Automatic Timing & Controls, Inc., King of Prussia, Pa.

CIRCLE NO. 327

Components

A 20-page condensed catalog details a complete line of components. Product categories covered are: ceramic capacitors, potentiometers and trimmer resistors, push-button and rotary switches, technical ceramics, thick-film circuits, EMI/ RFI filters, semiconductor devices and optoelectronic products. Globe-Union, Inc., Centralab Electronics Div., Milwaukee, Wis.

CIRCLE NO. 328

Resistors

A two-color, eight page catalog pictures and describes capabilities of 56 types of cermet, carbon and wirewound trimmers, potentiometers, cermet DIP resistor networks and Series 212 rotary selector switches. Distributor quantity prices are also included. CTS Corp., Elkhart, Ind.

CIRCLE NO. 329

Infrared data links

The economic and performance benefits of using infrared data links for direct transmission of data over short distances, without wires, are discussed in a four-page brochure. Computer Transmission Corp., Los Angeles, Calif.

CIRCLE NO. 330

Rotary switches

In addition to engineering specifications on eighteen series of rotary switches, this 28-page handbook includes inch/decimal/millimeter conversion charts, technical information on the patented design "Spider," engineering details, plus complete information on nine series of commercial switches. Technical information is also included for switches with PC terminals and switches preset for "divide by 'N' counter." A section of the handbook is devoted to homing switches, specifically developed for portable communications equipment. RCL Electronics, Inc., Irvington, N.J.

CIRCLE NO. 331

Miniature lamps

A broad line of miniature lamps is described in a brochure. The brochure provides dimensions and operating characteristics of lamps used in telephones, computers, control panels, automobiles, aircraft and radio panels. It also contains information on housing, lenses and strip and standard sockets for slide base pilot lamps. GTE Sylvania, Inc., Seneca, N.Y.

CIRCLE NO. 332

Cradle relays

A complete line of general-purpose cradle relays is described in a four-page bulletin. The brochure offers complete specifications for both plug-in and PC board types. Information includes coil and contact data, wiring diagrams, socket information and physical dimension drawings. Siemens Corp., Iselin, N.J.

CIRCLE NO. 333

Resistor packages

Two dual-in-line resistor networks in standard 14 and 16-pin DIP packages are featured in a brochure. This four-page catalog sheet provides specifications, outline drawings, and applications data on the company's full line of dual-in-line resistor networks. Beckman Instruments, Inc., Helipot Div., Fullerton, Calif.

CIRCLE NO. 334

Microprogramming handbook

The revised Microprogramming Handbook contains descriptions of the latest peripheral systems and communications interfaces offered by the company as well as an update of the Micro 1600 reference manual. The first section is a primer with the glossary of data processing terms. It is followed by application examples of microprogrammed computers, a Micro 800 user's manual with dozens of microprogrammed subroutines, the Micro 1600 reference manual, a firmware manual showing the architecture of a general-purpose computer implemented by microprogramming and a section of tutorial text on system design procedures. The final section is the expanded version of the product catalog. Microdata Corp., Santa Ana, Calif.

CIRCLE NO. 335

Crystals

Single crystals, including a complete line of metal crystals, are presented in a crystals catalog. Ultrahigh purity crystals, grown from 73 types of metals, alloys and nonmetallic materials are listed. And, for each crystal, the catalog provides method of growth, typical purity, available diameters and current prices. Materials Research Corp., Orangeburg, N.Y.

CIRCLE NO. 336

Filters

Bandpass, band-reject, high-pass and low-pass filters are described in a specification sheet. T T Electronics, Los Angeles, Calif.

CIRCLE NO. 337

bulletin board

IBM will provide **normal CPU maintenance** on **Fabri-Tek, Inc. core memory expansions** of 360/30 to 96 and 128 k-bytes. Fabri-Tek will offer these 360/30 add-on systems under a separate MOD 30 "c" model number to distinguish them from previous models which were acceptable to IBM under the "best efforts" maintenance. To date, this latest expanded memory for the Model 30 is the only independent Model 30 memory to earn the "normal maintenance" acceptance by IBM.

CIRCLE NO. 343

ITT Semiconductors has added **seven original circuits** to its 54/7400 **series.** The seven circuits constitute the first group of ITT original TTL circuits to be offered in the market. They include a universal pulse generator, quad two-input AND and OR power drivers, and quad/hex NAND Schmitt triggers.

CIRCLE NO. 344

Price reductions

Monsanto Commercial Products Co. has reduced prices of a number of its discrete **light emitting diode products** up to 34%. The products affected by changes include the MV54, MV5010 series, MV5030 series, and MV5080 series LEDs. All are red GaAsP diodes which have been commercially available from Monsanto for some time.

CIRCLE NO. 345

Interdata, Inc., has announced a new schedule of **peripheral pricing** that will reduce the cost of a typical 24 k-byte minicomputer system by about 10%. The pricing schedule offers a 24KB Series Model 70 system for $39,150, as compared with the old price of $43,400. The system includes 24 k-byte of core memory.

CIRCLE NO. 346

vendors report

Annual and interim reports can provide much more than financial-position information. They often include the first public disclosure of new products, new techniques and new directions of our vendors and customers. Further, they often contain superb analyses of segments of industry that a company serves.

Selected companies with recent reports are listed here with their main electronic products or services. For a copy, circle the indicated number.

Microwave Semiconductor Corp. Transistors, IC amplifiers and diodes.

CIRCLE NO. 347

Computer Products. Power modules, a/d interface units and software.

CIRCLE NO. 348

General Instrument Corp. Cable TV, entertainment-electronics, components, data-processing systems, semiconductors, aerospace, electromechanical products and electro-optics.

CIRCLE NO. 349

Computer Equipment Corp. Computer terminals, marine electronics and communications.

CIRCLE NO. 350

Digital Computer Controls Inc. Computers, minicomputers and data systems.

CIRCLE NO. 351

Alpha Industries, Inc. Microwave components and equipment.

CIRCLE NO. 352

Ametek, Inc. Pressure and temperature-measuring instruments, recorders, process controllers.

CIRCLE NO. 353

ITT. Avionics, communications, semiconductors, microwave devices, optoelectronics, consumer products, data equipment, medical electronics, aerospace, office and business equipment.

CIRCLE NO. 354

Eldorado Electrodata Corp. Test equipment, calculators, computers.

CIRCLE NO. 355

Electronic Design

ELECTRONIC DESIGN's function is:

- To aid progress in the electronics manufacturing industry by promoting good design.
- To give the electronic design engineer concepts and ideas that make his job easier and more productive.
- To provide a central source of timely electronics information.
- To promote communication among members of the electronics engineering community.

Want a subscription? ELECTRONIC DESIGN is sent free to qualified engineers and engineering managers doing design work, supervising design or setting standards in the United States and Western Europe. For a free subscription, use the application form bound in the magazine. If none is included, write to us direct for an application form.

If you do not qualify, you may take out a paid subscription for $25 a year in the U.S.A., $35 a year elsewhere. Single copies are $1.50 each.

If you change your address, send us an old mailing label and your new address; there is generally a postcard for this bound in the magazine. You will have to requalify to continue receiving ELECTRONIC DESIGN free.

The accuracy policy of ELECTRONIC DESIGN is:

- To make diligent efforts to ensure the accuracy of editorial matter.
- To publish prompt corrections whenever inaccuracies are brought to our attention. Corrections appear in "Across the Desk."
- To encourage our readers as responsible members of our business community to report to us misleading or fraudulent advertising.
- To refuse any advertisement deemed to be misleading or fraudulent.

Microfilm copies are available of complete volumes of ELECTRONIC DESIGN at $19.00 per volume, beginning with Volume 9, 1961. Work is now in process to complete the microfilm edition of Volumes 1-8. Reprints of individual articles may be obtained for $2.00 each, prepaid ($.50 for each additional copy of the same article) no matter how long the article. For further details and to place orders, contact the Customer Services Department, University Microfilms, 300 North Zeeb Road, Ann Arbor, Michigan 48106 telephone (313) 761-4700.

Want to contact us? If you have any comments or wish to submit a manuscript or article outline, address your correspondence to:

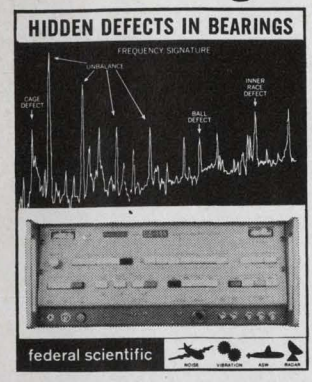
Editor
ELECTRONIC DESIGN
50 Essex Street
Rochelle Park, N.J. 07662

Design Data from

Manufacturers

Advertisements of booklets, brochures, catalogs and data sheets. To order use Reader-Service Card.
(Advertisement)

Instant Diagnosis Of Ailing Bearings



Mechanical occurrences in a bearing create concomitant frequency signatures. Free new 4-page "Application Note 3" shows how real-time frequency analysis can isolate the tell-tale frequencies of such specific defects as: cage and ball defects, unbalance, and inner/outer race defects. The readouts shown of typical defective jet engine bearings were obtained by an **on-line** Ubiquitous® Real-Time Frequency Analyzer and an oscilloscope. The Analyzer has no critical adjustments, is easily operated by non-technical personnel. For production, a Minicomputer/Analyzer System can automatically classify a bearing by comparison of its frequency signature to a known reference.

CIRCLE NO. 174

Federal Scientific Corporation
615 West 131 Street, New York, N.Y.10027

Now 5VDC Microcircuitry Supplies, 12 Amp to 100 Amp

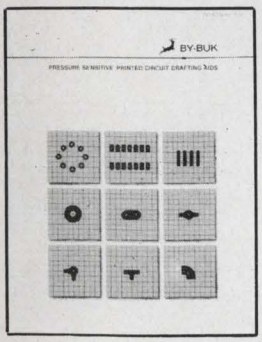
60 Watt to 500 Watt
Switching Regulator Power Supplies

Now you can squeeze your power supply down to fit your microcircuitry with our complete line of standard 60 watt to 500 watt supplies.
New "third generation" Series 650A features 1/2 the volume, 1/4 the weight, 1/4 the heat of most contemporary 5VDC supplies. Model 650A05 delivers 5V/12A in free air convection range of $-20°C$ to $+40°C$, 5V/10A at $+50°C$, 5V/8A at $+71°C$, typical efficiency 55%. Combined line & load regulation is 0.2%, changes only 0.005%/°C, output noise only $\leq$50MV P-P (total), fits in 94-cubic inches at 3.25 lbs — at $200 each, delivers 18.5W/lb, 0.64W/in.^{3}, at $3.33 per watt.

CIRCLE NO. 175

Trio Laboratories, Inc.
80 Dupont Street
Plainview, L.I., N.Y. 11803

PC Drafting Aids Catalog



Thousands of time saving, cost saving artwork ideas are found in the By-Buk P-50 catalog of pressure sensitive printed circuit drafting aids. With the most practical artwork patterns for: TO cans, multi-pads, dual-inlines and flat packs featured. Donuts, connector strips, teardrops, ovals, tapes, tees, elbows, etc., by the hundreds are included in the most comprehensive list of sizes. Opaque black, transparent red and transparent blue materials for one and two-sided board designs. For a free copy and samples, write today.

CIRCLE NO. 176

By-Buk Company
Subsidiary of Webtek Corp., 4326 W. Pico Blvd.
Los Angeles, California 90019 (213) 937-3511

Electronic Design

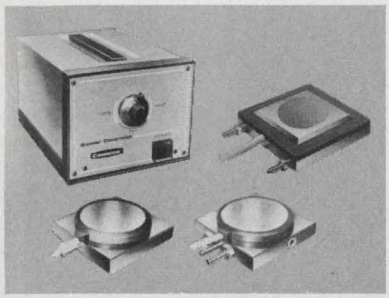
Advertising Sales Staff
Bryce Gray
Sales Manager
Rochelle Park, N.J. 07662
Robert W. Gascoigne
Daniel J. Rowland
50 Essex Street
(201) 843-0550
TWX: 710-990-5071
Philadelphia
Thomas P. Barth
50 Essex Street
Rochelle Park, N. J. 07662
(201) 843-0550
Boston 02116
Richard L. Green
20 Columbus Avenue
Boston, Mass.
(617) 482-7989
Chicago 60611
Thomas P. Kavooras
Berry Conner, Jr.
200 East Ontario
(312) 337-0588
Cleveland
Thomas P. Kavooras
(Chicago)
(312) 337-0588
(call collect)
Los Angeles 90303
Stanley I. Ehrenclou
Burt Underwood
2930 Imperial Highway
Inglewood, Calif
(213) 757-0183
San Francisco 94022
Jerry D. Latta
P.O. Box 1248
Los Altos, Calif.
(415) 965-2636
London W. 1
For United Kingdom and Holland
Brayton C. Nichols
For Eastern Europe
Peter Kehr
The American Magazine Group
27 Maddox Street
London, W. 1, England
Phone: 499-0180
Cable: Ammagnic, London
Verviers, Belgium
For Continental Europe
Andre Jamar
1, Ru Mallar, 1
087) 253.83 Telex 41563
Tokyo
Haruki Hirayama
Electronic Media Service
5th Floor, Lila Bldg.,
4-9-8 Roppongi
Minato-ku
Phone: 402-4556
Cable:Electronicmedia, Tokyo

AMERICAN BUSINESS PRESS, INC.

advertiser's index

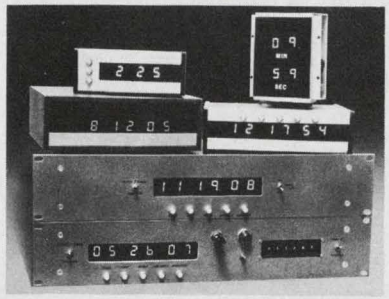
quick ads

New and current products for the electronic designer presented by their manufacturers.



Wafer probes/controllers. Accurate measurement of electrical parameters of ICs thru 811-2000-01 bipolar controller with automatic temperature regulation. Gold plated vacuum chuck, 0 to +50°C range. 0.1°C accuracy. Other stages available. CAMBION. 445 Concord, Cambridge, Mass. (617)-491-5400).

INFORMATION RETRIEVAL NUMBER 181

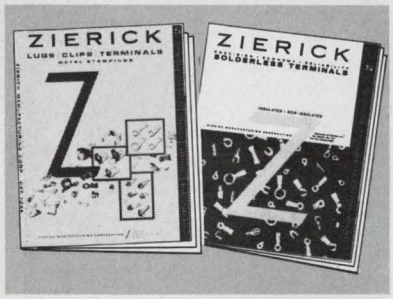


Digital clocks, timers and counters. Solid state, custom design or: ES 112/24-12-24 hr. clock $100. ES 300-100 min. up down timer $125. ES 400-10 min. timer $68.50. ES 500-12 hr. clock timer $110. ES 510-60 min. timer $95. ES Enterprises El Segundo, Ca. 90245. 213-772-6176.

INFORMATION RETRIEVAL NUMBER 182

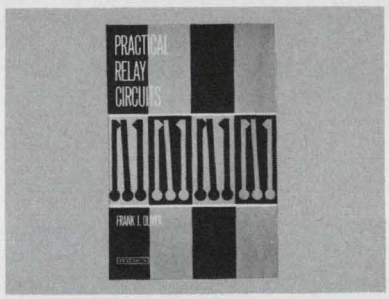
Thin-Trim® variable capacitors are designed to replace fixed tuning techniques. Applications include crystal oscillators, CATV amplfiers, communication and test equipment. Series 9410 has high Q's with five capacitance ranges from 1.0 - 4.5 pf to 10.0 - 50.0 pf. Johanson Manufacturing Corporation, Boonton, N. J. (201) 223-2676

INFORMATION RETRIEVAL NUMBER 183



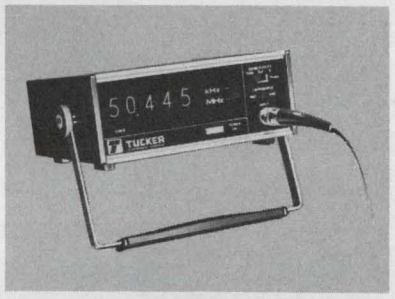
Thousands of Standard Terminals: the greatest selection of types, configurations, sizes — precision made by Zierick! Send for Catalog 25 . . . sixty pages of lugs, clips, brackets, clamps. Solderless Terminals Catalog details insulated and non-insulated units. Zierick Manufacturing Corp., 24 Radio Circle, Mt. Kisco, N.Y. 10549; (914) MO 6-2911.

INFORMATION RETRIEVAL NUMBER 184



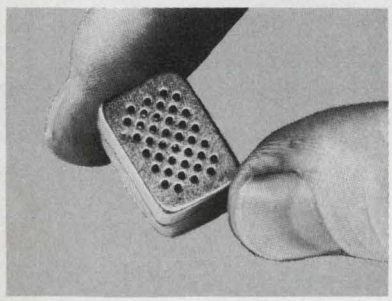
Practical Relay Circuits, by Frank J. Oliver. Time-saving guide classifies relays by function, presenting a rapid overview of the circuits that can solve the problem at hand. 384 pp., illus., cloth, $14.95. Circle below for 15-day examination copies. Hayden Book Co., New York, N.Y. 10011.

INFORMATION RETRIEVAL NUMBER 185



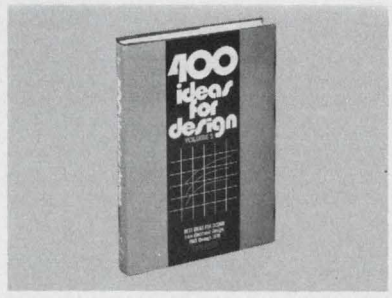
Low-cost 60MHz Frequency Counter. With five digits (overflow to 8 digits) the Tucker 60 is a 1 KHz to 60 MHz Counter with resolution to 1 Hz. Aging Rate is 1 part in 10^{-6}/week. $299.00 from stock. Tucker Electronics Company, P. O. Box 1050, Garland, Texas. (214) 348-8800.

INFORMATION RETRIEVAL NUMBER 186



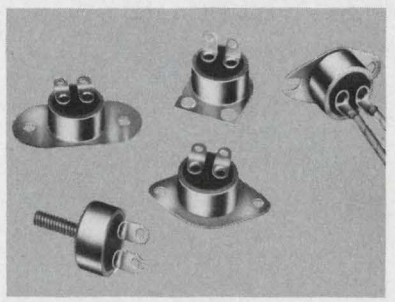
Micro-buzzer needs only 15 milliwatts of power, produces 70 decibels of sound from 1.5 volts d.c. Less than 2-1/2 ounces, it measures 5/8″ X 7/8″ X 1/2″. Samples $1.30 check or money order. OEM discounts, 30-day delivery on large quantities. Citizen America Corporation, 9201 Olympic Boulevard, Beverly Hills, California 90212.

INFORMATION RETRIEVAL NUMBER 187



400 Ideas for Design, Vol. 2, Edited by Frank Egan. Ready to borrow, modify, or adapt, the top recent contributions to Electronic Design's popular "Ideas for Design" column range from amplifiers to switching circuits. 288 pp., illus., cloth, $11.95. Circle below for 15-day examination copies. Hayden Book Co., New York, N.Y. 10011.

INFORMATION RETRIEVAL NUMBER 188



Prototypes of precision snap-action thermostats from Elmwood, widely specified for quick, reliable response; proven industrial and military performance record. Environ. expos. −85° to 550°F; narrow or wide diff.; rated to 15 amps. Wide choice of brackets, terminals. Elmwood Sensors, Inc. (401) 781-6500. TWX 710-381-6413.

INFORMATION RETRIEVAL NUMBER 189

product index

Information Retrieval Service. New Products, Evaluation Samples (ES), Design Aids (DA), Application Notes (AN), and New Literature (NL) in this issue are listed here with page and Information Retrieval numbers. Reader requests will be promptly processed by computer and mailed to the manufacturer within three days.

new literature

design aids

evaluation samples

KONEKTCON® MAKES THIS EASY! It's the Molex system that solves the most complex board-to-board, board-to-component, chassis-to-board interconnection problems. It's economical. Reliable. Quick. Versatile. Uses only four basic connectors. Unique rigid square wire male terminals permit stacking of multiple board connections to the same circuits. Molex vibration assembly method stakes up to 300 terminals per minute for wave soldering. Preassembled round male terminal wafers also available for 2 to 18 circuits. Three female terminal assemblies provide incomparable flexibility: cable-to-board; board-to-board, parallel; board-to-board, perpendicular; and board-to-chassis. Plus a variety of options, including a 3-circuit power transistor. For technical specs call (312) 969-4550. Or write: Molex Incorporated, Lisle, Illinois 60532.

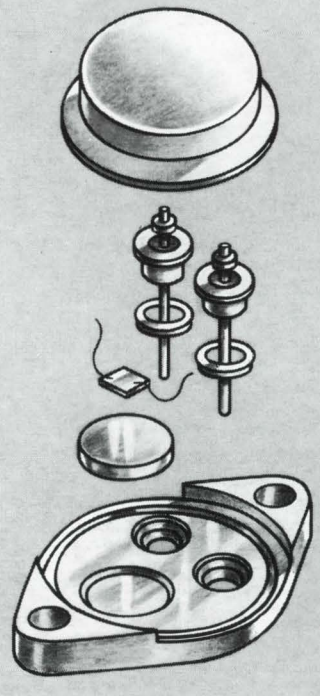
...creating components that simplify circuitry

molex

INFORMATION RETRIEVAL NUMBER 233

If your aluminum packages leak, you didn't buy RCA hermeticity—in steel.

Aluminum Package—TO-3, soldered, preformed eyelets
Thermal Cycling Test Conditions—16 W, $\triangle T$ case = 90°C (40°C to 130°C)
Typical Performance (cycles to failure)—3 K
Typical Requirements (cycles)—25K



Steel package—TO-3, glass-to-stem, compression seal
Thermal Cycling Test Conditions—16 W, $\triangle T$ case = 90°C (40°C to 130°C)
Typical Performance (cycles)—50 K (Test terminated; no failures.)
Typical Requirements (cycles)—25K

The case for RCA in popular TO-3 transistors is steel...rated from −65°C to +200°C.

The aluminum package can have an inherent weakness in the solder bond between the eyelets and the aluminum header. Under temperature cycling, fractures develop at this interface, destroying the device's hermeticity.

The RCA steel package, with its glass-to-stem high compression seal, welded cap, and controlled solder process, offers you at least an order of magnitude improvement over aluminum in terms of hermeticity, reliability, and long-term, trouble-free performance.

Ask for RCA's Reliability Report ST6071, or conduct your own tests. Write: RCA Solid State, Section 57I-28 UTL31, P. O. Box 3200, Somerville, N.J. 08876. International: RCA, Sunbury-on-Thames, U. K., or Fuji Building, 7-4 Kasumigaseki, 3-Chome, Chiyoda-Ku, Tokyo, Japan. In Canada: RCA Limited, Ste. Anne de Bellevue 810, Quebec.

RCA Solid State
products that make products pay off

INFORMATION RETRIEVAL NUMBER 234