Pot and trimmer specs: Don't let them point you the wrong way. The wide variety of potentiometer and trimmer types can make you go in circles. Are you sure you know what vendors mean when they specify tempco, linearity or noise? And don't forget specs like rotational life and backlash. For some bearings, see p. 52.
Don’t cheat yourself on trimmer performance.

Compare element size and see why Dale gives you better value!

Low profile doesn’t have to mean low performance. The larger cermet element in Dale Low Profile trimmers gives you extra value for your money. Extra assurance of trouble-free performance. You get: More Power 1 watt at 70°C lets you derate for assured long-term stability. Better Adjustability – ±0.10% output resistance, ±0.05% output voltage ratio. Low Noise 1% Contact Resistance Variation standard. Low T.C. ±100 PPM standard.

Immediate delivery from stock...

Cermet Models (781, 783, 784)
Wirewound Models (721, 723, 724)

Phone 402-564-3131 today for complete details.
At 20mA our new High-Efficiency red display is 5 times brighter than our standard red displays. Just 3mA per segment gives you all the brightness you need and makes it ideal for battery powered applications. These large 0.43" displays are offered in High Efficiency Red, Yellow, or Green and are readable up to 20 feet. The 5082-7650 (High Efficiency Red), -7660 (Yellow), -7670 (Green) are available in standard DIP packages with left-hand d.p. and common anode configuration. Just $3.95* each in quantities of 100.

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A big hit: Teledyne TO-5 relays.

Improve shallow depth operation. Counter target decoys. Enhance rejection of false echoes. Tough goals for any torpedo acoustic guidance/control system. But Northrop did it — turning misses into hits — with a little help from Teledyne TO-5 relays. Whenever military, commercial or industrial switching jobs call for high packaging density, low power consumption and low heat dissipation — coupled with high reliability — we answer the need with our TO-5 relays. They're less than half the size and weight of 1/2 crystal can relays, and use up to 75% less coil power. What's more, our TO-5's are all-welded, hermetically sealed, and fully qualified to MIL-R 39016B, "L" and "M" levels. And you have your pick from a wide selection of TO-5 relays — including ultra-sensitive types, maglatches, internal suppression diodes and drive transistors, and many contact arrangements.

In short, there's a Teledyne TO-5 relay ready to meet your requirements. For full data or applications help, contact your local Teledyne Relays people. We're sure to make a big hit with you, too.

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INFORMATION RETRIEVAL NUMBER 3
NEWS
19 News Scope
24 Semiconductor companies are speeding up the drive to develop new circuits for future logic designs.
28 Improved analog integrated circuits are now matching discrete modular components in performance.
36 16-k random-access memory and reprogrammable read-only memory races are beginning to heat up.
43 Washington Report

TECHNOLOGY
52 FOCUS on pots and trimmers. Zero in on the problems you're likely to face when specifying potentiometers and trimmers. To avoid mistakes during selection, check your application and the data sheets carefully.
62 Bypass and feedthrough filters: You needn't experiment with their design. A simple graphic technique provides accurately predictable filter performance.
70 Consider using resolvers and synchros when you design mechanical positioning and sensing systems. They offer advantages, even in digital applications.
76 Ideas for Design:
Two components added to CMOS flip-flop convert it to one-shot or level detector.
Impedance matching made easy: a three-step uncomplicated method.
Power op amps drive dc motor from single-ended power supply.
Low-cost temperature controller built with timer circuit.
Jimmy R. Young of Motorola Semiconductor wins annual 'Idea for Design' award.
86 International Technology

PRODUCTS
104 Modules & Subassemblies: Multichannel data-acquisition systems cut costs but not versatility.
91 Instrumentation
94 Integrated Circuits
100 Packaging & Materials
110 Data Processing
115 Power Sources
118 Microwaves & Lasers
123 Components
127 Discrete Semiconductors

DEPARTMENTS
49 Editorial: The man who was never wrong.
7 Across the Desk
130 Evaluation Samples
130 Application Notes
132 New Literature
Cover: Photo by Art Director, Bill Kelly. Props courtesy of Allen-Bradley, Amphenol, Beckman, Helipot Div., Bourns, CTS, Centralab, Clarostat, Duncan (Systrom-Donner), Mineleo, Ohmite, Piher, Stackpole, TRW-IRC, Weston.
“Scientific” pocket calculators abound these days, at prices that are superficially attractive. But one stands apart, and ahead: our uncompromising HP-21.

The HP-21 is the first of our second generation of scientific pocket calculators. We started it all back in 1972, when we introduced the world’s first scientific pocket calculator, and we’ve shown the way ever since.

The HP-21 offers you technology you probably won’t find on comparable calculators for some time to come, if ever. It performs all arithmetic, log and trig calculations, including rectangular/polar conversions and common antilog evaluations. Its display is fully formatted, so you can choose between fixed decimal and scientific notation. Try to find all these features on competitive machines.

The HP-21 just plain gives you more capability than other scientific calculators, at or below its price. It offers an exceptional price: performance ratio.

Also exceptional: its RPN logic system, an HP hallmark. Here’s what Harvard professor John Ball wrote about RPN in Electronic Design (1/18/75): “In an objective evaluation, based on algorithms for all the basic arithmetic operations with four variables, RPN gets the best score.”

He continues: “Though RPN uses fewer keystrokes on the average, which system is easier to use is a subjective decision. For the author, again RPN won. He made fewer mistakes and selected it for his personal use.”

Fewer keystrokes. Easier to use. Fewer mistakes. That’s what RPN is all about, and that’s why you should never buy a scientific pocket calculator that lacks it.

As uncompromising as the HP-21’s design is its assembly. From double injection molded, positive action (Click-when-you-press-them) keys to rugged plastic case, every detail reflects a concern for quality. We know how people treat pocket calculators.

Before you invest in a lesser machine, by all means test the HP-21. You’ll see why we call it the uncompromising one. The uncompromising HP-21, $125.00* worth of scientific calculator for $125.00*. Call 800-538-7922 (in Calif. 800-662-9862) for a dealer near you.
Reduce Your Power Supply Size and Weight By 70%

A new way has been found to substantially reduce power supply size and weight. Consider the large power supply shown at left in the above photo - it uses an input transformer, into a bridge rectifier, to convert 60 Hz to 5 volts DC at 5 amperes. This unit measures 6⅛"x4"x7½" and weighs 13 pounds. Abbott's new model Z5T10, shown at right, provides the same performance with 70% less weight and volume. It measures only 2⅝"x4"x6" and weighs just 3 pounds.

This size reduction in the Model Z5T10 is primarily accomplished by eliminating the large input transformer and instead using high voltage, high efficiency, DC to DC conversion circuits. Abbott engineers have been able to control the output ripple to less than 0.02% RMS or 50 millivolts peak-to-peak maximum. This design approach also allows the unit to operate from 100 to 132 Volts RMS and 47 to 440 Hertz. Close regulation of 0.1% and a typical temperature coefficient of 0.01% per degree Celsius are some of its many outstanding features. This new Model "Z" series is available in output voltages of 2.7 to 31 VDC in 12 days from receipt of order.

Abbott also manufactures 3,000 other models of power supplies with output voltages from 5 to 740 VDC and with output currents from 2 milliamps to 20 amps. They are all listed with prices in the new Abbott catalog with various inputs:

- 60 V to 120 V to DC
- 400 V to 120 V to DC
- 28 VDC to 120 VDC
- 28 VDC to 400 VDC
- 12-28 VDC to 60 VDC

Please see pages 307-317 Volume 1 of your 1974-75 EEM (ELECTRONIC ENGINEERS MASTER Catalog) or pages 853-860 Volume 3 of your 1974-75 GOLD BOOK for complete information on Abbott Modules.

Send for our new 60 page FREE catalog.
User offers tips on scope cameras

"Focus on Scopes and Scope Cameras" (ED 8, April 12, 1975, p. 48) was well done. Your readers should be made aware of three additional facts about scope cameras that use Polaroid film:

1. The hand-held scope camera—for example, Polaroid CR-9—is usually a very satisfactory low-cost camera, but it has a major shortcoming that does not become apparent until after the purchase: It isn't easy to use for multiple-exposure photographs. Such photographs superimpose waveforms from two or more different test conditions on the same photograph for easy comparison of results—such as with and without some circuit feature, or with setting A and setting B of some system variable. When the hand-held camera is held against the scope face for the second exposure, it can't be positioned exactly as it was the first time. Result: two sets of graticule lines that are not quite superimposed. If the graticule is exposed only on the last photo, there may be only one graticule, but the multiple traces aren't all aligned the same with respect to the graticule. The more expensive bolt-on cameras don't have that problem.

2. The article stated that a disadvantage of Polaroid film is that it is difficult to write on the prints. It's very easy to write on the black background with the heated fine tip of a small soldering iron, either before the liquid coating material has been applied or after it has been applied and has hardened. The result is illegible, white writing on the black background. Alternatively, a sharp-pointed tool, such as a metal scribe, can easily scratch white writing on the black background before the print is coated. Or thirdly, a ballpoint pen can be used to write in the white border before or after the print is coated on the back, but the coating liquid shouldn't be applied on top of the writing because it smears the ballpoint ink.

3. The article said that Polaroid prints don't reproduce well on office copiers. Polaroid film type 55PN (ASA 50) and type 105PN (ASA 75) yield transparent negatives that reproduce well on office copiers. The penalty paid for the reproducibility of these films is their low film speeds relative to the 3000 speed of type 107, but that's quite acceptable for most scope photography work. Polaroid's print copy service (coupon packed with film) has always given me excellent copies within one day of the expected two-way mail delivery time. The cost is 15 cents each for 2-1/2 × 3-1/4 copies and 20 cents for 3-1/4 × 4-1/4 copies, plus a 75-cent handling charge.

Nathan O. Sokal
President
Design Automation, Inc.
809 Massachusetts Ave.
Lexington, MA 02173.

A simpler way noted to tape-record EEGs

The EEG (electroencephalograph) unit described in the June 7 issue represents a significant advance in low-power, high-density digital storage of analog data ("EEG Unit Worn by Patient Records Data for 12 Hours at 7000 BPI," ED No. 12, p. 30). As pointed out in that article, a few features of the Opticrype unit were not fully explained. For instance, the fact that Polaroid film is used and that prints can be obtained directly only through the Opticrype unit, and that the unit itself is a "suitcase," were not mentioned.

The EEG unit described in the June 7 issue was designed to be portable and to provide a record of the EEG activity of a patient over a period of a few hours. The unit's main advantage is that it is small enough to be worn by a patient, and that it provides a continuous record of the EEG activity, which can be used to diagnose the patient's condition. The unit is powered by a small battery, and it uses Polaroid film to record the EEG activity, which can be developed later and used to analyze the patient's condition.

(continued on pg. 10)
Right now you need ideas like these you can put to work to make your power circuit more effective in today's difficult market place.

We furnish many for your application: And, the silicon power devices to fit them:
From switching supply to audio amplifier
More than 1,400, to be exact.
We've extracted 200 standard device providing leading edge, best value advantage in today's, and tomorrow's demanding equipment designs.

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The silicon power brochure tells all.
Including technology overviews, device technology and tradeoffs, practical selector considerations, power Darlington uses Switchmode application, high reliability programs, product options and technical publication list. Plus a special reply card for direct ordering any application note or data sheet.

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We've said it before: We'll be competitive on 99.9% of the power transistors in our broad line.
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All the extras are with Motorola. At no increase in cost! You may find lower prices elsewhere.

You'll have to work at it.
The device

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THE ADVANTAGES:
Volt-ampere ratings as much as 250% higher than those of older designs. Deliver large peak currents with lowest possible inductance and dissipation factor.


ACROSS THE DESK
(continued from pg. 7)
ed out in the article, however, the use of a digital recording technique to achieve such a high packing density greatly increases the cost and manufacturing difficulty of the recording system. Because absolute amplitude accuracy is not required for diagnostic EEGs (better than ±10% suffices), greater packing density can be achieved with ordinary ac bias recording.

We have developed a 24-hour, four-channel EEG cassette recording system that consists of "active electrodes" affixed to the scalp and a miniature tape recorder worn on the belt. The active electrode housings (0.68 in. diam and 0.25 in. thick) contain integrated-circuit differential preamplifiers, and they are so small that they are attached to the scalp like ordinary electrodes. The miniature tape recorder is 4-1/2 × 3-3/8 × 1-1/2 in. and weighs less than a pound with batteries included inside.

This EEG recording system, produced by Research Instrumentation Associates Inc. of Cleveland, has been commercially available for 1-1/2 years.

Richard C. Burgess
Howard P. Apple, Ph.D.
Patient Monitoring Laboratory
Case Western Reserve University
School of Medicine
2065 Adelbert Rd.
Cleveland, OH 44106

Wrong picture, right facts
In the New Product item "Voltage Sensing LED has 2.5 V Threshold," (ED No. 13, June 21, 1975 on p. 116), a Data Display photo inadvertently accompanied the Hewlett-Packard product announcement. For those readers desiring more information from HP,

CIRCLE NO. 319

Who? Me an editor?
Who knows? You could be our next star on the West Coast. We're looking for an engineer in the San Francisco Bay Area who has

(continued on pg. 14)
International Rectifier.

New 10 Amp device makes one-stop shopping easy for fast-switching power transistors.

Now, IR is your source for a wide variety of 3, 5 and 10 Amp JEDEC fast-switching power transistors, to simplify your buying. These hard-glass passivated devices are the ones to use for better reliability and lower costs in line operated power supplies, whether you're chopping line voltages at 20 KHz or inverting and stepping down at high frequency.

Fast Switching Speed—Cooler Operation...the oscillographs show typical fall times in the one-microsecond and lower range. Gives extremely low switching losses for cooler operation and higher reliability.

Lower Leakage—High Temperature Stability...with $I_{CEO}$ in the microamp range, IR devices are about one-tenth the accepted leakage rates of others. Provides the higher stability important for high performance at elevated temperatures.

High Second Breakdown — High Reliability...high second breakdown helps provide a broad safe-operating area for an extra margin of safety.

Glass Passivation — Long Term Reliability...high reliability and long term stability is achieved by hard glass passivation. Also, if you're using chips to make your own circuits, IR's glass passivation gives you the most stable, easy to assemble chips yield higher.

If you are paralleling devices, the tight gain, switching time and saturation voltage control of these transistors make the job easier. And through 100% testing of key parameters we can provide even closer matching if necessary.

JEDEC types listed are immediately available, so contact your local IR salesman, rep or distributor today.

International Rectifier, 233 Kansas Street, El Segundo, California 90245. (213) 678-6281.

<table>
<thead>
<tr>
<th>Part No</th>
<th>$V_{CEO}$ (Max)</th>
<th>$I_{C}$ (Max)</th>
<th>$I_{F}$ (Max)</th>
<th>$I_{D}$ (Max)</th>
<th>$I_{G}$</th>
<th>$P_{G}$ (W)</th>
<th>$t_{f}$ (µs)</th>
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<tbody>
<tr>
<td>2N6306</td>
<td>250</td>
<td>16</td>
<td>15/75</td>
<td>3.0</td>
<td>0.8</td>
<td>3.0</td>
<td>125</td>
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<td>2N6307</td>
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<td>16</td>
<td>15/75</td>
<td>3.0</td>
<td>1.0</td>
<td>3.0</td>
<td>125</td>
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<td>2N6308</td>
<td>350</td>
<td>16</td>
<td>15/75</td>
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<td>1.5</td>
<td>3.0</td>
<td>125</td>
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<td>2N6542</td>
<td>300</td>
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<td>7/35</td>
<td>3.0</td>
<td>1.0</td>
<td>3.0</td>
<td>100</td>
</tr>
<tr>
<td>2N6543</td>
<td>400</td>
<td>10</td>
<td>7/35</td>
<td>3.0</td>
<td>1.0</td>
<td>3.0</td>
<td>100</td>
</tr>
<tr>
<td>2N6544</td>
<td>300</td>
<td>16</td>
<td>7/35</td>
<td>5.0</td>
<td>1.5</td>
<td>5.0</td>
<td>125</td>
</tr>
<tr>
<td>2N6545</td>
<td>400</td>
<td>16</td>
<td>7/35</td>
<td>5.0</td>
<td>1.5</td>
<td>5.0</td>
<td>125</td>
</tr>
<tr>
<td>2N6249</td>
<td>200</td>
<td>30</td>
<td>10/50</td>
<td>10.0</td>
<td>1.5</td>
<td>10.0</td>
<td>175</td>
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<tr>
<td>2N6250</td>
<td>275</td>
<td>30</td>
<td>8/50</td>
<td>10.0</td>
<td>1.5</td>
<td>10.0</td>
<td>175</td>
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<tr>
<td>2N6251</td>
<td>350</td>
<td>30</td>
<td>6/50</td>
<td>10.0</td>
<td>1.5</td>
<td>10.0</td>
<td>175</td>
</tr>
</tbody>
</table>

**INTERNATIONAL RECTIFIER**

the innovative power people
INTRODUCING THE WORLD'S FIRST

THE INTERDATA 8/32—UNMATCHED LEVELS OF PERFORMANCE IN A MINICOMPUTER SYSTEM.

MEGAMINI ARCHITECTURE: AN ABUNDANCE OF SHEER POWER.

Interdata's new 8/32 Megamini has performance characteristics found only on large scale computers. Like direct addressing to one million bytes. Full 32-bit hardware with performance enhancers such as dual instruction look-ahead stacks, multiple register sets, interleaved 32-bit memory, and fast floating-point hardware. What our 8/32 Megamini means to you is an unequalled combination of power, flexibility, and reliability in a compact package. All at a price that's fully competitive.

MEGAMINI SOFTWARE: POWERFUL, FLEXIBLE, EASY-TO-USE.

Today's hardware must be designed to ease your software effort. You shouldn't have to spend a lot of expensive programming time trying to figure out how to get around minicomputer hardware limitations. With the 8/32 Megamini you don't—because there are none.

For example. The direct addressing capability of the 8/32 Megamini allows you to build programs and data arrays in any size up to the amount of memory you have—no more 64K limits.

It also means we can give you versatile and powerful software to help lower the cost of building your system. Software with a multi-tasking operating system, OS/32MT, with unique multi-user
COMPARE: THE INTERDATA 8/32 MEGAMINI VS. THE-LESS-THAN-MEGAMINI COMPETITION.

<table>
<thead>
<tr>
<th>WORD LENGTH</th>
<th>INTERDATA 8/32</th>
<th>XEROX 550</th>
<th>IBM 370/158</th>
<th>DEC 11/70</th>
<th>DG Eclipse</th>
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<tbody>
<tr>
<td>32 bits</td>
<td></td>
<td>32 bits</td>
<td>32 bits</td>
<td>16 bits</td>
<td>16 bits</td>
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<tr>
<td>INSTRUCTION TIMES (Register to Memory)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integer Add</td>
<td>1.25</td>
<td>1.8</td>
<td>.9</td>
<td>1.8</td>
<td>2.5</td>
</tr>
<tr>
<td>Multiply</td>
<td>3.54</td>
<td>6.2</td>
<td>2.0</td>
<td>3.9</td>
<td>8.8</td>
</tr>
<tr>
<td>Divide</td>
<td>5.8</td>
<td>14.4</td>
<td>9.9</td>
<td>8.3</td>
<td>11.2</td>
</tr>
<tr>
<td>Floating Point Add</td>
<td>2.3</td>
<td>6.1</td>
<td>2.4</td>
<td>8.25</td>
<td>5.5</td>
</tr>
<tr>
<td>Multiply</td>
<td>3.0</td>
<td>9.1</td>
<td>2.3</td>
<td>11.25</td>
<td>7.2</td>
</tr>
<tr>
<td>Divide</td>
<td>5.35</td>
<td>23.3</td>
<td>8.9</td>
<td>12.25</td>
<td>7.9</td>
</tr>
<tr>
<td>HARDWARE I/O</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>MAX. DMA RATE/SECOND</td>
<td>6MB</td>
<td>4MB</td>
<td>6.7MB</td>
<td>4MB</td>
<td>2MB</td>
</tr>
<tr>
<td>DIRECT ADDRESSING RANGE</td>
<td>1MB</td>
<td>1MB</td>
<td>16MB</td>
<td>64KB</td>
<td>64KB</td>
</tr>
<tr>
<td>GENERAL PURPOSE REGISTERS</td>
<td>2 stacks</td>
<td>4 stacks</td>
<td>1 stack</td>
<td>2 stacks</td>
<td>1 stack</td>
</tr>
<tr>
<td>PRICING (Basic Configuration)</td>
<td>16 each*</td>
<td>16 each</td>
<td>16 each</td>
<td>8 each</td>
<td>4 each</td>
</tr>
<tr>
<td>CPU + 128KB Memory</td>
<td>$51,900</td>
<td>$128,700</td>
<td>N/A</td>
<td>$54,600</td>
<td>$32,500</td>
</tr>
<tr>
<td>CPU + 1048KB Memory</td>
<td>$179,400</td>
<td>$478,700</td>
<td>$1,905,700</td>
<td>$163,800</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*(6 Additional Stacks Optional)

FOR MORE MEGADATA, CLIP AND MAIL.

Interdata, Inc., Oceanport, N.J. 07757

☑ All that power sounds marvelous. Send me more information on the Interdata 8/32 Megamini.

☑ You may have hit on the solution to my megaproblem. Have a representative call me.

Name
Title
Company
Address
City State Zip
Telephone

INTERDATA
Subsidiary of Perkin-Elmer
Oceanport, N.J. 07757. (201) 229-4040

INFORMATION RETRIEVAL NUMBER 10

Electronic Design 17, August 16, 1975
ACROSS THE DESK
(continued from pg. 10)
a good knowledge of semiconductors and test equipment from the user's point of view. This person should enjoy interviewing industry authorities, asking sharp questions, and writing clear and simple English prose.
If you think that's you, call or write David Kaye, who is listed next to where you might appear on page 6.

Coil inductance—it's a running argument
It was interesting to read the comments that came Across the Desk on coil inductance. We have been winding coils since radio became commercial in the 20's and, it seems, have solved the same problem every year. What is a tightly wound coil to one person is not necessarily tightly wound to another, and though wire standards are precise and exact, they are not without tolerance.

Therefore, unless the coil is wound at specific turns per inch—which allows room for a maximum sized wire and a maximum serving of insulation—the argument is going to continue. Even with these precautions, you will continually have the change in nominal diameter, which can be changed, of course, for every batch of wire.

Alfred Sfreddo
General Instrument Corp.
F. W. Sickles Div.
165 Front St.
Chicopee, MA 01014

Yes. It happened.
We ran an incorrect caption in our Misplaced Caption Dept. (ED No. 15, July 19, 1975, p. 10). Those lovely ladies in the painting were not having lunch on the grass and the artist was not Edouard Manet. That picture appeared in ED No. 11, May 24, 1975, p. 16. The painting that appeared in ED No. 15 is Jean Francois Millet's "The Gleaners," which hangs at the Louvre in Paris.

Sorry. That's Sandro Botticelli's "Portrait of a Man with a Medal," which hangs in the Uffizi Gallery in Florence.

Misplaced Caption Dept.
BOURNS trims more circuits than anyone else in the world!

here's why...

NOBODY KNOWS MORE ABOUT TRIMMERS THAN WE DO
Marlan E. Bourns, President of Bourns, Inc., invented the modern miniature TRIMPOT® trimming potentiometer. This company pioneered the industry, and has maintained its leadership position for over a quarter of a century.

WE GIVE YOU WHAT YOU NEED
Bourns has the broadest line of trimming potentiometers in the industry. We produce just about any type, shape, size, style you're likely to need. We make them more readily available via a large factory inventory . . . and 92 stocking distributors.

YOU CAN DEPEND ON BOURNS
Trimming potentiometers are the most cost-effective method of adjusting, regulating and controlling circuits . . . and they will remain so for the foreseeable future. Bourns is the most capable, straightforward and reliable supplier of trimming potentiometers. Depend on Bourns.

QUALITY, SERVICE, VALUE — Bourns is No. 1
. . . you can depend on it!

BOURNS, INC., TRIMPOT PRODUCTS DIVISION • 1200 COLUMBIA AVENUE, RIVERSIDE, CALIFORNIA 92507

INFORMATION RETRIEVAL NUMBER 13
It's a systems workhorse

The Fluke 5½ digit 8400A systems DVM

Perhaps you've only known the 8400A as the ultimate bench DVM. It has a basic accuracy of 0.002% over five ranges of DC from 1 µV to 1100 V.

But did you know that it's also the ultimate systems DVM as well?

The 8400A has field installable data output and remote control systems interface options. The 34 bit, buffered, isolated data output option can be easily configured for 4, 8, 12 or 16 bit character serial operation, and is separately addressable in multimeter installations.

Inverted logic levels or codes other than 8-4-2-1 can be user configured.

Systems settling timeouts are also provided in the data output option. The isolated remote control option features stored and continuous modes with appropriate inhibit functions.*

Other options (all field installable) include:

- 4 ranges of AC volts.
- True RMS AC from 10 µV to 1100 V.
- 7 ranges of resistance with 4 terminal capability.
- DC ratio.
- AC ratio.

Here's what you get for $1895 (US price only). Patented Recirculating Remainder A/D conversion system, five ranges DC volts, 1500 V peak overload protection, 0.001% resolution, switched filter for AC and DC measurements with better than 65 dB noise rejection at 60 Hz.

Finally, there are the toughest published DVM specs around, including 10,000 hour MTBF. And the Fluke name is second to none.

*For more system interface information, dial our toll-free hotline and ask for applications bulletin #11.

For data out today, dial our toll-free hotline: 800-426-0361

John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043
For a demo circle = 281. For literature only circle = 282
For information on the rest of the Fluke line, see EEM or the Gold Book.
More Super-Fast Silicon Rectifiers

Featuring 30 nanoseconds Reverse Recovery Time

A breakthrough in junction technology makes Super-Fast silicon rectifiers possible. These new high speed silicon rectifiers feature low forward voltage drop at higher operating currents and reverse recovery time better than 30 nanoseconds. In addition, these devices have extremely low reverse leakage and high surge ratings. Super-Fast rectifiers use Semtech’s proven Metoxilite non-cavity monolithic high temperature construction. Designed for high frequency applications, such as high speed switching regulators and converter circuits. Semtech’s Super-Fast silicon rectifiers are stocked for immediate delivery.

**LO-VF Metoxilite**

Available as JAN, JAN TX & JAN TXV to MIL-S-19500/503 (EL)

<table>
<thead>
<tr>
<th>Types</th>
<th>PIV</th>
<th>Reverse Current (Max.)</th>
<th>Capacitance @ 12V DC (Max.)</th>
<th>Single Cycle Surge Current</th>
<th>Dimensions (Max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1N6073, 74 &amp; 75 (Trr 30ns)</td>
<td>50, 100 &amp; 150V</td>
<td>1µA DC @ 25°C</td>
<td>24 pF</td>
<td>35A</td>
<td>Body : .070&quot; D x .165&quot; L Leads : .031&quot; D x .125&quot; L</td>
</tr>
<tr>
<td>1N6076, 77 &amp; 78 (Trr 30ns)</td>
<td>50, 100 &amp; 150V</td>
<td>5µA DC @ 25°C</td>
<td>20 pF</td>
<td>25A</td>
<td>Body : .140&quot; D x .165&quot; L Leads : .040&quot; D x .110&quot; L</td>
</tr>
<tr>
<td>1N6079, 80 &amp; 81 (Trr 30ns)</td>
<td>50, 100 &amp; 150V</td>
<td>20µA DC @ 25°C</td>
<td>230 pF</td>
<td>250A</td>
<td>Body : .424&quot; D x .405&quot; H Stud : 28 UNF x .43&quot; L</td>
</tr>
</tbody>
</table>

**LO-VF DO-5L Stud**

Types: STFF05, 10 & 15 (Trr 40ns)
Add "R" to type number for reverse polarity

<table>
<thead>
<tr>
<th>Types</th>
<th>PIV</th>
<th>Reverse Current (Max.)</th>
<th>Instantaneous Forward Voltage</th>
<th>Capacitance @ 12V DC (Max.)</th>
<th>Single Cycle Surge Current</th>
<th>Dimensions (Max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3FF30, 3FF40 &amp; 3FF50 (Trr 30ns)</td>
<td>300, 400 &amp; 500V</td>
<td>5µA @ 25°C</td>
<td>1.5V @ 25°C</td>
<td>15 pF</td>
<td>10A</td>
<td></td>
</tr>
<tr>
<td>SF05, 10 &amp; 15 and *2SF05, 10 &amp; 15 (Trr 30ns)</td>
<td>50, 100 &amp; 150V</td>
<td>10µA DC @ 25°C</td>
<td>1.1V @ 25°C</td>
<td>1.25A</td>
<td>Body : .424&quot; D x .405&quot; H</td>
<td></td>
</tr>
<tr>
<td>SDOubblers &amp; Center Taps</td>
<td>SDFF05, 10 &amp; 15; SNFF05, 10 &amp; 15; SPF05, 10 &amp; 15 (Trr 30ns)</td>
<td>10µA DC @ 25°C</td>
<td>1.1V @ 25°C</td>
<td>1.25A</td>
<td>Body : .424&quot; D x .405&quot; H</td>
<td></td>
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</table>

**LO-VF DO-4 Stud**

Types: SF05, 10 & 15 and *2SF05, 10 & 15 (Trr 30ns)

<table>
<thead>
<tr>
<th>Types</th>
<th>PIV</th>
<th>Reverse Current (Max.)</th>
<th>Instantaneous Forward Voltage</th>
<th>Capacitance</th>
<th>Single Cycle Surge Current</th>
<th>Dimensions (Max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FF30, FF40 &amp; FF50 (Trr 30ns)</td>
<td>300, 400 &amp; 500V</td>
<td>1µA @ 25°C</td>
<td>1.5V @ 25°C</td>
<td>35A</td>
<td>Body : .070&quot; D x .165&quot; L Leads : .031&quot; D x .125&quot; L</td>
<td></td>
</tr>
<tr>
<td>FF30, FF40 &amp; FF50 (Trr 30ns)</td>
<td>50, 100 &amp; 150V</td>
<td>5µA @ 25°C</td>
<td>1.5V @ 25°C</td>
<td>25A</td>
<td>Body : .140&quot; D x .165&quot; L Leads : .040&quot; D x .110&quot; L</td>
<td></td>
</tr>
</tbody>
</table>

**NEW**

**LO-VF DO-5DL Isolated Stud**

Types: STFF05DL, 10DL & 15 DL (Trr 30ns)

<table>
<thead>
<tr>
<th>Types</th>
<th>PIV</th>
<th>Reverse Current (Max.)</th>
<th>Instantaneous Forward Voltage</th>
<th>Capacitance</th>
<th>Single Cycle Surge Current</th>
<th>Dimensions (Max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1N6073, 74 &amp; 75 (Trr 30ns)</td>
<td>50, 100 &amp; 150V</td>
<td>1µA DC @ 25°C</td>
<td>1.5V @ 25°C</td>
<td>15 pF</td>
<td>10A</td>
<td></td>
</tr>
<tr>
<td>1N6076, 77 &amp; 78 (Trr 30ns)</td>
<td>50, 100 &amp; 150V</td>
<td>5µA DC @ 25°C</td>
<td>1.5V @ 25°C</td>
<td>20 pF</td>
<td>25A</td>
<td></td>
</tr>
<tr>
<td>1N6079, 80 &amp; 81 (Trr 30ns)</td>
<td>50, 100 &amp; 150V</td>
<td>20µA DC @ 25°C</td>
<td>1.5V @ 25°C</td>
<td>230 pF</td>
<td>250A</td>
<td></td>
</tr>
</tbody>
</table>

1975 NATIONAL SBA SUBCONTRACTOR OF THE YEAR

SEMTECH CORPORATION

652 Mitchell Road, Newbury Park, California 91320
(805) 498-2111, (213) 628-5392
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CS: (312) 352-3227
DALLAS: (214) 387-3551
FLORIDA: (305) 644-5404
MARYLAND: (301) 424-6663
NEW JERSEY: (201) 654-4884
SAN FRANCISCO: (415) 494-0113
EUROPEAN SALES HQ: Bourns AG Zug, Switzerland (042) 232-242
There's nothing semiconductor ex
You’d be surprised to know in how many industries Delco Electronics has firsthand power semiconductor application experience. They include, among others, transportation and medical, computers and communication, with products that range from motor speed controls to ultrasonic equipment. And the list goes on.

But we realize that you’re most interested in how your new product should be designed, how your equipment is functioning and how your business is going. That’s where Delco comes in personally.

You see, Delco Electronics has a staff of application engineers available to assist you when you’re developing new designs. They have a wide range of application experience to draw from and a wide range of dependable Delco high-energy power semiconductors to work with. Power semiconductors that have been meeting tough government and industrial specifications for years.

Put the two together, and chances are you’ll end up with a well-designed, reliable piece of equipment, sooner.

Call us or your local Delco semiconductor distributor and ask about our full line of reliable semiconductors. And how Delco Electronics engineers may assist you.

DELCO ELECTRONICS—Regional Sales Offices
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Box 2968
Van Nuys, California
91404
(213) 988-7550
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700 E. Firmin
Kokomo, Ind.
46901
(317) 459-2175

Delco Electronics.
The Power Specialists.
Two for your budget.

Affordable spectrum analyzers that typically will make over 90% of your everyday frequency domain measurements. Easily. Accurately.

Ease of use is another important feature of these HP Spectrum Analyzers. For most measurements you use just three controls:

1. Tune to the signal. Frequency is displayed on a digital readout.
2. Set the Frequency Span. View a wide spectrum then zoom in on your signal — resolution, sweep time, video filtering are all set automatically for optimum signal presentation.
3. Measure Amplitude Level. Read it directly from Reference Level control and CRT.

To help minimize chances for erroneous measurements, panel markings show optimum signal levels, and there's out-of-range blanking or limiting.

Economical for use on every bench, these analyzers provide the performance for over 90% of your everyday applications. This means they can relieve the need to use the more expensive high-resolution analyzer for routine measurement, with equivalent amplitude and frequency accuracy.

Want more information? Just call your nearest HP field office, or write.

HEWLETT PACKARD

Sales and service from 172 offices in 65 countries.
1501 Page Mill Road, Palo Alto, California 94304

INFORMATION RETRIEVAL NUMBER 133

16D

ELECTRONIC DESIGN 17, August 16, 1975
Elco Distributors

ALAS., HUNTSVILLE
Powell/205-539-2731
ARIZ., PHOENIX
Moltronics/602-272-7951
CALIF., EL SEGUNDO
T. I. Supply/213-973-2571
CALIF., LOS ANGELES
Kierulf/213-685-5511
CALIF., MOUNTAIN VIEW
Powell/415-964-0820
CALIF., PALO ALTO
Kierulf/415-368-6292
CALIF., SAN DIEGO
Kierulf/714-278-2112
Moltronics/714-278-5020
Richey/714-565-4444
CALIF., SANTA CLARA
Moltronics/408-244-7600
CALIF., SUN VALLEY
Richey/213-875-2862
COLO., DENVER
Kierulf/303-371-6500
Newark/303-757-3351
CONN., NEW HAVEN
Connector Co/203-624-0127
FLA., MIAMI SPRINGS
Powell/305-592-3260
ILL., CHICAGO
Newark/312-638-4411
MD., BELTSVILLE
Kierulf/301-937-4030
MD., SAVAGE
Pytronic/301-792-7000
MASS., WATERTOWN
D.R.W./617-923-1900
MINN., MINNEAPOLIS
Newark/612-331-6350
MO., ST. CHARLES
Lectronix/917-229-1122
N.J., CLARK
T. I. Supply/201-382-6400
N.Y., BUFFALO
Summit/716-884-3450
N.Y., FARMINGDALE
D.R.W./516-249-2860
N.Y., WOODBURY
Tennant/516-364-9070
N.C., GREENSBORO
Hammond/919-275-6391
OHIO, CLEVELAND
Pioneer-Standard
216-587-3600
PA., MONTGOMERYVILLE
Pytronic/215-643-2850
PA., PHILADELPHIA
Powell/215-365-1900
TEXAS, GARLAND
Newark/Dallas
214-271-2511
TEXAS, HOUSTON
Newark/Houston
713-782-4800
WASHINGTON
Almac/Stroum
206-373-2530
WIS., MILWAUKEE
Electronic Expeditors
414-228-8100

We've got three facts to tell you and 20 seconds of your time to tell it. We'll make it short and sweet.

FACT #1. To meet market needs, Elco Corporation announces the in-stock availability of the new LOW INSERTION FORCE VARICON* contact in a complete line of Rack and Panel Connectors.

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INFORMATION RETRIEVAL NUMBER 15
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INFORMATION RETRIEVAL NUMBER 16
$15 microprocessor coming for simpler applications

For the designer who doesn’t really need the performance of a general-purpose microprocessor, a specialized unit will be announced next month for $15 in quantity lots.

Built by National Semiconductor, the unit, called Scamp (simple cost-effective applications microprocessor), will be good for simple control and timing functions usually taken care of by random logic, says Philip Roybal, the company’s marketing manager for microprocessors.

Scamp is expected to find application in appliance controls, small building security monitors, fuel-injection units for cars as well as traffic-signal control, word-processing terminals and scales and electronic toys—“anything that doesn’t require speed or too much computation,” Roybal says.

The 8-bit PMOS microprocessor operates at 2-μs cycle time. It requires a single 12-V supply, with a comfortable margin of ±2 V. And it generates its own timing right on the chip, as opposed to a need for other chips to handle this function.

Multiple Scamps can communicate with one another when they all share a common bus. Logic built on the chip allows each Scamp to sense when the bus is in use. Only one Scamp can use the bus at a time, but a daisy-chain arrangement notifies each Scamp when its turn comes. When one of the Scamps stops transmitting or receiving, the one next to it can take over. If it declines, the one adjacent to it is given a chance.

Meanwhile, for more demanding applications, RCA plans to introduce an advanced high-speed version of its Cosmac microprocessor early next year. It will be a CMOS-on-sapphire unit with a cycle time of less than 1 μs. Cosmac’s cycle time is 6 μs.

An advance reported in optical modulators

A new gallium-arsenide waveguide structure—the result of a breakthrough in fabrication technology—is described as the first practical ultra-wideband optical modulator that can be interfaced directly with microwave stripline traveling-wave devices.

The claim is made by Dr. P.K.E. Cheo, senior research scientist at United Technologies Center, East Hartford, CT, who says that in contrast, optical waveguides made by diffusion or thin-film techniques are too fragile or not physically suited for integration into a practical microwave device. And their power-handling capability is low, he adds.

The new waveguide device, which is being developed by United Technologies to modulate CO₂ lasers in optical radars and high-data optical communications, has exceptionally high optical transmission efficiency, Cheo says. The structure has passed tests using 100 W of microwave power, he points out.

In a recent experiment, using germanium prism couplers to feed optical energy into and to take it out of the waveguide, more than 3-W output was obtained from a CO₂ Gaussian beam input of 6 W—a power previously unattained with this type device.

The efficiency in this case was 52%, but Cheo says this figure can be raised substantially closer to the theoretical maximum level of 81%.

The new waveguides have been subjected to optical power densi-
ties of greater than 7 kW/cm² without damage, according to Cheo. And he sees the power-handling capability raised to as high as 20 W without heating problems.

The three major advances of the new design—compatibility with microstrip circuitry, high efficiency and high power-handling capabilities—are due to the method of fabricating the structures, Cheo points out.

The waveguide structure itself is a slab of gallium arsenide that is typically 1 cm wide, 4.5 to 5 cm long, and 20 to 30 µm thick. The thickness, Cheo says, is governed by the 10-µm wavelength of the CO₂ laser. Ion-beam milling is used to thin the GaAs to 20 to 30 µm from 0.015 in. thick bulk material.

The waveguide strip is optically polished and bonded to an optically polished copper block. This forms a stiff, rugged device that permits the use of prism couplers—the most efficient—because they require pressure against the waveguide.

The copper block forms the ground plane of the microwave modulator, which is designed to operate in the 10- to 15-GHz region. The copper also serves as a good heat sink for optical microwave power.

When used as a modulator, the waveguide is interfaced with the microwave system, and variations in the microwave field phase-modulate the optical energy.

The United Technologies development program is funded by the Advanced Research Projects Agency.

Independent entered in IEEE election

To some, Irwin Feerst is a Don Quixote jousting at imaginary IEEE enemies. To others, he is a Martin Luther crusading for total IEEE reform.

Whatever he is, Feerst has accomplished a goal after two previous failures. His name will appear on this year’s presidential ballot for the Institute of Electrical and Electronics Engineers. This makes it the first time a nominee for the IEEE presidency has been challenged.

Feerst is an independent engineering consultant with a masters degree in electrical engineering from New York University. He will oppose Joseph K. Dillard, manager of advanced-systems technology for Westinghouse Electric Corp., Pittsburgh.

Flick of wrist gives time in new Pulsar

A flick of the wrist is all that’s needed to command the latest Pulsar solid-state watch to display time.

Available from Time Computer, Inc., a division of HMW Industries, Lancaster, PA, the new Pulsar Auto/Command digital watch contains an inertial switch built around a minute ball of mercury trapped in a hermetically sealed glass tube. The mercury ball rolls with the movement of the wrist to first activate then deactivate circuits that turn on the LED display.

To prevent the Pulsar time display from lighting at unwanted moments, the watch is designed to work only with a specific wrist motion and within a specific time sequence. Too fast or too slow a movement will not light the display.

Gun fells intruders with electrical current

There is an alternative to shooting an intruder with a gun. You simply pull out a Taser TF-1, squeeze a trigger and two barbed contacts connected to fine electrical wires strike the intruder. A pulsating electrical current charges through his body, knocking him to the floor, helpless. The current continues as long as the electrical release button on the Taser is held down. When it’s held down as long as 2.7 seconds, an intruder may lose consciousness—a volunteer “intruder” did.

Developed and built by Taser System, Inc., City of Industry, CA, the TF-1 looks like a flashlight, is smaller than a pack of cigarettes and operates on 3 W. Voltage is high—50 kV and up.

The Taser develops short, microsecond-long pulses of electrical energy, delivered at about 10 pps and peaking at 50 to 60 kV, according to its inventor, John Cover.

The peak power per pulse delivered into the human body is greater than 10 kW. To prevent heart fibrillation—the predominant factor causing death from electric shock—the Taser operates in a region some 100 times below the maximum safe level for the heart.

Power is provided by rechargeable nickel cadmium batteries. Circuitry for the inverter was specially developed to minimize the number of components and size, with over-all efficiency at about 40%. High-voltage insulation, a key requirement, was accomplished through a combination of encapsulation, spatial-geometric placement of parts, the use of plastic materials throughout the case and a unique method of switching the high voltage for the two-shot capability, Cover says.

Gas-pressure sensor offers ultra precision

A unique quartz diaphragm is the sensitive but stable pressure sensor that allows a new portable field instrument to measure or control barometric or gas pressure. Laboratory-standard accuracy is claimed.

The instrument, developed by the Bendix Test Systems Div., Teterboro, NJ, uses the proprietary rugged quartz element as one arm of a solid-state, temperature-compensated capacitance bridge. Pressure measurements are accurate to better than ±0.002-in. of mercury over the range of 0.6 to 40 in. of mercury, according to Bernard Gollomp, Bendix senior engineer.

Competing systems with comparable accuracies use laboratory-tube mercury barometers with temps of typically 0.008-in. per °C for a 30-in. column, Gollomp says. In addition these setups are highly sensitive to vibration and must be used in a stable environment.

The Bendix instrument has an unusually high frequency response on the order of 150 to 200 cycles, Gollomp notes, and the sensor is being used to test elements like air-data computers and dynamic pressure sensors on the F-15 aircraft program.
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SR-51A: simple arithmetic to complex statistics.
Sheer math power. Log and trig and hyperbolics and functions of x. The SR-51A has these and also statistical functions. Like mean, variance and standard deviation. Factorials, permutations, slope and intercept. Trend line analysis. And there’s a random number generator. Plus 20 preprogrammed conversions and inverses. Check this list for a closer look at the real math power you can get in both the SR-51A and the SR-50A:

<table>
<thead>
<tr>
<th>FUNCTION</th>
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<th>SR-50A</th>
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<tr>
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<tr>
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<td>x!</td>
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<tr>
<td>Exchange x with y</td>
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<td>Second function key</td>
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</tr>
<tr>
<td>Constant mode operation</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>

Performance, accuracy and efficiency. Both the SR-50A and SR-51A deliver answers you can trust. Quickly and efficiently. To problems ranging from simple arithmetic to highly complex calculations. You don’t have to learn special entry methods or difficult-to-master key sequences. There’s a better way – TI’s algebraic entry system lets you key your problem just the way you would say it. Naturally. You don’t worry about losing data in stacks, or keeping track of what is in each stack, or remembering if the stack is full. The way you learned math is the way it’s done. On both the SR-50A and SR-51A – you can command tremendous math power with confidence – from the beginning. Power and accuracy you can really put to work.

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Scientific notation is automatic when you need it. For numbers as large as ±9,999999999 x 10^18. Or as small as ±1 x 10^-99.

<p>|</p>
<table>
<thead>
<tr>
<th>integer</th>
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<tr>
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<td>exponent</td>
</tr>
<tr>
<td>mantissa</td>
<td></td>
<td>sign</td>
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</tbody>
</table>

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SR-51A Preprogrammed Conversions

<table>
<thead>
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<tbody>
<tr>
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</tr>
<tr>
<td>inches</td>
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</tr>
<tr>
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</tr>
<tr>
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<tr>
<td>miles</td>
<td>kilometers</td>
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<td>nautical miles</td>
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<tr>
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<tr>
<td>fluid ounces</td>
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<td>pounds</td>
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<tr>
<td>short ton</td>
<td>metric ton</td>
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<tr>
<td>BTU</td>
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<td>rectangular</td>
</tr>
<tr>
<td>voltage ratio</td>
<td>decibels</td>
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</tbody>
</table>

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A special report on ICs

Semi firms speed up drive to develop new logic circuits

Semiconductor manufacturers have accelerated a three-way drive to develop new circuits for future logic designs.

One approach involves MOS and bipolar microprocessors and their peripheral support circuitry. Another encompasses special-purpose LSI circuits that run the gamut from completely dedicated ICs (like calculator chips) to high-speed families. The third approach consists of user-programmable logic arrays and read-only memories.

Intense competition in each of these areas has produced the following major developments:

- Following a pattern set by MOS predecessors, newer bipolar “bit-slice” microprocessors have increased speeds, and they are moving to longer word-length slices.
- Emerging bipolar/LSI families are providing fast, flexible and complex components for applications ranging from microcomputers to mainframes.
- With the arrival of field-programmable logic arrays, digital designers now have a vastly more efficient alternative to PROMs to replace hardwired logic.

Bipolar/LSI microprocessors

Just two years ago, only Monolithic Memories offered a bipolar microprocessor slice. Now five other manufacturers have entered the field, and more are expected. The current list includes Advanced Micro Devices, Intel, Motorola Semiconductor, Signetics and Texas Instruments.

Edward A. Torrero
Associate Editor

A 4-bit microprocessor slice, or microcontroller, has a cycle time of about 100 ns. The low-power Schottky-TTL circuit from Advanced Micro Devices can be used for minicomputer emulation.

The bipolar speeds of these microprocessor slices, or microcontrollers, assure a precise emulation of conventional systems which employ standard bipolar circuits. By using microprogramming techniques, designers can replace scores of SSI and MSI packages at reduced power. The leading applications are currently in minicomputers.

“In a 16-bit mini that has been built and delivered,” says Monolithic Memories’ systems and applications manager Joseph McDowell, “the TTL-package count was reduced from 157 to 70.” As a result, an original PC-board size of $15 \times 15$ in. became $6 \times 9$ in. Power dissipation dropped by 50% to 14 W, and system speed increased by 20% to a 1.2-µs instruction execution time.

“And this compact system is a
complete mini consisting of central processing unit, interrupt and direct-memory-access structures and input/output buffers," McDowell observes.

Like Monolithic Memories, Advanced Micro Devices and Intel employ Schottky-TTL. Cycle times range from about 100 ns for the AMD microcontroller to about 200 ns for the other two. A slower speed is offered in the TI version, which uses integrated injection logic (IPL) to decrease power dissipation.

In forthcoming product introductions, Motorola's entry will be an emitter-coupled-logic circuit having a cycle time of about 55 ns. Signetics will alternate source Intel's model.

The next announcement might well be from Monolithic Memories. The manufacturer plans a higher-speed version that will decrease cycle time to 150 ns, thereby closing the speed gap between its product and AMD's. Both have similar internal architectures.

A growing application area for bit-slice processors—high-speed, stand-alone controllers—makes use of special support circuits. These peripheral ICs are intended to enhance and match the microprocessor slices they support. One key circuit is a control unit that contains the necessary sequencing capability for a complete subsystem.

With the chip set, manufacturers envision as few as eight IC packages forming, say, a 10-megabyte disc controller. The eight ICs consist of four 4-bit processor slices, one control unit and three PROMs.

Even more dramatic benefits are in the wings when the industry advances from the present 4-bit slice up to 8 bits. "I would expect to see an 8-bit slice, but not from us," says McDowell, who believes yield problems would be a formidable barrier. First, chip size would probably increase from a current low of about 20,000 sq. mils to over 30,000. And the chip's internal RAM would grow to 128 bits. "Trying to combine this RAM with other functions on a bipolar chip is no trivial task," McDowell observes.

Meanwhile on the MOS front, manufacturers have overcome early sole-source limitations. In less than a year, three 8-bit n-channel processors have found alternate sources. American Microsystems now offers Motorola's 6800 microprocessor family, while Mostek has agreed to produce Fairchild's F8 series. Intel's 8080 has two new homes: Advanced Micro Devices and Texas Instruments.

Next in line might well be National Semiconductor's microprocessors. The company is reportedly on the verge of announcing an alternate-source agreement with benefit from bipolar/LSI peripheral circuits. Motorola's Megalogic family, for example, contains a programmable delay module, $8 \times 8$-bit multiplier and a DMA controller.

"The delay module and multiplier can support any bus-oriented microprocessor, bipolar or MOS. The DMA controller is being designed specifically for our 6800," says Jim Loro, Motorola's bipolar/LSI product planner. Expected early next year, all three monolithic

ELECTRONIC DESIGN 17, August 16, 1975
Thin-Trim capacitors

Like other manufacturers investigating I-L potentials, Motorola's effort is a two-way thrust. One approach seeks to develop low-cost LSI circuits having speeds in the 50-to-100-ns range of current NMOS ICs and power dissipation heretofore associated with CMOS circuits. The other approach aims for the 5-to-15-ns speed range of current TTL parts. Which approach will lead to a Motorola I-L microprocessor has yet to be decided.

Meanwhile the company that introduced I-L processors—Texas Instruments—has upgraded its original fabrication methods. Recently developed I-L techniques make feasible 4-bit slices with 100-ns cycle time at less than 1 W dissipation per chip. The same techniques could also be used to build a complete 16-bit microcomputer on a single chip.

Further, TI's Schottky capability now extends to the nanosecond range. And several members of a family of 1-ns parts have been sampled. By year's end, the high-speed Schottky family will include a 4-bit microprocessor slice with expected cycle times of about 50 ns. This is about the speed range of Motorola's forthcoming ECL processor slice, so a new battle between ECL and Schottky may be in the offing.

For subnanosecond speeds, Fairchild employs ECL in its version of the MECL 20-k family, a low-profile segment of Motorola's ECL arsenal. Fairchild's version, ECL 100-k, features propagation delays of only 700 ps from an actual gate driving a 50-Ω load. Circuit complexity doesn't yet exceed MSI.

"It's probably the last conventional logic family," predicts Robert Walker, Fairchild's manager for new product planning. Any faster family would have to be all LSI. Otherwise, delaying interconnections could neutralize the speed enhancements built into the chip.

While ECL 100-k can provide the springboard for future LSI products, current LSI efforts focus on the company's Macrologic circuits. The family has a typical chip complexity of 150 to 250 gates. It consists of one set of TTL circuits and another set of functionally equivalent, pin-compatible Iso-planar-CMOS versions. A CMOS or TTL microcontroller can be built by combining several packages.

Field-PLAs arrive

One of the fastest growing new products is the field-programmable logic array (FPLA). Within the last few months, six manufacturers have either announced products or said they will do so. The list consists of Advanced Micro Devices, Harris Semiconductor, Intersil, Monolithic Memories, National Semiconductor and Signetics.

Why the sudden popularity? Manufacturers say the quick turnaround benefits of FPLAs will assure rapid acceptance by designers.

"With earlier mask-programmable logic arrays," says Ralph Kaplan, Signetics' bipolar marketing manager, "designers had to wait 10 to 12 weeks and spend up to $1000 just to get prototype parts."

The cost includes tooling charges for the mask and the price for a minimum number of parts. "But with FPLAs," continues Kaplan, "a designer can get a programmed and tested FPLA within a week, spending only a few hundred dollars."

Besides entailing fewer IC packages than PROMs, FPLAs permit substantial compression of truth tables. So a complete set of logic states, generated by control variables, need not be programmed fully. FPLAs even have an editing capability that allows post-programming design changes.

FPLAs are best suited for designs calling for a small subset of the total numbers of logic states possible. Examples include the 12-bit Hollerith code, which contains only 96 graphic characters out of 216 coding states. Similarly, a typical 16-bit microprogrammed machine may really need only 50 or so subroutine-start addresses out of a total of 216.

But the use of FPLAs does entail some difficulties, too. For example, programming involves three successive and different steps. Further, FPLA testing is not a trivial task. Manufacturers are responding to the problem by developing several software and hardware design aids.
HP displays.

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You put a lot into each OEM system: good circuit design, quality components, careful testing. But end users will judge it by what comes out—the information they can get from the display. They expect bright, sharply detailed images. And that’s why HP’s 1332A and 1335A CRT displays make excellent choices for all types of systems, from spectrum, network, and chemical analyzers, to automatic test systems.

The 1332A and 1335A have very small spot size that focuses uniformly over the complete viewing area regardless of writing speed or intensity level. This eliminates the need to refocus at each intensity setting and assures crisp images, even around the outer edges of the screen. Because these displays reproduce fine image detail with excellent contrast and uniformity, they are particularly suited for applications involving complex graphics, especially those with alphanumeric data.

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OEMs who need a display with a larger viewing area and a brighter image at faster scan rates have made the 1332A a popular choice. They appreciate its 9.6 x 11.9 cm viewing area, its superior performance, and the ease with which the 1332A, like the 1335A, integrates into a variety of racks, cabinets, or systems. All frequently used controls on both displays have been placed on the front panel for maximum accessibility.

Which display best fits your requirements? Let your local HP field engineer help you decide. Or write for specific details. We’ll help you pick a display that makes your system look as good as it actually is.
A special report on ICs

Better analog ICs are matching discrete modules in performance

“Day by day, in every way, I am getting better and better,” said Emil Coué, French founder of a form of self-suggestion called Coësism in the early 1900s. Today the analog IC industry has apparently adopted that philosophy, according to a survey of the new analog ICs available and of those to be introduced in the coming months.

Performance once found only in discrete modular components can now be found in small hybrid and monolithic IC versions. And the performance-to-cost ratio is getting better with the newer products.

“The modular circuits are being challenged by hybrid versions of the same thing,” says Joseph Santen, product manager of analog circuit functions for Burr-Brown Research, Tucson, AZ. “These newer versions are much smaller and give comparable performance for one-half to one-third the price.”

And for very high-volume products, the semiconductor companies tend to make the ICs in monolithic form, which is even more cost-effective.

A major influence in producing better analog ICs at lower costs is improved fabrication. Better understanding by manufacturers of the fabrication processes has led to the following:

- Increasing use of multiple IC technologies on the same chip—like combining bipolar and MOS or CMOS.
- Laser trimming on both monolithic chips and hybrid ICs to improve performance.
- Ion-implantation techniques to produce circuits that have less noise.
- I2L technology to reduce chip size and permit more effective use of a chip.

More op amps per chip

The use of multiple technologies and improved processing have probably had the greatest impact on monolithic op amps. A major trend is the production of two or four op amps on one chip. One result is an improvement in the tracking of various tolerances, such as the temperature-sensitive factors.

The first—and so far the only—monolithic chopper-stabilized amplifiers to hit the market, the Harris HA-2900 series, resulted from combined bipolar and MOS technology. The series features a low offset drift of 0.2 \(\mu\)V/°C, bias currents in picoamperes and offset voltage drift of \(\pm 10 \mu\)V per year. The price for commercial temperature range is $25 (100 quantities).

Stereo decoder printed circuit board contains an RCA 3090 phase-locked loop IC. These decoders are produced by the millions for use in home, auto and hi-fi FM radios.

The inputs of the 2900 series are symmetrical and differential, notes Frank Abreu, linear product marketing manager for Harris Semiconductor, Melbourne, FL. Which means that the series can be operated in an inverting, non-inverting or balanced configuration.

A combination of MOSFET, bipolar and CMOS in RCA’s CA-3130 series provides an input resistance on the order of \(1.5 \times 10^{12}\) \(\Omega\), a gain-bandwidth product of 16 MHz at unity-gain crossover, an open-loop gain of 110 dB and a slew rate of 10 V/μs typical.

Merle Hoover, manager of bipolar applications engineering in the RCA Solid State Div., Somerville, NJ, points out that the CA-3130 uses a CMOS transistor pair at the output. This pair can swing the output voltage to within millivolts of either supply voltage.

Jim McDermott
Eastern Editor
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Solving switching problems is what we’re all about.
The output current is high, Hoover says—typically 20 mA.

While Harris is still sole supplier of the monolithic chopper-stabilized op amp, National has just introduced a two-chip non-chopper hybrid that is intended to compete with it. Dean Coleman, National's marketing manager for standard analog modules, says that the new precision op amp—the LH0044—has guaranteed offset voltage and drift of 50 µV and 0.5 µV/°C, along with very low 1/f noise. The long-term stability is given as better than 1 µV per month and the noise level as lower than 0.7 µV, pk-pk, from 0.1 to 10 Hz. The open-loop gain is better than 120 dB.

The improved characteristics were achieved by new processing techniques and laser trimming of critical metal-film resistors to minimize offset voltage and drift.

To reduce op-amp noise, National Semiconductor uses ion-implantation techniques that put JFET transistors and bipolar devices on the same monolithic chip. Previously the production of a pair of JFETs matched to a bipolar pair was difficult, because control of the vertical JFET implant dimensions required a tolerance 10 times closer than that for the bipolar devices. Ion implantation solved the problem in National's LF series by producing an ultra-thin, precisely controlled doped layer.

The noise figure of the National LF 156 is typically 15 nV/√Hz at 100 Hz. Typical input current is 30 pA; the offset, 3 nV, and drift with temperature, 5 µV/°C. The supply current for the device is only 5 mA.

Phase-locked-loop monolithic circuitry currently found in integral packages—the Exar 2211, for example—is designed to perform such functions as tone detection and decoding and FSK data modulation and demodulation.

Advantages of PLLs

The phase-locked-loop circuitry is also incorporated on monolithic chips for consumer ICs, along with additional circuitry on the same chip, to provide such functions as stereo multiplex decoding (where PLLs are used most), TV chroma subcarrier regeneration, TV horizontal sync and FM i-f demodulation.

The temperature instability of the VCO in integral PLLs—a principal early problem—has been substantially improved, says Alan Grebene, Exar's president and developer of the first monolithic PLL. The temperature stability of the Exar-2211 VCO, one of the latest devices, has been increased to 20 ppm/°C, compared with 600 ppm or more for first-generation devices.

"The stability is now high enough so the devices can be used for narrow-band tone decoding, such as in telegraph FSK channels," Grebene points out. These channels have a bandwidth of ±5 cycles, compared with about ±20 cycles for telephone tone decoding.

A trend in PLLs, notes RCA's Hoover, is toward higher frequencies and lower power for portable applications. As an example, he points to RCA's 4046 micropower CMOS PLL.

Frequency drift is spec'd at 0.06/°C at a V_{DD} of 10 V. The operating frequency range is 1.2 MHz max, and power requirements are typically 70 µW at 10 kHz with a drain voltage of 5 V.

Laser trimming cuts costs

The use of laser trimming is proving widely useful in improving precision and reducing the costs of a/d and d/a converters, multipliers and other functional circuits.

"The ability to laser-trim a monolithic chip is important," notes Burr-Brown's Santen. "On a low-cost, low-accuracy, 2 to 4% multiplier, we can laser-trim the resistors on the chip to give us accuracies down to 1%. For example, our 4205 is a 1% monolithic device that sells for $26 in small quantities.

At Motorola a new 10-bit DAC being readied for the end of this year—the MC 3510—"will be a low-price unit with real performance," says Ronald Campo, marketing manager of linear circuits.

"To achieve this, we've had to go to the laser-trim technique," he reports. "And we can supply 8-bit DACs in the $3 or $4 range because of the inherent low-cost advantage of monolithic design.

Jerry Fishman, marketing manager of Analog Devices' Semiconductor Div. in Wilmington, MA, says:
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For a demonstration and complete information send the reader service card or write to Norland Instruments, Dept. D-2.
Complex mathematical operations can be performed using this 4204 multifunction converter by Burr-Brown. This $23.50 package uses hybrid design.

"Laser trimming is necessary to achieve the kind of accuracies that designers want in IC converters. We trim at both the wafer level and also do outboard trimming on a separate substrate for these devices.

"In the 12-bit area, we believe that the best technology possible is that of a two-chip hybrid design. But within the 10-bit a/d area we have a new monolithic CMOS device made in our Santa Clara Facility, the AD7250. In the low-accuracy end of the spectrum, we have a monolithic 8-bit d/a converter.

"We've just introduced a very-high-precision op amp, the AD610, a laser-trimmed bipolar amplifier with initial offset voltages as low as 25 μV. Previously the best we could get was about 1 mV."

Low-cost monolithic d/a

An unusual low-cost monolithic d/a converter recently introduced—the MonoDAC-08, by Precision Monolithics, Santa Clara, CA—is an 8-bit multiplying d/a converter—that is, the output current is the product of a digital number and an input reference current of 0 to 4 mA.

Selling for $6.95 each in quantities of 100, the device has 0-to-70°C temperature range, and a settling time of 85 ns, according to Donn Soderquist, the company's applications engineer. Linearity of the unit is 0.40% over the temperature range.

The input supply of the MonoDAC-08 ranges from ±4.5 V to ±18 V. An output compliance from -1 V to 18 V allows current-to-voltage conversion without output op amps. This feature has not been available before, Soderquist points out.

"It's also the first DAC capable of interfacing with all forms of logic, and it's also the first one with complementary output," he adds.

"With no external components or trims, we get 0.25% accuracy," says Burr-Brown's Santen. "Adding external resistors to eliminate some offset will provide 0.1%.

JFETs supersede PMOS

Analog switches and gates for selection and multiplying now are available as monolithic and hybrid IC devices. Some years ago Siliconix introduced PMOS analog switches, which were monolithic having up to eight channels.

"But the PMOS switches required high drive and had a large variation in RON along with the input signal," says James Spicer, product marketing manager for analog switches at Siliconix.

"Today these devices have been supplanted by JFET analog switches driven by a variety of process-type drivers. The most popular is a combination of bipolar, Schottky and PMOS technology, all integrated on one substrate.

"This gives the advantage of TTL compatibility at the input, very high speed at the drive point—due to the Schottky transistors—and zero variation of JFET channel resistance with the applied signal."

Intersil uses five fabrication techniques in its line of switches and gates, according to George Krautner, product manager of the analog gate line. One hybrid approach uses a bipolar driver with JFET for the switch, and another employs a bipolar driver with a PMOS switch array.

A third approach, Krautner says, is the use of monolithic CMOS switches, such as in the IH5060 16-channel multiplexer and the IH5070 differential eight-channel IC.

A fourth type uses a CMOS driver with a proprietary VarafET switch. Rather than supply gate voltage to turn the device on or off, the VarafET works on a charge-transfer principle.

The fifth approach is found in Intersil's low-cost analog gate family—hybrids having from one to four gates per package. This family uses a JFET with a p rather than an n channel. It is TTL-compatible, Krautner points out.

Consumer ICs improve

In the consumer field, audio ICs for radios, TV and stereos are improving steadily. John Oliver, radio IC designer at Sprague Electric in Worcester, MA, points out that while 10 years ago the output stages of an audio IC were capable of a few tenths of a watt, today 3, 5 and 10-W power amplifiers are feasible as fully monolithic devices.

For example, Sprague's ULN 2280 is a 3-W power amplifier that is short-circuit protected and also has inherent thermal shutdown.

Motorola has IC projects that use I2L technology in all consumer areas, according to John Comeau, consumer linear product planner.

"We've taken the I2L process and made it linear-compatible," Comeau says. "I2L is most effective when you have a digital function that you can put in one corner of an IC chip, and then put all the linear interfacing, and buffers on that same chip."

Among new parts developed for color TV circuitry, Motorola has two triple chroma demodulators—the 1323 and the 1399. While the MC 1399 is suitable only for TV, Comeau says, the MC 1323 can also be used in applications where a simple modulator-demodulator is needed.
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A special report on ICs

16-k RAM and reprogrammable ROM races begin to heat up

Even before the dust has a chance to settle in the hotly contested 4-k RAM sweepstakes, semiconductor manufacturers are straining at the starting gate as the race to capture the 16-k crown is about to begin.

In another contest, the 1-k SOS/CMOS RAM is challenging the well-entrenched 1-k bipolar RAM for applications requiring high speed and low power.

Meanwhile, the enormous demand for reprogrammable ROMs—which has been caused in part by the increased use of microprocessors—has prompted two industry leaders to come out with bigger and better devices.

16-k RAMs on the way

True to Gordon Moore's rule of four, which states that the memory density advances will come in multiples of four, the semiconductor industry is on the verge of introducing the 16-k RAM. While commercial parts are not expected to be available for at least a year and maybe more, semi makers are racing the clock to see who will be the first to announce, on the theory that the first one will get the lion's share of the business. Some think Intel will keep up the tradition of being the leader and once again will announce the latest development in semi memories at the International Solid-State Circuits Conference next February.

When the 4-k RAM was introduced, confusion erupted in the marketplace because just about every manufacturer had a different design. The situation will be different for the 16-k devices because most semi makers are expected to come out with pin-compatible memories. At a recent meeting in Colorado, the memory makers got together to discuss the pin assignments for the 16-k device.

While no official standard was adopted, it was generally agreed that most 16-k offerings would be patterned after the Mostek 16-pin 4-k device. All the pinouts would remain the same except for the chip-select bar, which would be eliminated and replaced by another address pin. Since the address lines in this configuration are multiplexed, adding one more address pin effectively gives two additional address lines. This permits the jump from 4-k to 16-k. Also, since the same address pins are used to select both the row and column being addressed in the memory, speculation is that the 16-k RAM will have a 128-by-128 format.

Though most semiconductor manufacturers seem satisfied with the modified Mostek pin arrangement discussed, Texas Instruments indicates that it may try to come out with an initial offering in a 22-pin package.

According to Ed Huber, TI's manager of MOS memory marketing, the 16-pin package has a serious constraint—it is only 300 mils wide. This, says Huber, limits the size of the chip that can be used for the 16-k memory. Estimates are that a chip would be limited to a width of 150 mils and a length of 220 mils. On the other hand, he points out, a 22-pin package is 400 mils wide, making feasible a larger chip and one that is easier to fabricate. The larger 22-pin package has other advantages as well, notes Huber. Its thermal impedance is lower, and consequently its power dissipation is better.

Another thing that makes the 22-pin package more attractive, he remarks, is that the extra pins allow full binary addressing instead of multiplexed. This should result in a higher performance memory.
Commenting on the cell size required for the 16-k memory, Huber notes that it should be about half the size of the cell used in the 4-k memory. That would make it anywhere between 0.75 and 1 sq. mil.

Ron Livingston, National Semiconductor's manager of random-access memories, agrees with Huber that the cell size has to come down. He also points out that this could lead to a potential problem. In theory, says Livingston, if the cell size becomes smaller, refresh and data retention problems are likely to crop up. This is due to the smaller capacitances involved and the high leakage rates. But, he continues, if the process improves—as it does continuously—it will be possible to get better surfaces and thus lower leakages. The net result is a break-even situation, he reports.

Livingston cautions that it is essential for memory makers to stay with a simple process, like standard silicon-gate technology. Otherwise, he warns, manufacturers are likely to have problems such as Mostek had when it went to the more complex nitride process.

Motorola's Peter Bagnell agrees. He points out that the combination metal-gate, silicon-gate process that Mostek used on the 4-k RAM resulted in reliability problems. These were primarily related to oxide steps and microcracking of the metallization. Industry sources indicate that Mostek is still having problems and that it is redesigning its 4-k 16-pin device so that it will use standard silicon-gate technology.

RCA's memory manager Hank Miiller disagrees with both Bagnell and Livingston. 16-k memories, says Miiller, require the perfection of the nitride process. Both nitride transistors and nitride capacitors are needed for storage. Miiller acknowledges that it's easy to rationalize simplicity such as that attainable with the silicon-gate process. But, he predicts, one guy is going to be a bit more clever and he's going to perfect nitride processing. And when he does, he's going to have an advantage over everyone else. Explaining further, Miiller notes that nitride technology offers a size advantage over the silicon-gate approach. The chip size required for silicon gate is not competitive, he claims. "You need a chip with a total area of between 28,000 and 29,000 sq. mils," he reports. And it may not be possible with silicon-gate technology.

As to availability, National's Livingston says we'll probably see a few people playing with the 16-k RAM by the end of the year. But, he cautions, don't look for any production quantities before 1977. After all, he continues, we're just now getting the 4-k into production; why screw it up by sending out a 16-k device?

4-k RAMs for here and now

Back on the production front, semiconductor manufacturers are turning out 4-k RAMs by the thousands, but as yet there is no industry standard. There are now five different 4-k RAMs available with five different pin configurations and three different package sizes. But indications are that at least one of them—the Mostek 16-pin device, MK 4096—will become a de facto standard. The reason is that in addition to Mostek, at least six and maybe even seven other semi makers are planning to come out with memories compatible with RAMs. So most customers have an alternate PC-card design that will accommodate the 16-pin devices.

But the most powerful selling feature of the 16-pin 4-k RAM, claims Motorola's Bagnell, is that it is extremely simple to update any design using it to the 16-k memory chip when it becomes available.

"Since all but one of the pinouts on the 16-k are the same as the pinouts on the 4-k, it is only necessary to change the connection to one pin to update the circuit to the 16-k device," he notes.

Bagnell believes the race for top spot in the production of 4-k devices will be between Motorola and Intel. "Before the end of the year we'll have shipped about a quarter of a million units. Intel should be doing about the same." And Mos-
Static ROMs like this p-channel 4096-bit device from National Semiconductor use a low threshold voltage technology to achieve bipolar compatibility.

tek, which pioneered the design that is expected to make such a big impact on the marketplace, will be in third position, Bagnell contends. Explaining why, he points to the reliability problems they've had and the redesign they are now going through. "They're simply not in a volume mode yet," he says.

Taking a look at the overall 4-k memory market for next year, Bagnell predicts that 55% to 65% will go to the 16-pin device, 15% to 20% to the 18-pin design and the remaining 20% to 25% to the 22-pin unit.

TI's Huber strongly disagrees with Bagnell. He claims that a large majority of the 4-k devices that will be sold next year will be of the 22-pin variety, because they have been designed in and are being shipped in large quantities. Everyone else, except for Mostek, is just getting started in the 16-pin design, and it will be some time before they can get volume up, Huber points out.

SOS challenges 1-k bipolar

Bipolar RAMs, which are still only at the 1-k density level, are finding wide applications in areas where speed is most important. But parts like the 93415 are in for some stiff competition from 1-k SOS/CMOS RAMs from RCA and Advanced Memory Systems.

According to RCA's Müller, the SOS memory, called the TA6780, is currently being sampled. It provides speeds comparable to those of the 93415, consumes less power and has the same pinouts. At 10 V, the access time for the TA6780 is about 120 ns. By the end of the year, RCA expects to be able to cut that time in half. In the active mode, the SOS memory consumes 20 mW of power and dissipates only 1 mW in standby. This compares with 0.5 W for the 93415.

Commenting on the viability of SOS as a memory technology, Müller notes that CMOS on sapphire is now a production technology. RCA has overcome a lot of the problems that have plagued would-be CMOS/SOS manufacturers by combining silicon-gate technology with ion implantation. Ion implantation, reports Müller, overcomes a lot of control problems. It is no longer necessary to overdesign in order to be sure that you'll get exactly what you want, he claims.

Talking about future plans for SOS technology, Müller predicts that by next year RCA will have a 4-k SOS/CMOS RAM. That just...
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<table>
<thead>
<tr>
<th>MECL III</th>
<th>PLESSEY PECL III</th>
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<tbody>
<tr>
<td>MC1644 Digital Mixer</td>
<td>SP1644</td>
</tr>
<tr>
<td>MC1648 Voltage Controlled Oscillator</td>
<td>SP1648</td>
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<tr>
<td>MC1658 Voltage Controlled Multivibrator</td>
<td>SP1658</td>
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<td>MC1660 Dual 4-Input OR/NOR Gate (High Z)</td>
<td>SP1660</td>
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<td>MC1669 Dual Clocked Latch (Low Z)</td>
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<td>MC1670 Master-Slave Type D Flip-Flop (High Z)</td>
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<tr>
<td>MC1671 Master-Slave Type D Flip-Flop (Low Z)</td>
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<tr>
<td>MC1672 Triple 2-Input Exclusive OR Gate (High Z)</td>
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<td>MC1673 Triple 2-Input Exclusive OR Gate (Low Z)</td>
<td>SP1673</td>
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<td>MC1674 Triple 2-Input Exclusive NOR Gate (High Z)</td>
<td>SP1674</td>
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<tr>
<td>MC1675 Triple 2-Input Exclusive NOR Gate (Low Z)</td>
<td>SP1675</td>
</tr>
<tr>
<td>MC1690 UHF Prescaler Type D Flip-Flop</td>
<td>SP1690</td>
</tr>
<tr>
<td>MC1692 Quad Line Receiver</td>
<td>SP1692</td>
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Write on your letterhead and we'll send you a copy of temperature stressing data on PECL III, and specifications. If you're interested in ECL II, ask Plessey about our extensive range of PECL II devices. Has a second source ever looked better?

Finally, a second source for ECL III. Plessey's got 'em!
might beat the bipolar memory makers to the punch.

**EAROMs getting bigger**

Electrically alterable ROMs are quickly becoming the darlings of the PROM market. Yet only a few short years ago, most industry experts were wondering whether the complex nitride processing and extra expense that these devices require, would make them a viable product.

Bruce Moore, National's marketing manager for ROMs and PROMs, notes that the sudden interest in reprogrammable PROMs is due largely to the dramatically increased use of microprocessors. In fact, industry sources estimate that more than half of the EAROMs that will be sold will go into microprocessor systems.

Another reason for the increased use of EAROMs, says Moore, is that they are being accepted more. People are not as nervous about using them and accidentally losing their data as they used to be. Also, he continues, the larger fusible-link PROMs are producing extremely poor yields when they are programmed. The reason for this, he explains, is that there is no way of final-testing them. Once the link is blown, that's it. It can't be restored. No one, says Moore, can supply a 4-k fusible link PROM that will yield in the 90% range.

This is where the EAROM has a fantastic advantage, he declares. Because it iserasable, every single bit can be programmed and tested. If a part isn't up to par, the customer never sees it.

Until this year, any designer who wanted to use an EAROM was limited, with a few exceptions, to the 1702A, a 2-k ultraviolet erasable device. Then, answering the prayers of circuit designers for larger, easier-to-use devices, Intel and National announced larger devices almost simultaneously.

National came out with the MM-5204, a p-channel silicon-gate device that is organized into 512 words of 8 bits each. The device that Intel announced during the second quarter of this year was a 4-k unit similar to National's, and the industry's first 8-k EAROM.

The new reprogrammable devices operate at twice the speed, dissipate only one third as much power per bit and can be programmed five times faster than the 2-k standard.

Even though Intel's 8-k EAROM has only recently been announced, National's Moore thinks they may be having problems with it. Explaining why, he notes that they are already speed-selecting the device for a slower part.

In fusible-link bipolar PROMs, the latest development is Harris Semiconductor's family of Generic PROMs. According to Ed Fernandez, Harris' manager of memory products, the Generic PROMs are aimed at overcoming a major problem that faces users of programmable ROMs—lack of standardization. Unlike other fusible-link PROMs whose programming requirements vary from device to device, all the PROMs in the new Harris family have the same programming requirements and standard dc parameters.
Finally! A unique low-cost multi-turn cermet that speaks for itself!

The New Spectrol 3/8-inch Model 64

Unique mechanical design of rotor, clutching assembly, and housing provides superior setability and stability with virtually no backlash ... 28-fingered brush contact for low CRV ... compact 3/8-inch square sealed unit ... top-adjust or side adjust with 6 configurations ... directly replaces the models 3299 and 66. Available now from the factory and 75 distributor outlets.
your source for digitally programmed d-c power supplies

This, for example, is a dual-output power supply system comprised of a pair of Kepco JMK Power Supplies, each controlled in both voltage and current by type SN Digital Interface Cards.

One power supply, Model JMK 100–1M produces 0–100 volts controlled in 12-bit binary; and 0–1 ampere controlled in 8-bit binary. The other unit, Model JMK 15–6M produces 0–15 volts controlled in 3-digit BCD; and 0–6 amperes controlled in 2-digit BCD. The two SN Cards that program each power supply are mounted in pairs, each in a type CA–6 dual enclosure. The whole system is assembled in Kepco's RA–24 enclosure, that will occupy only 5¼" of space in your 19" rack.

The SN Digital Interface Card accepts your data input on parallel lines, strobed for noise immunity, and stores the data in a buffer register. For isolation, the program is transferred across optical couplers so that your digital signal and the power supply it controls can be up to 1000V apart. The five types of SN Cards offer a choice of BCD or complementary binary programming.

The analog output from the SN Card is in the form of a 0–1V/0–10V range-selected signal* that is linearly amplified by the companion power supply to produce the desired output. In the illustrated combination of JMK 100–1M and SN–12, the power supply functions as a gain of 10 amplifier, with 12 bits (0.024%) resolution. The JMK 15–6M, programmed by SN–3, functions as a gain of 1.5 amplifier, with 3 digit (0.1%) resolution. The range selector on the SN allows the full resolution to be spread over the lowest 10% of the output.

*The SN Card also produces ±10V & ±5V outputs to control bipolar power supplies and 0.5V, 1.0V outputs to control current stabilizers.

These SN Cards are fully self-contained digital programmers, featuring an on-card line-operated power supply. Kepco offers a variety of housings and accessories to accommodate them to various programmable power supplies. As many as eight cards can be accommodated in a standard 5¼" x 19" panel.

SN CARDS AVAILABLE

<table>
<thead>
<tr>
<th>MODEL</th>
<th>RESOLUTION</th>
<th>LINEARITY</th>
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</thead>
<tbody>
<tr>
<td>SN–2</td>
<td>2 BCD</td>
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<tr>
<td>SN–3</td>
<td>3 BCD</td>
<td>±0.05%</td>
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<td>SN–8</td>
<td>8-bit</td>
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<td>SN–10</td>
<td>10-bit</td>
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<tr>
<td>SN–12</td>
<td>12-bit</td>
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For complete specifications, write Dept. EX–05

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INFORMATION RETRIEVAL NUMBER 31
Congress bids to halt long-range spending

A move is under way in Congress to impose time limits on long term spending authorization, not only for major weapon systems but for small projects as well.

Sen. Joseph R. Biden Jr. (D-Del.) would like to limit congressional spending authorization to four years, and has introduced such a bill.

After four years a review would be conducted to examine not only the increased costs, but to evaluate the worthiness of the program itself. "Once a program gets started," he says, "it is very difficult to stop it, or even change its emphasis, regardless of its past performance."

Sen. Biden is also concerned that many small spending programs might otherwise automatically be continued without careful scrutiny. A lot of bad small programs could add up to a lot of wasted money.

Is technical innovativeness on the decline?

There is growing pressure in Congress for a national policy regarding research and development.

Sen. Lloyd Bentsen (D-Tex.), chairman of the Joint Economic Subcommittee on Economic Growth, warns of an increasing tendency in the U.S. to favor the protection of threatened industries over innovative moves into new and risky areas. Over the past 15 years, he says that U.S. companies have found it easier and safer to expand by manufacturing old products than to create new ones.

The Senator, decrying the nation's declining commitment to technological innovation, relates the drop in R&D spending to the decline in export sales. From 1953 to 1964 the annual R&D spending rate increased at a 12% clip and the balance of trade surplus in 1964 was $6.1-billion. From 1964 to 1971, R&D spending increased at a rate of five per cent and the 1972 surplus became a $6-billion deficit.

Environmentalists are gunning for PCBs

If the Environmental Protection Agency succeeds in pushing through its proposed effluent-discharge standards for polychlorinated biphenyls (PCBs), it may cost industry, and eventually the consumer, $500-million a year. The cost will come from less efficient capacitors and transformers, which require more energy to produce. The extra energy would probably eat up 35-million barrels of oil a year, EIA says.

PCBs are compounds produced by replacing hydrogen atoms in biphenyls with chlorine atoms. They are used as fluid electrolytics in capacitors and in large electric utility transformers. Major advantages are their
fire retardant qualities and desirable chemical qualities.

The proposed alternative chemical substitutes are not fire retardant and are not as safe and reliable. Also to get equivalent performance, capacitors and transformers made with the substitute materials will be physically larger.

EIA proposes adoption of two standards, one for Monsanto's PCBs, which are sold only to transformer and capacitor manufacturers, and one for imports which are not as biodegradable as American products.

The trade association argues that with over 200 variations of PCBs with differing characteristics they can't justifiably be lumped under one standard. EIA says the proposed standards are "unnecessarily stringent, practically unattainable and legally indefensible."

---

**Avionics contract gets field performance clause**

The Air Force has awarded the first large avionics production contract within the Defense Dept. with a Reliability Improvement Warranty—a clause that holds the contractor responsible for the field performance of the equipment for a specified period of time. The $14.6-million contract with Rockwell International's Collins Radio calls for an initial 1000 solid-state AN/ARN-118 (V) tactical air navigation Tacan units with options for 7000 more. The new units have an air-to-ground range of 390 nautical miles and an air-to-air range of 200.

---

**Capital Capsules:** The National Science Foundation has been reorganized. The present Research Directorate now becomes three directorates: Mathematical, Physical and Engineering Sciences; Astronomical, Earth and Ocean Sciences; and Biological and Social Sciences. Functions of the Research Applications Directorate are unchanged, as are existing procedures, such as submitting proposals. . . . The Energy Research and Development Administration has awarded $1.4-million in contracts to General Electric, Westinghouse and Spectrolab to study designs of terrestrial photovoltaic electric power systems. . . . The Air Force is soliciting manufacturers to produce high reliability nickel-cadmium batteries and nickel hydroxide electrodes for nickel-hydrogen batteries. Sources are also sought to conduct exploratory development on octave bandwidth YIG-tuned oscillators in the 4-to-10-GHz range. . . . Companies planning to export technology vital to the national interest no longer have to file a report with the East-West Foreign Trade Board. Since the same information is included in the application for export licenses the Board has decided that this will be sufficient. . . . The Navy will hold a briefing on SIRCs—Shipboard Intermediate Range Combat System—on Aug. 19 at the Naval Surface Weapons Center in Silver Spring, MD. SIRCs is an integrated, detection-to-kill, modular combat system for the mid-1980s and beyond for defending surface ships . . . . The Federal Council for Science and Technology has published a directory on Federal technically oriented programs. Called the "Directory of Federal Technology Transfer," it describes programs, agency contact points, and technical support resources of 43 agencies of the Federal government. Copies sell for $4.30 through the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. . . . A low-cost, advanced flight control system for general aviation aircraft in which about one-third of the control surfaces are controlled by a new automated avionics system is being tested by the National Aeronautics and Space Administration in a Beechcraft Model 99 commuter aircraft.
If you can't bring your troubleshooting into your lab, roll Tektronix TM 500 to the problem.

- digital multimeters
- counters
- generators
- amplifiers
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- oscilloscopes
- a blank plug-in for your own circuitry
- and more

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The modular Rollabout Configuration provides up to six operating test and measurement instruments, which you can tailor from a growing line of 29, plus the TEKTRONIX portable or plug-in oscilloscope of your choice . . . all on a SCOPE-MOBILE cart. TM 500 modular instruments can work together through a common interface circuit board within their mainframe enclosures, and they can also function totally independently. Some are general purpose, such as DMMs, some are highly specialized, such as those for oscilloscope calibration. They comprise a test and measurement system that is difficult to duplicate with “monolithic” instruments.

The TM 500 Product Line is a growing, compatible family of 29 plug-in modular instruments, accessories, and one, three, four, and six-compartment mainframes providing the common power supply. The modular Rollabout Configuration can accommodate two TM 503, 3-compartment mainframes. Select the plug-ins from 11 signal sources, 5 counters, 2 digital multimeters, 5 power supplies, 3 signal processors, 1 oscilloscope, and an X-Y monitor. There’s also a blank plug-in kit to make it more convenient for you to assemble the specialized circuits you require. A TM 500 modular Rollabout Configuration lets you take the instrumentation you need where you need it.

Find out what TM 500 instrumentation can do for you. Send for the TM 500 Booklet A-3072 with full specifications and suggested selections of instruments for typical applications. Or contact your local Tektronix Field Engineer for a demonstration of how TM 500 instruments can solve your needs. Write to Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077. In Europe write Tektronix Limited, P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.
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INFORMATION RETRIEVAL NUMBER 34
Electronic Design 17, August 16, 1975
FOR DEMONSTRATION CIRCLE 290
HiNIL Interface

Prevent CMOS latch-ups and failures with a high noise immunity logic I/O.

CMOS systems are subject to latch-ups and failures in the field because of high voltage transients, static charge and improper field maintenance procedures. Moreover, due to their increased output impedance, CMOS is more susceptible to transient errors than corresponding bipolar logic.

A simple solution to these problems is to use Teledyne's bipolar High Noise Immunity Logic (HiNIL) as the system I/O interface. The I/O design approach shown in Figure 1 has solved these problems in applications such as business equipment, industrial controls and electronic games. The HiNIL interfaces protect the delicate CMOS inputs with a rugged bipolar "front end" not susceptible to CMOS failure modes. Also system noise immunity is maximized, and the HiNIL output devices provide direct, high current logic drive of relays, displays and long lines.

HiNIL Schmitt triggers. They prevent latch-up at DC input levels from -5 volts to \( V_{cc} \) +5 volts and suppress 100 volts transients as wide as 1 \( \mu \)sec (Figure 2).

HiNIL inputs on plug-in cards will protect a CMOS system from problems associated with "on power" fault isolation, a widely used TTL system maintenance method. Plugging CMOS into powered connectors has led to latch-up failures because it allows inputs to see logic "1" signals before \( V_{cc} \) rises on the card. The failure is frequently catastrophic if input current is not limited.

HiNIL's lower output impedance and DC noise margin of 3.5 volts ignore large voltage noise transients that can cause CMOS logic errors. Also, static charges large enough to rupture CMOS oxide regions are often generated in dry environments by movement of materials and users. A HiNIL input gives more immunity to static and maximizes noise protection.

Examples of HiNIL Interface Devices

- 301 Dual 5-Input Power Gate
- 302 Quad Power NAND Gate (OC)
- 303 Quad Power NOR Gate (OC)
- 304 Quad Power AND Gate (OC)
- 305 Quad Power OR Gate (OC)
- 306 Quad Power NOR Gate (OC)
- 307 Quad Power AND Gate (OC)
- 308 Quad Power OR Gate (OC)
- 309 Quad Power XOR Gate (OC)
- 310 Quad Power XNOR Gate (OC)
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- 369 Quad Power XOR Gate (OC)
- 370 Quad Power XNOR Gate (OC)
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- 372 Quad Power NOR Gate (OC)
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- 374 Quad Power OR Gate (OC)
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- 376 Quad Power XNOR Gate (OC)
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- 378 Quad Power NOR Gate (OC)
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- 381 Quad Power XOR Gate (OC)
- 382 Quad Power XNOR Gate (OC)
- 383 Quad Power NAND Gate (OC)
- 384 Quad Power NOR Gate (OC)
- 385 Quad Power AND Gate (OC)
- 386 Quad Power OR Gate (OC)
- 387 Quad Power XOR Gate (OC)
- 388 Quad Power XNOR Gate (OC)
- 389 Quad Power NAND Gate (OC)
- 390 Quad Power NOR Gate (OC)
- 391 Quad Power AND Gate (OC)
- 392 Quad Power OR Gate (OC)
- 393 Quad Power XOR Gate (OC)
- 394 Quad Power XNOR Gate (OC)
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- 396 Quad Power NOR Gate (OC)
- 397 Quad Power AND Gate (OC)
- 398 Quad Power OR Gate (OC)
- 399 Quad Power XOR Gate (OC)
- 400 Quad Power XNOR Gate (OC)

HiNIL reliability insurance costs little since the I/O circuits—unlike filters and shielding—generally replace other logic and drive circuits. So, don't wait until your new CMOS system runs into costly problems in the field. We'll show you how to build foolproof low-power systems. Call or write today for HiNIL application notes and specifications.
The man who was never wrong

I used to think that arrogance was inversely proportional to a man's competence. I was wrong; competent people can be arrogant, too. My view was colored by Harry, an engineer who had more jobs than he could remember. Harry was good and, if you weren't certain, you had merely to ask him. There was nothing that he couldn't justify with the most cogent logic.

Harry was, in fact, one of the brighter engineers. But he was sloppy. He made lots of mistakes that could have been avoided with some care. If you showed him his mistakes, he always came out clean. He changed the subject; he gave a logical justification for the errors; or he blamed someone else, usually his technician.

When Harry lost a job, that was always someone else's fault: he had been knifed by someone playing company politics; the chief engineer was stupid and didn't recognize Harry's genius; people didn't like his showing up the ineptness of others; or somebody was making room for the boss' nephew.

Clarence was different. Clarence never lost a job; he owned the company. Like Harry, he never made mistakes. When he initiated design changes that made equipment blow up, he laced into his engineers for their stupidity. When his salesman made realistic sales forecasts, he boosted their sales quotas because, of course, his salesmen were simply lazy. And he raised hell when they didn't make the new quotas. When Clarence visited customers, he tried to show some humility, but couldn't quite succeed. Not surprisingly, he lost customers. These losses, of course, were always the fault of his inept salesmen or blundering engineers.

Clarence often harasses his staff and chews everybody out. He treats them like children and teaches them "lessons" about business. It's no surprise that Clarence's company is much smaller than it could have been.

But Clarence, like Harry, is extremely bright. So his company may survive. The unfortunate thing is that Harry and Clarence are completely unaware of the damage caused by their arrogance. Neither knows he's arrogant. Either could instantly justify every move and every decision with inexorable logic. They simply can't see what they're doing.

Can the rest of us?

GEORGE ROSTKY
Editor-in-Chief
Breakthrough in mass termination.

Lower-cost coaxial ribbon cable assemblies. In any length.

New AMP coaxial ribbon cable is just that—true coax in ribbon form. With no compromises. No degradation in system performance. Solves the long-existing coaxial cable termination problem.

We can provide complete assemblies for your specific requirements. In any length, with 6 to 26 positions. The assemblies come in 50-, 75- or 93-ohm ratings, on .100-inch grid spacing. And 95-ohm rating on .125-inch spacing. Connectors mate with .025² posts—either 90° board-mount pin headers or I-O posts.

Revolutionary patented concept with drain wire parallel to center conductor, permits low-cost gang stripping and terminating, and still further demonstrates AMP’s leadership in quality solutions to termination problems.

For information on AMP coaxial ribbon cable that gives you true coaxial performance, and reasonable price, call (717) 564-0100, circle the Reader Service Number, or write AMP Incorporated, Harrisburg, PA 17105.

AMP is a trademark of AMP Incorporated.
The ribbon is made up of individual coaxial cables, each with a solid center conductor and a foil-wrapped drain wire shield. The drain wire is not spirally wound around the dielectric, but runs parallel with the center conductor. This feature allows the cable to be cut anywhere and yet be consistently and reliably terminated.
Environment, shock, vibration and even testing can shorten the life of a potentiometer or trimmer from millions or hundreds of operations to just one or a few.

The expected life is just one of the many factors that must be considered when you select and use a pot or trimmer. Here are some others: temperature coefficient, conformity, linearity, resolution, contact resistance variation, starting torque, backlash, environmental endurance and power rating.

Studying the pot or trimmer data sheet may not give you the true facts, even if the numbers are guaranteed minimum or maximum specifications. Let’s look at some of the different specifications that relate to both pots and trimmers.

Resistances change with temperature

As the external temperatures change, resistance elements will drift off their specified values. Each element type has a temperature coefficient that the manufacturer specifies. Or does he? Some companies define the tempco over the entire range of the device and might give you a number like 100 ppm/°C. But this number could remain constant over the entire range or it could be 200 ppm/°C in the higher temperatures and only 30 ppm/°C at lower temperatures. Most likely the number you get from the data sheet is an average and can’t really be trusted over a narrow range. Check out some units yourself to determine their actual drifts.

Also, make sure the amount of temperature drift doesn’t take the resistance out of the tolerance band you need. A drift of, say, 200

Dave Bursky
Associate Editor

Precision bulk-metal trimmer potentiometers, made by Vishay, keep any resistance drift in check with their temperature coefficients of only 10 ppm/°C.

Large and small pots and trimmers by Bourns fill almost any application. There are sealed and unsealed versions in either single and multiturn configurations.
ppm/°C over a 50-C temperature change may alter the resistance enough to cause a failure in the external circuit.

How well does the resistance element conform to the specified linear, or other, characteristic. As the wiper travels along the element, you can check conformity by plotting the transfer function of the pot or trimmer as a graph of voltage vs percentage of shaft rotation. And how does temperature affect the conformity? If the element is made of one material, there should be no difference.

But, wirewound pots may have several types of wire, connected together in one element to form the characteristics you need. Each wire can have a different tempco and thus throw the conformity out of whack as temperatures change.

If you’ve selected a linear resistance device, how does the manufacturer define linearity? Vendors use several definitions. The Variable Resistive Components Institute (VRCI), 1717 Howard St., Evanston, IL 60202, lists most in standards VRCI-p-100A and VRCI-t-110A. And in standards VRCI-p-200A and VRCI-t-215A the institute describes how to inspect and test precision pots and trimmers, respectively.

The military also has specifications that describe several types of pots and trimmers: MIL-R-22097, 27208, 39015 and 39035 are just a few.

Make sure you can set the value

Whether you need a pot or trimmer, you have a choice of single or multiturn shaft capabilities. The multiturn types provide better resolution and settabiliy but, of course, cost more than equivalent single-turn devices.

Multiturn pots and trimmers also have more complex mechanical drive mechanisms. Consider your application carefully, since the cost of a multiturn can range from double to 10 times that of a comparable single-turn unit. And some wiper drive mechanisms are more reliable than others. Ask the manufacturer how many rotations his unit can withstand. Another thing: How many turns do you need? Manufacturers offer a wide variety, from 1 to 40.

Some manufacturers now offer see-through trimmers that let you see the position of the wiper. This permits you to set the value faster and also gives you an initial “feel” for the setting. And you can get other mechanical aids that can indicate wiper position—turns-counting dials and pointers.

Pot or trimmer resolution depends upon the mechanical drive used, the type of resistance element selected and the shape of the element. For instance, wirewound elements usually produce an output that looks like a staircase—jumping up at discrete values as the wiper arm
Ultraminiature panel-mounting potentiometers (Model 9917) from the IRC division of TRW require only 0.33 in. of behind-panel width and handle 0.5 W at 85°C.

A helical resistance element is just one of the parts that makes up a Duncan Pixipot. These units are available with resistances up to 150 kΩ.

moves from turn to turn. Some companies, though, have overcome this step problem by using a wiper that tracks a spirally wound wire; it doesn’t miss any of the winding. This type of system is used in precision multiturn pots.

Another alternative to calibrated dials is provided by decade potentiometers that use thumbwheel switches to set values to within the desired accuracy. However, the mechanical life of the thumbwheel switches is usually far less than the usable life of the resistance elements.

Most element types provide so-called “infinite” resolution—as long as you don’t need resistances down in the 0-to-50-Ω region. In this low area only wirewound elements reliably provide the low resistances.

As a wiper arm moves over a resistance element, how does the contact resistance vary? This error source, commonly called CRV, depends upon the pressure of the wiper against the element and can change the resistance “seen” by the external circuit. Some of the newer pots and trimmers use multifingered wipers that help eliminate some of this variation. An example of a fairly good CRV spec for a multifingered wiper would be 1% of total resistance or 3 Ω, maximum.

A side benefit of the multifingered wiper is lower noise. As the wiper moves across the element, it generates noise, but by spreading out the wiper contacts, manufacturers have reduced the noise.

Wirewound elements generate the least noise; carbon-composition elements generate the most. The noise is random and stems from several sources: friction and heat generated by the moving wiper, electrical heating due to current flow, and impurities within the element.

The wiper contact wears down the element material as you vary its position. Here’s where you can get into trouble. If the pressure is light, you’ll have minimal wear, but you’ll also have a high value of CRV. Heavier pressure will wear the element faster but will lower the CRV. And the heavier the pressure the more torque needed to turn the adjustment shaft.

Adjust the units with care

How many times can you turn the shaft before the pot or trimmer fails? Most precision potentiometers are rated for over a million cycles, commercial pots in hundreds of thousands of operations and trimmers in hundreds of operations.

Precision units such as servo pots must be durable since they must go through hundreds of operations in just a single use. Low cost pots—like those used in stereos and TV sets—are not usually cycled over their full range but are
adjusted over a limited span. They can thus be rated for a lower number of cycles.

Trimmers, on the other hand, are usually set once and then forgotten until it's time to recalibrate the equipment they're used in. They might be adjusted 10 to 20 times over the life of the equipment.

Whether you use a pot or trimmer, you must adjust the resistance with either a rotating knob, screwdriver or sliding knob. If the applied force or torque is too much, it can damage the unit; if too little, it won't move the wiper. Thus you'd like to know what starting torque is needed. If it's not on the data sheet, check with the vendor.

When you set the pot or trimmer, backlash caused by the mechanism changes the pot or trimmer setting by a slight amount. Check the data sheet for the backlash. Small changes in resistance after setting can cause measurement problems or a need for constant readjustment.

Aside from mechanical backlash, there are other problems when you try to return the resistance to a previously set value. Most of the time you'll be able to get within about 0.1% or better without much difficulty on calibrated precision devices and to within 5% on most noncalibrated units. Many companies spec this as settablility—and along with a percentage figure they'll tell you how long, at the most, it will take you to set the value. However, every time the wiper moves, the resistance element value changes ever so slightly, as does the surface smoothness of the element and the pressure of the wiper. Thus, returning to a previously set value may not be as easy as you think.

After a pot or trimmer is set, what type of shock and vibration will it encounter? Even the lightest jar can move the wiper slightly. Make sure the shaft or slide doesn't move when the unit bounces. Many painstaking calibration procedures can be wasted if you don't use a locking shaft or some other preventive to keep the shaft from moving.

When the pot or trimmer is mounted on a circuit board, heat from the assembly process or fumes from the solder, flux or cleaner can ruin the element.

Be sure the pot or trimmer you've selected can withstand the assembly conditions. Some manufacturers may use a solder with a low melting point for element connections within the pot or trimmer. When you solder the unit into your circuit, you may open the connections to the resistance element or loosen them enough so vibration will cause an intermittent open.

There are some types of connections that are fairly immune to typical solder temperatures. These include swage bonding, welding and clip terminations.

As for the flux or solvent you use, check with
Inside view of a cermet trimmer made by Beckman. This Model 91 is a single-turn cermet device made for mounting onto printed-circuit boards.

Miniature trimming potentiometers on ceramic substrates from Centralab permit the mounting of multiple units with just a single machine operation.

High-precision potentiometers from Electro-Techniques are available in slide, round and turns-counting styles. You can also get units with locking shafts.

Precision potentiometers from Spectral are available with many different shaft styles and stacking arrangements. Also, switches can be added to the last element in a stack.

This quadrasonic joystick-panner control element made by Computer Instrument Corp. provides a 90° sine/cosine function and has mechanical travel of 60°.

the manufacturer to find out if it can contaminate the resistance element in unsealed pots or trimmers. The elements are very vulnerable to chemical attack. Even with sealed pots and trimmers, some solvents can get through the air-tight seals or damage the seal material and cause leaks.

Know the size you need

Size can be a determining factor when you select a pot or trimmer. For instance, if you need a unit that can handle 2 W or more don't expect to find it in a 0.25-in. square package or a 1-in. rectangular. You'll probably have to use a panel mounting pot. If you need a device with 5-W capability don't expect to buy a carbon composition pot in a 0.5 in. diam. case; wirewound and cermet units can fill this need.

Whether the pot or trimmer is square, rectangular or round, there are limitations on the power-handling capability. The larger the case, the larger the resistance element and the higher the power dissipation capability.
Typical sizes of rectangular trimmers, for instance, have decreased from the 1.25 in. long unit of the 1960s to the 0.75 and 0.5 in. models of today. Square and round trimmers are available in diameters or widths as small as 0.1875 in. Power ratings, of course, run from a few milliwatts for the carbon units to about 1.5 W for the cermet and wirewound trimmers.

Potentiometers have also shrunk in size, but not in capability or power-handling capacity. Cermet elements offer improved power ratings over carbon, and in some cases over wirewound elements. Wirewound pots and rheostats usually have the highest power ratings—you can pack 7.5-W capabilities into round cases with diameters of about 0.5 in. Cermet pots are not too far behind and should be in the 4-to-10-W range in the next few years.

Mounting the pot or trimmer is the next problem.

There are many types of mechanical mounting schemes. Custom mounting is usually available from most manufacturers, but you’ll pay dearly for it. First, you’ll probably have to commit yourself to a large order; many companies won’t talk unless you want 100,000 pieces at between 5 and 50 cents each. Then comes a tooling charge for those custom metal or plastic parts needed to mount the device. Unless your requirements are so exotic that they rule out a standard mounting scheme, don’t go custom. Many companies offer hundreds of mounting options, including different shaft styles for their own pots and trimmers, but you have to scour the catalogs to find what you need.

Picking the element taper

The resistance taper of potentiometer elements is another area where exotic requirements can prove expensive. Check the standard types available before you order a custom design. For customs, you’ll spend from five to 100 times more.

But choose the standard taper carefully. Make sure both you and the manufacturer agree on exactly what’s meant by a certain characteristic—for example, the type of logarithmic function, the number of decades and the percent rotation per decade. There are more variations than can be written for resistive elements; you can get types that conform to the sine, cosine, tangent or any other function that you care to create.

It’s easy enough to zap the resistance element—just try using a VOM to measure the resistance of a low-power pot or trimmer. If one lead of the VOM is connected to the wiper and the other to one end of the element, the scale set on ohms ×1 and you try to measure the minimum resistance of the unit—you can easily end up with a burned out element.
The VOM has an internal power source that generates a current that can reach several hundred milliamperes when using the ×1 setting. This current can generate enough power and heat through the element to open it before the pot or trimmer is ever put into a circuit.

Placing too high a voltage across the element is another fast way to wipe it out. In this case, though, you can cause even more damage. If the voltage is too high it can break down the dielectric material that separates the resistance element from the case or panel in which the unit is mounted. Make sure you don’t accidentally set the stage for subsequent shock hazards.

Ground potential differences can also cause unexpected failures. Make sure there are no large differences that can cause dielectric breakdown. If you do have large differences get a unit that is specially designed for high voltages.

When you use a pot or trimmer as a variable voltage divider to supply a large current, the power dissipation along the resistive element may be uneven. The section from the wiper to the end terminal connected to the supply conducts a current that is the sum of the load current and the current through the rest of the element. The power dissipation per unit length of the element is a function of the square of the

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**Need more information?**

We wish to thank the many companies that provided information for this report. Readers may wish to consult the manufacturers listed below and in Electronic Design's GOLD BOOK for further technical details. (Companies that manufacture pots are noted with a P and those that make trimmers with a T.)

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**International Importers**, 2242 South Western Ave., Chicago, IL 60608. (312) 847-6363. (S. Davidson) P Circle No. 426

Littin Systems Inc., Potentiometer Div., 226 E. 3 St., Mount Vernon, NY 10550. (914) 664-7755. (J. E. Pinck) T Circle No. 427


Maury Instruments, 4559 W. 60 St., Chicago, IL 60629. (312) 581-4555. (E. Maury) P Circle No. 429


Micro Dynamics Inc., 9855 Deepstree St., So. Orange, CA 91713. (213) 579-1166. (A. Vaughn) P Circle No. 431


Mineco Div. General Time, 135 S. Main, Thomaston, CT 06787. (203) 283-8261. (P. Famiitetti) P Circle No. 433


Nichcon America Corp., 6428 N. Ridgeway Ave., Chicago, IL 60645. (312) 679-6300. (J. Takeita) T Circle No. 435

Ohmite Mfg., 3601 Howard St., Skokie, IL 60076. (312) 675-2600. (F. P. Malia) P Circle No. 436

Pelecnic Electronics Inc., 174 Lakeshore Dr., E., Falmouth, MA 02536. (617) 540-1200. (C. Tyndale) P Circle No. 437

Perkin-Elmer Corp., Main Ave., Norwalk, CT 06850. (203) 762-1000. (P. Hutchinson) P Circle No. 438


Piper International Corp., 399 Washington St., Woburn, MA 01801. (617) 935-8750. (T. Forristal) P Circle No. 440

Rex Rhestat & Co., 149 Babylon Tpke., Roosevelt, NY 11575. (516) 379-1030. (R. Wolpert) P Circle No. 441

Sakata International Inc., 60 Minipie Ln., Elk Grove Village, IL 60007. (312) 593-3211. (G. L. Pundt) P Circle No. 442

Samaris Inc., 300 Seymour Ave., Derby, CT 06418. (203) 735-7405. (R. C. Heitz) P Circle No. 443


Spectral Electronics Corp., 17070 E. Gale Ave, City of Industry, CA 91745. (213) 964-6555. (F. McGee) T Circle No. 446

Stackpole Components Co., P.O. Box 14466, Raleigh, NC 27619. (919) 829-6201. (J. Dunlap) T Circle No. 447

Subminiature Instruments Corp., 3147 Durahart St., Riverside, CA 92507. (714) 684-7133. (J. F. Shear) P Circle No. 448

Systron-Donner Corp., 1 Stryon Dr., Concord, CA 94518. (415) 676-5000. (J. White) P Circle No. 449

TRW/IRC Potentiometers, 2601 72nd St., N., St. Petersburg, FL 33733. (813) 347-2181. (G. Smith) P Circle No. 450


United Mineral & Chemical Corp., 129 Hudson St., New York, NY 10013. (212) 966-3300. (H. M. Rosenthal) P Circle No. 452


Frishay, Resistor Products, 63 Lincoln Hwy., Malvern, PA 19355. (215) 644-1300. (T. Troianello) T Circle No. 454

Vogue Instrument Corp., 131 St., Jamaica, Long Island, LI 11418. (212) 641-8800. (R. Kaplan) P Circle No. 455

Waters Mfg., Inc., 1 Longfellow Center, Wayland, MA 01778. (508) 356-9095. (R. Osborne) P Circle No. 456

Weston Components Div., Archbold, PA 18403. (717) 876-1500. (F. Butterfield) T Circle No. 457

Whitbread electronics Inc., 240 Plato Blvd., Beverly, MA 01915. (617) 222-2791. (J. Whitbread) P Circle No. 458

Wiring, Electronics Design, 17 August 16, 1975
current passing through it.

And, when you use the pot or trimmer as a rheostat, don't use the rating given on the data sheet unless it is specifically for that application. Only a fraction of the pot or trimmer power rating can be used in the two-terminal mode.

Fortunately, power handling requirements are now dropping with the increasing use of solid-state circuits. Most of the newer active components need less power to do the job of older circuits, and thus need lower ratings on pots and trimmers within the equipment. But this advantage is offset by the need for miniaturization.

Picking the element material

Pot or trimmer resistance elements can be made from many materials—wire, carbon composition, carbon film, metal film, cermet, conductive plastic and bulk metal are the most common. Each has different electrical and mechanical properties (see table) that best fit widely divergent applications.

Some applications call for extra precautions. Wirewound elements, for instance, have a limited useful frequency range, from dc to about 5 kHz, while cermet and some film elements aren't much use if the required resistance is under 50 Ω.

No matter which element material you select, check the element size. Manufacturers use different chemical compositions for their resistance elements, and elements may thus have different sizes or shapes, even if they are all rated for the same resistance or power dissipation. In general, the larger the resistance element, the better the resolution and the higher the power dissipation.

A mix of capabilities is provided by hybrid potentiometers—in these units the wiper path of a wirewound element is coated with a conductive film, such as plastic or metal.

These units backstop the catastrophic failure problems that plague film elements. And, they blend the stability of wirewounds with the long life and infinite resolution of the metal film elements.

There are even some wiperless potentiometers available. These devices use variable transformers to handle ac voltages, or a mechanical transducer and conditioning circuitry for dc voltages, or Hall-effect transducers that change resistance depending upon the position of a nearby magnet. Some of these units do, however, require an external power supply to bias the sensor or conditioning circuitry.

And, if you need the ultimate in stability, bulk-metal elements produce trimmers that have tempcos down to 10 ppm/°C and settabilities to within 0.05%.

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by JOHN H. FASAL
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by MITCHELL O. LOCKS
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VIBRATION AND ACOUSTIC MEASUREMENT HANDBOOK
edited by MICHAEL BLAKE & WILLIAM S. MITCHELL
This giant, field-tested, 680-page manual enables you to master today's vibration equipment and techniques—shows you how to spot up to 90% of equipment problems months in advance and take corrective action before trouble starts. Uses scores of actual industrial problems and solutions in outlining specific procedures and techniques. #9195, $34.50

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Schematics of both idealized and practical low-pass capacitor filters are shown in Fig. 1. The practical version includes a series inductance to account for capacitor lead length. Insertion-loss curves for the ideal capacitor filter are plotted over a range of normalized frequency ratios, \( F \), for several values of mismatch ratio \( A \). And a nomograph solves for cutoff frequencies (Fig. 2).

The normalized frequency ratio is
\[
F = \frac{f}{f_0},
\]
where \( f \) is the frequency of interest and \( f_0 \) is the filter cutoff frequency. The mismatch ratio is
\[
A = \frac{R_L}{R_s},
\]
where \( R_L \) is the load resistance and \( R_s \) is the source resistance. And the normalized insertion

1. A family of normalized insertion-loss curves for idealized bypass circuits and a universal curve to correct for capacitor lead length enable accurate prediction of the filter’s insertion-loss performance.
2. A nomograph simplifies the calculation of a bypass filter's cutoff frequency, $f_o$. 

**Electronic Design** 17, August 16, 1975
3. Computed insertion loss agrees closely with measured results, especially at the practical lead lengths.

4. Measured resonant frequency vs lead length is provided for a variety of capacitor types used in bypass filters. The resonant frequency, \( f_r \), is used to align the universal resonance curve with the idealized curve.

loss equation for an ideal capacitor filter is

\[
\text{I.L.} = 10 \log \left(1 + F^2 \left[ \frac{4A^2}{(1 + A)^2} \right] \right). \tag{1}
\]

The cutoff frequency, expressed as

\[
f_c = \frac{1}{\pi R_s C},
\]

is the frequency at which the filter's insertion loss equals 3 dB when \( A = 1 \).

**Capacitor leads modify the results**

The degrading effects of capacitor lead-length inductance is taken into account in the practical filter circuit by the equation

\[
\text{I.L.} = 10 \log \left\{ 1 + \left[ F^2 / (1 - F_r^2) \right] \left[ \frac{4A^2}{(1 + A)^2} \right] \right\}. \tag{2}
\]

The normalized resonant frequency of the filter is

\[
F_r = \frac{f}{f_r},
\]

where
\[ f_r = \frac{1}{2\pi \sqrt{LC}}. \]

Note that the equations for the practical and ideal cases differ only in the term \((1-F_r)^2\), which is defined as the universal resonance correction factor. A plot of Eq. 2 for a ratio \(f_r/f_0 = 100\) yields the cusp-shaped curve shown superimposed in Fig. 1 on the ideal insertion-loss curve for \(A = 1\). This curve is universal. The same curve shape is used to correct for lead inductance of all bypass filter capacitance values and any degree of mismatch.

For small values of \(f\), the universal resonance

5. Normalized insertion-loss resonance correction curves for a variety of feedthrough capacitor types help simplify insertion-loss predictions.
6. Self-resonant frequencies, $f_r$, for some types of feedthrough capacitors are dependent upon the capacitors' curve corresponds to the shape of the ideal insertion loss curve, because the universal resonance correction factor is close to unity. Thus to obtain a corrected insertion loss curve for any capacitor's self-resonant frequency, all that need be done is to shift the cusp curve along the ideal curve for any value of A until the capacitor's peak, or resonant-frequency point, aligns with the corresponding frequency on the frequency coordinate axis (Fig. 3).

Figs. 4a through 4f provide resonant-frequency values vs. lead length for a variety of capacitor types. Mylar capacitors have been the most popular for low-pass filter work, because they are inexpensive and rugged (Fig. 4a). However, metalized capacitors can save space in low-voltage applications (Fig. 4b). For values larger than 5 $\mu$F in ac filter work, paper capacitors are often a good choice (Fig. 4c). Ceramic units are used in miniature filters, because of their high volumetric efficiency, and mica is best suited for high-frequency applications.

Working with the curves

A design example is the best way to explain how to use the curves and nomograph. Suppose a low-pass filter is needed to reduce the noise level on a matched 50-$\Omega$ line by 57 dB at 1 MHz. Obviously the mismatch ratio, A, equals unity. From Fig. 1, the intersection of the A =1 curve and the 57-dB loss line yields the normalized frequency ratio, $F = 700$. From this ratio, the filter's cutoff frequency is easily calculated as

$$f_0 = f / F = 1 \text{ MHz} / 700 = 1.4 \text{ kHz}.$$ 

The required capacitor value is found by use of Fig. 2. Place a straight edge through the points $f_0 = 1.4 \text{ kHz}$ and $R_s = 50 \Omega$ to yield a value $C = 4.5 \mu$F.

To obtain a corrected loss curve for this example in terms of actual frequency (Fig. 3), a transparent sheet of seven-cycle semi-log graph paper of the same dimensions as the normalized curve of Fig. 1 is provided with a convenient frequency scale on its x axis. This transparent graph paper is then aligned over the normalized A = 1 curve. The frequency scale of the overlayed graph at $f_0 = 1.4 \text{ kHz}$ is made to correspond with $F = 1$. First, the A = 1 curve is traced onto the transparent sheet. Then the universal self-resonant cusped curve is traced, with its resonant, or peak, frequency properly located along the frequency axis and its low-frequency portion coincident with the A = 1 curve.

If a Mylar capacitor is selected to construct the filter, the capacitor's self-resonance can be determined from data provided by the curves on Fig. 4a. For lead lengths of 0.1, 2 and 4 in., the resonant frequencies are approximately 640, 350 and 245 kHz, respectively.

Note that with even an impractically short lead length of 0.1 in., the insertion loss of the...
7. Measured and predicted insertion loss for feedthrough capacitors agree closely below 100 MHz.

practical circuit at 1 MHz is less than desired—about 53 instead of 57 dB—because of the resonance correction. Either this lower degree of filtering must be accepted or another capacitor type found that can provide a higher resonant frequency and with longer leads. However, a small disc ceramic capacitor in parallel with the 4.5-µF Mylar unit might be an easier solution.

Feedthroughs have complex properties

A practical equivalent circuit for feedthrough capacitors is complex and results in equations that are difficult to use. Instead, measured and normalized universal resonance correction curves are provided for a variety of capacitor types (Figs. 5a through 5e).

All feedthrough capacitors exhibit at least one resonance point and some as many as three. The first, or lowest frequency, is designated \( f_r \).

Measured \( f_r \) values for some feedthrough types show a strong relationship between the capacitor's voltage rating and its \( f_r \) (Figs. 6a and 6b). The smaller dimensions of low voltage rated Mylar and paper capacitors, of course, result in lower inductances and higher resonant frequencies. In addition the shapes of the normalized correction curves sometimes change with voltage rating (Figs. 5b and 5c).

By contrast, in bypass filtering a capacitor's voltage rating is not an important factor. For example, as the lead length of a metalized 1-µF polycarbonate capacitor is increased from 0.1 to 3 in., the self-resonant frequency of a 50-V unit changes from about 1.3 MHz to 530 kHz, and a 400-V unit covers almost the same range—from 1 MHz to 530 kHz.

As a design example of how to use the feedthrough filter curves, consider a 50-Ω matched line that requires noise suppression of at least 70 dB between 1.5 MHz and 1 GHz. The line voltage level is 24 V dc. To find the size and type of capacitor best suited for this job, proceed as follows:

- In Fig. 1 for \( A = 1 \) and I.L. = 50 dB, find \( F = 300 \).
- Compute \( f_r = f/F = 1.5 \text{ MHz} / 300 = 5 \text{ kHz} \).
- In Fig. 2 with \( R_s = 50 \Omega \) and \( f_r = 5 \text{ kHz} \), find \( C = 1.3 \mu F \).
- Trace on a piece of transparent seven-cycle semi-log paper the ideal response, with \( f_r = 5 \text{ kHz} \) aligned with \( F = 1 \) on Fig. 1 (see Fig. 7).
- Consider a 50-V ceramic feedthrough capacitor. From Fig. 10, find \( f_r = 13.5 \text{ MHz} \) for a 1.3-µF ceramic capacitor.
- Align the resonant dip, \( f_r \) on Fig. 5e to coincide with 13.5 MHz on the ideal response curve for \( A = 1 \), as in Fig. 6. Trace the universal resonance correction curve. The resulting response coincides very closely with the measured response.

Now consider solving the same problem with a 100-V-dc, 1.3-µF paper-and-foil feedthrough capacitor. From Fig. 6b, \( f_r = 4.8 \text{ MHz} \). The response is now traced from Fig. 5d. This capacitor does not provide the required 50 dB of insertion loss until 9 MHz.

The paper-and-foil capacitor is inadequate because its lower \( f_r \) significantly impairs the insertion loss in the desired frequency range. To achieve 50 dB at 1.5 MHz with a paper capacitor, a very large capacitor value would have to be used to bring its \( f_r \) down to about 0.15 MHz, and its size and weight would be excessive. ••
Mergers and acquisitions, like marriage proposals, fare best when pursued in private. The recent acquisition of Signetics by U.S. Philips Corporation wasn’t talked about until it became a fact. Then the announcement naturally prompted a number of questions. We would like to reply to those which have been asked frequently enough to indicate that the answers are of general interest to our friends, customers and vendors.

Sincerely,

Charles C. Harwood, President
Signetics Corporation
(Q) Where does Signetics fit into Philips, anyway?
(A) Signetics is now owned 100% by U.S. Philips Corporation, which is an American company owned by The United States Philips Trust. Consequently, Signetics remains a U.S. corporation. However, it will now benefit fully from the relationship existing between the United States Philips Trust and N.V. Philips Gloeilampenfabrieken, a large public company, active in the manufacture and sales of electronic equipment, electronic components, and other products.

(Q) Will Signetics now be a captive supplier to Philips Europe, Magnavox, or any other Philips interests?
(A) In a word, no. Where appropriate, Signetics will certainly be a normal, competitive supplier to Philips companies around the world. But not as a "captive" supplier, because Signetics' aim is to serve the world market as a component supplier.

(Q) Will Signetics be part of North American Philips and perhaps use the North American Philips sales force?
(A) No. Signetics is completely separate and will operate with its own selling organization.

(Q) Will Philips change top management?
(A) Philips does not plan to, and Signetics' management has committed to remain, and continue functioning in key positions.

(Q) What is Signetics' financial position?
(A) Despite the economic downturn which has affected its profit and loss, Signetics is in a positive cash flow position. Inventories are in solid shape, and we have unused credit lines. We are well-positioned financially, poised for the upturn in business.

(Q) Will Philips be infusing capital into Signetics?
(A) Capital will be invested as needed to meet our primary world-wide growth objectives from sources as will be available and required for a sound financial structure.

(Q) Will Signetics supply the international markets now?
(A) Yes, but keep in mind we are talking about a continuing operation — Signetics is already supplying the international markets. In fact, we intend to increase sales and services world-wide by also using the N.V. Philips sales and marketing organizations outside the United States.

(Q) Will Signetics customers see many changes now, due to Philips?
(A) Many changes, yes, but not due primarily to Philips. Signetics has been continually developing a variety of new products and technologies — many recent achievements will come on the market very soon: such as the #2650 microprocessor and the #2604, the 4096-bit Random Access Memory. Signetics' sales force is currently being strengthened, but this is in accordance with previously determined plans. Expanded marketing tools, advertising programs, internal changes to improve service to customers and prospects — all these are underway now. Of course, Signetics anticipates a significant plus through Philips' technological contributions and basic research.

(Q) Will there be changes in Signetics' price structure for products?
(A) Certainly not because of the acquisition. Signetics' growth, which has been quite substantial, has resulted from a combination of technology, quality, service, and competitive pricing. Neither Signetics nor Philips foresees any departure from the effort to keep improving in all four areas.

(Q) How will Philips help Signetics?
(A) Philips has a long and intimate understanding of the semiconductor business. They have done an immense amount of research and development in semiconductor devices. Signetics will benefit from this historical work, as well as all future inventions and technological breakthroughs — just as Philips will benefit from Signetics.

811 EAST ARQUES AVE., SUNNYVALE, CALIF. 94086
Consider using resolvers and synchros when you design mechanical positioning and sensing systems. They offer important advantages, even in digital applications.

Resolvers and synchros are found in many electromechanical systems that sense position, perform machining operations and do simple calculations. These analog transducers provide infinite-resolution sinusoidal output signals that define the position of a rotating shaft.

There is one essential difference between resolvers and synchros—resolvers provide a two-phase signal while synchros deliver three-phase signals. But you can use either a resolver or synchro, as long as you use a Scott-T network to convert two-phase signals into three-phase or vice-versa. You can also make the sinusoidal outputs of these transducers compatible with digital displays or computers by use of solid-state converter circuits.

Basically, the resolver and synchro are built with one moving winding on the armature and several fixed windings. As the armature shaft turns, the coupling between it and the fixed coils varies with the sine of the angle, and, in turn, modulates a carrier signal that is fed into the armature coil. Thus the output signals in the fixed coils are a modulated form of the carrier, displaced by the angular distance between each coil.

There is very little wear, so life expectancy of these transducers is good. The cost, for moderate precision units (equivalent to about 14-bits), is less than for other types of encoding systems.

Resolvers and synchros are each available in three different versions, defined in terms of function—transmitter, receiver and differential transmitter.

Each type has its own function

The transmitter develops sinusoidal output signals whose amplitude ratios define the angle to which the connected shaft has been positioned. Resolver or synchro transmitters are referred to as control transmitters and designated by the transmitter symbol CX in most literature.

A receiver accepts electrical carrier-borne input data that define the angle to which an associated servo motor will turn the receiver's shaft. The receiver develops an error signal that is proportional to shaft deviation from the incoming electrically specified angle. Synchros and resolvers for this function are usually referred to as control transformers—designated by CT.

The differential develops an electrical output signal that defines the sum (or difference) be-
2. The electrical circuit of the resolver receiver looks identical to that of the transmitter, except that the roles of the coil windings are reversed.

3. A simple resolver control system consists of a resolver transmitter, receiver, phase-sensitive detector and a power amplifier to boost the output.

tween an electrical input angle in resolver or synchro format and the differential's own shaft angle. The full name for this device is control differential transmitter—designated by CDX.

The basic resolver transmitter has a rotating primary and fixed secondaries (Fig. 1a). The resulting variable-coupling transformer impresses outgoing shaft angle data onto a sinusoidal carrier (usually around 400 Hz, though versions are available for other frequencies). The rotor winding, excited by the carrier voltage $V \sin \omega t$, induces variable fractions of the carrier—depending upon the shaft angle $\theta$—into the two secondaries.

Secondary windings are oriented at right angles to each other, which results in outputs that vary with the sine and cosine of the shaft angle $\theta$. If we assume a 1:1 turns ratio between primary and secondary coils, the two stator output voltages become

$$V_1 = V \cos \omega t \sin \theta$$
$$V_2 = V \sin \omega t \cos \theta$$

As the resolver shaft turns, the amplitude envelopes of outputs $V_1$ and $V_2$ will rise and fall $90^\circ$ out of phase with each other (Fig. 1b). However, the carrier components, $V \sin \omega t$, remain in phase. Only $V_1$ and $V_2$ amplitude envelopes, $\sin \theta$ and $\cos \theta$, which convey the shaft angle information, are in quadrature.

The instantaneous ratio of the information components, $\sin \theta$ and $\cos \theta$, accurately expresses the resolver’s shaft-angle information. By taking the ratio of $V_1/V_2$, you get $\tan \theta$ and can, in turn, find $\theta$ by taking the arctangent. Phase-sensitive demodulation techniques separate the information components of $V_1$ and $V_2$.

Some solid-state circuits can make exact measurements of instantaneous $V_1$ and $V_2$, from which angle information can be extracted. Other circuits, using servo-nulling techniques, apply ratiometric methods for angle computations.

**Determining receiver-shaft position**

The resolver receiver looks electrically identical to the CX, except that the roles of the primary and secondary windings are interchanged (Fig. 2). Usually, though, the CX will have higher VA ratings and lower impedances for its secondary windings, since it may be required to energize several parallel CTs. Otherwise both CX and CT functions are interchangeable.

The CT’s two stator windings couple fractions of the incoming angular data, $V_1$ and $V_2$, into the common rotor winding. The coupled data develop a rotor output voltage, $V \sin \omega t \sin (\theta - \alpha)$, which is a function of the angular difference between the two inputs. The stator-rotor coupling varies...
with the receiver shaft angle, \( \alpha \), and, as with the CX, conforms to the sine and cosine of the shaft angle.

The resolver receiver's rotor output, \( V (\sin \omega t) \sin (\theta - \alpha) \), is used in mechanical positioning systems (Fig. 3). The rotor output, or error voltage, drives a servo through a phasesensitive detector and servo driver.

The resolver differential, or CDX, develops an electrical output in resolver format (Fig. 4). This unit retransmits the angular signals that come from resolvers. The input signals are redefined as the difference between the electrical input angle, \( \theta \), and the differential's own shaft angle, \( \phi \). The CDX's electrical output defines the difference angle \( (\theta - \phi) \) in terms of the carrier borne signals \( V_1 = V (\sin \omega t) \sin (\theta - \phi) \) and \( V_2 = V (\sin \omega t) \cos (\theta - \phi) \).

The stator of the CDX is electrically similar to the resolver receiver's and handles incoming angular signals, \( \theta \), in resolver format. The CDX rotor, however, has two windings at right angles to each other and thus produces two output signals that are related by the sine and cosine functions. If one CDX output is \( V_1 = V (\sin \omega t) \sin (\theta - \phi) \), the other differs by 90° and is thus \( V_2 = V (\sin \omega t) \cos (\theta - \phi) \). These output voltages, \( V_1 \) and \( V_2 \), are obtained by connection of the \( V_1 \) and \( V_2 \) inputs so the rotor-induced signals conform to the basic trigonometric relationship

\[
\sin(A - B) = (\sin A) \cos B - (\cos A) \sin B.
\]

However, if the incoming signals are connected to the opposite stator coils the voltage components induced into coil A will be \( V_1 \sin \phi \) and \( V_\cos \phi \) instead of \( V_1 \cos \phi \) and \( V_\sin \phi \). Thus the coil A output will be the difference between \( V_1 \) (\( \sin \theta \) \( \sin \phi \)) and \( V_1 \) (\( \cos \theta \) \( \cos \phi \)).

With the use of another trig identity

\[
\cos(A + B) = (\cos A) \cos B - (\sin A) \sin B,
\]

you can see that the induced voltage in coil A, \( V (\sin \omega t) (\sin \theta \sin \phi - \cos \theta \cos \phi) \), can be simplified to \( -V (\sin \omega t) \cos(\theta + \phi) \). The 90° mechanical displacement of coil B produces a signal of \( V (\sin \omega t) \sin (\theta - \phi) \) as an output. Thus the CDX can be connected to develop an output that represents the sum of two angular inputs as well as their difference.

**Synchros can also resolve**

Synchros differ from resolvers in only one way—they have three, rather than two, stator windings (Fig. 5). Thus instead of having sine and cosine voltage relationships, a synchro transmitter delivers signals related to the rotor shaft angle by

\[
\begin{align*}
V_1 &= V (\sin \omega t) \sin \theta, \\
V_2 &= V (\sin \omega t) \sin (\theta + 120^\circ) \text{ and} \\
V_3 &= V (\sin \omega t) \sin (\theta + 240^\circ).
\end{align*}
\]

4. **The resolver differential transmitter** has two fixed coils at 90° to each other and two moving coils, also at 90° to each other. These moving coils determine the output of the unit in terms of the input angle and the shaft angle of the differential.

5. **Synchro transmitters or receivers** have three fixed coils that are spaced at 120° around a moving coil. The carrier signal on the moving shaft gets modulated and impresses signals in the three fixed coils that are 120° out of phase with one another.

6. **The Scott-T transformer** changes the three-wire synchro signals into four-wire resolver-compatible data, or vice versa since the transformer is bidirectional.

It is uneconomical to manipulate these three-phase signals with solid-state interface circuits. There is no true solid-state counterpart of the synchro transmitter or receiver; instead, these functions are usually performed by solid-state resolvers that use Scott-T (or equivalent) transformers to convert the synchro signals into resolver format (Fig. 6).

The Scott-T networks, well known in power engineering, provide the link or interface between three-phase and two-phase systems. Scott-T transformers function bidirectionally and provide isolation between input and output circuits. Many newer systems, though, use active networks to perform the signal conversion and thus require less space within the interface module.
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Two components added to CMOS flip-flop convert it to one-shot or level detector

The addition of a resistor and a capacitor to a CMOS edge-triggered D-type flip-flop can convert it into a one-shot or level-detector circuit (Fig. 1). A sharp-edged pulse or step produces a one-shot output (Fig. 2a). For any other arbitrary wave shapes (Figs. 2b and 2c), the circuit triggers when the input signal crosses the circuit’s CMOS threshold voltage.

Here’s how the circuit works: With the Q output normally low and the D input tied to a logic ONE, a positive-going step applied to the clock input, C, causes the Q output to go to a logic ONE state. After a delay determined by R, and C, the Q signal fed back to the reset terminal causes the flip-flop to reset, and the output from Q returns to its ZERO state. The circuit thus behaves as a one-shot.

The one-shot delay can be determined from

\[ T_D = R_C \ln \left( \frac{V_{DD}}{V_{DD} - V_{TH}} \right) \]

where

- \( V_{DD} \) = supply voltage (\( V_{SS} = 0 \))
- \( V_{TH} \) = CMOS threshold voltage.

The values in Fig. 1 provide a delay, \( T_D \), of 1.32 ms.

Reference


CIRCLE No. 311

### Impedance matching made easy: a 3-step uncomplicated method

Even a specialist in digital design sometimes has to match two complex impedances. The result often is a frantic search for that misplaced textbook on the subject. Next time try a straightforward approach that requires only three steps to solve either purely resistive or complex impedance-matching problems accurately and without guesswork. Also, the designer has the option of using either a high-pass or low-pass matching section. However, the networks are matched at only one frequency, and the VSWR increases as the frequency moves off the design center.

Fig. 1a shows a typical matching situation. Reactive elements \( X_M \) and \( X_M' \), which are used...
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to match $R_1$ and $R_2$, also tune out the effects of $X_1$ and $X_2$. The circuit is considered to be matched when $R_1$ equals the effective series resistance, $R_s$, and $XM_1$ tunes out $X_1$ and the effective series reactance, $X_M$, across terminal $B$ in the equivalent circuit (Fig. 1b).

Thus $R_1 = R_s$ and $JXM_1 = -(JX_1 + JX_2)$.

First solve for the quantities $R_1$ and $JX_2$ in terms of $R_s$, $X_2$ and $XM_2$:

$$Z_0 = R_s + JX_2 = \frac{(R_2 + JX_1) \cdot (JXM_2)}{R_2 + J(X_2 + XM_2)}.$$  \hspace{1cm} (1)

And by separation of the real and imaginary parts, we get:

$$R_1 = \frac{R_s (XM_1) \cdot (X_2 + XM_2) - (X_1) \cdot (XM_2) \cdot (R_2)}{(R_2)^2 + (X_2 + XM_2)^2},$$  \hspace{1cm} (2)

and

$$X_1 = \frac{X_2 \cdot (XM_1) \cdot (X_2 + XM_2) + (R_2)^2 \cdot (XM_2)}{(R_2)^2 + (X_2 + XM_2)^2}. $$ \hspace{1cm} (3)

For a match, $R_1$ must equal $R_s$. Thus we set Eq. 2 equal to $R_s$ and solve for the required value of $XM_2$:

$$XM_2 = \frac{R_s (X_2) \pm \sqrt{(R_2)^2 R_s + R_s (R_2) \cdot (X_1)^2 - (R_2)^2 (R_2)}}{(R_2 - R_s)}.$$ \hspace{1cm} (4)

Of course, if the load is only resistive, $X_2 = 0$, and Eq. 3 and 4 are greatly simplified.

To determine $XM_1$, we substitute the value of $XM_2$ into Eq. 3. Reactance $XM_1$ may then be calculated as

$$JXM_1 = -(JX_1 + JX_2).$$

Two examples of the use of the equations are shown in Figs. 2a and 2b.

Roy Nardin, Staff Engineer, Frequency Electronics Inc., 3 Delaware Dr., New Hyde Park, NY 11040.

CIRCLE NO. 312

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For a low-pass matching section, $XM_1$ is inductive and $XM_2$ is capacitive. However for high-pass, $XM_1$ is capacitive and $XM_2$ inductive, as determined by the two solutions for $XM_2$. 

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ELECTRONIC DESIGN 17. August 16, 1975
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INFORMATION RETRIEVAL NUMBER 44
Direct application of power to aircraft electrical devices from the aircraft's standard 28-V source avoids the inefficiencies and undesirable side effects of power conversion. The circuit in the figure can drive a permanent-magnet dc motor with the power op amps energized solely from the single-ended 28 V.

The motor is differentially driven from two power op amps. The op amps are biased midway between +28 V and ground, and thereby each applies +14 V to each motor terminal under zero-signal conditions. As an amplifier input signal is applied, the voltage on one terminal increases and the other decreases. Obviously motor rotation direction depends on the polarity of the op-amps' input signal.

Op-amp A is connected as an inverting amplifier, and op-amp B is noninverting. Positive input signals cause the output from A to decrease toward ground and that from B to increase toward +28 V. Signal inputs can originate from any low-impedance source that is capable of sinking a low dc milliamp-range current and driving a 1-kΩ load.

RCA HC2500 power op amps are used. Their slew rate and bandwidth is controlled by external 470-pF capacitors, and their standby current drain is determined by external 249-Ω resistors. The closed-loop gain of each stage is approximately 2.6, and no feedback capacitors are required to stabilize the circuit. Commutation diodes at the output prevent op-amp damage from motor spiking.

Features of this circuit include the following:
- Low standby power—less than 1 W per op amp, including bias network.
- Good gain-bandwidth product, allowing use as a servoamplifier in closed-loop applications.
- Low parts count—11 resistors, two capacitors and four diodes, in addition to the two op amps.
- High power output. In an experimental setup, the circuit was able to drive a 30-W permanent-magnet motor.

C. E. Musser, Project Engineer, General Electric Co., Avionics Controls and Electrical Systems Dept., P.O. Box 5000, Binghamton, NY 13902.

CIRCLE NO. 314

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Variable modulation oscillator option — 20 Hz to 600 KHz; use for internal AM or FM; also available at front panel.

Built-in counter — measures external signals to 550 MHz.

Spectral purity — high Q, cavity-tuned solid-state oscillator yields excellent low noise performance needed for new stringent receiver testing. SSB noise 130 dB/Hz down at 20 KHz offset.
Two power op amps can drive a 30-W PM motor from a single-ended power supply.

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These are just a few of the reasons why the 8640 does today's job so well, and gives you built-in assurance that you won't run out of capability as tomorrow's demands come along. Price $5900 (w/o options); $6650 (1100 MHz). Also available with avionics option specially adapted for testing ILS (marker, glide slope, localizer), VHF communication and VOR receivers.

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INFORMATION RETRIEVAL NUMBER 45
Low-cost temperature controller built with timer circuit

The internal trigger comparator of the 555 timer IC can be used with a thermistor-resistor divider to build an inexpensive temperature controller. You don't even need a well-regulated supply, since all voltages are derived as ratios of $V_{cc}$.

When thermistor $R_3$ cools below a set value, the voltage at pin 2 of the 555 drops below $1/3 V_{cc}$. This turns on the triac-controlled heating element and starts the timing cycle. If the thermistor temperature rises above the set point before the end of the timing cycle, the heater shuts off at the end of the timing period, otherwise the heater stays on.

Thermistors of different values can be used as long as the relationship $R_3 + R_2 = 2R_1$ holds true at the desired temperature. Larger values of $R_2$ provide wide adjustment ranges, but sensitivity is reduced.

A timing interval equal to $1.1R_1C$ is selected to be small, compared with the thermal time-constant of the system. Yet it must be long enough to prevent excessive RFI caused by rapid on-off switching of the triac.


CIRCLE NO. 313
New series of generic PROMs—a family affair.

Stand alone PROM designs are now a thing of the past. Now the diverse requirements for density, modularity and performance within a system can be satisfied with Harris' new family of PROMs featuring generic characteristics.

This generic concept of PROMs offers many unique advantages. For instance, each device within the series will feature identical DC electrical specifications plus common programming requirements, permitting easy use of other family elements. So learning is just once per family.

In addition, these PROMs have fast programming speeds. Equivalent I/O characteristics for easy upgrading. Faster access time, guaranteed over temperature and voltage. Improved testability.

Right now, the first two PROM devices are in volume production. The 256 x 4 organization (1K) and the 512 x 4 (2K). Other PROM devices will be available in the months ahead (see table).

So instead of settling for PROMs with unique performance capability and diverse programming requirements, get the new Harris generic family of PROMs. Lower your system costs and make your life easier.

For details see your Harris distributor or representative.

Important features of Harris' new generic family of PROMs.

• Simple, high speed programming procedure (Typically less than 1 second per thousand bits).
• Inputs and outputs TTL compatible; Low input current: 400 µA logic “0”, 40µA logic “1.” Full output drive: 15 mA sink, 2 mA source.
• Fast access time—guaranteed over voltage and temperature (see table).
• Expandable—three-state or open collector—“wired-or” outputs with chip select.
• Industry standard pin-out.

<table>
<thead>
<tr>
<th>Device #</th>
<th>No. of Bits</th>
<th>Organization</th>
<th>No. of Pins</th>
<th>Max. Access Time* comm/mil.</th>
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<td>January '76</td>
</tr>
</tbody>
</table>

*Access time guaranteed over full temperature and voltage range.
Industrial (TA = 0°C to 70°C, VCC = ±5%)
Military (TA = -55°C to 125°C, VCC = ±15%)


Electronic Design 17, August 16, 1975
Jimmy R. Young of Motorola Semiconductor wins annual 'Idea for Design' award

“This isn’t what I expected,” said Jimmy Randy Young. What the senior design engineer did expect was a company patent award for a CMOS-circuit design. The first step toward a patent had been taken some time ago. And Motorola provides cash awards for these achievements.

And what other reason would there be for him and his boss, Section Manager Jim Remedi, to be in the office of John Welty, Vice President and General Manager of the Semiconductor Products Div.?

Well, the visit had to do with Young’s IC all right. But it was his use of the chip in an ELECTRONIC DESIGN Idea for Design that was about to be recognized. Young’s idea had been selected as the best in 1974.

Jimmy developed a special RC oscillator that was made part of a three-digit counter, Motorola’s MC 14553. The idea—“Low-Power CMOS Digital Voltmeter Built With Only Six Integrated Circuits”—hooked up the counter, five other CMOS chips and LED readouts to form a compact instrument.

The tall, friendly engineer didn’t learn he was the winner until Associate Editor Edward A. Torrero presented him with an engraved plaque. Then Young could only shake his head in disbelief as Torrero handed him a $1000 check.

To Welty’s query on what he would do with the prize money, Young replied: “Keep my wife from spending it.” In a more serious vein, he said he would use it for their next vacation, one that would serve as a 10th-anniversary honeymoon. “We had one when we married,” he said, “but after 10 years, you need a renewal.”

Young’s winning idea stemmed from years of systems work that led him far from his native Phoenix. He has worked on aerospace equipment in Colorado and in data communications in California. Motorola, the first semiconductor house he has worked for, took him back to Arizona.

Past experience helped to smooth his adjustment to semiconductors. “It’s easier to go the route I took than the other way,” Young believes. After having designed hybrid and discrete systems, his understanding of interface problems improved, as did his feel for the special problems customers face.

Young and his wife, Kitty, have two girls—Lorie, 7, and Tanya, 5. In his spare time he likes woodworking, hiking or playing tennis. Now, buoyed by his prize, he thinks he would like to write more technical articles for magazines. Furthermore, Young expects more of his coworkers will want to write, too.

A happy winner, Jimmy Randy Young (left), is congratulated by his boss, Jim Remedi, after receiving Idea for Design plaque and $1000. Motorola Semiconductor’s General Manager, John Welty, looks on.

RENEWAL ISSUE
Three minutes is all it takes to keep ELECTRONIC DESIGN coming your way. RENEW TODAY (see inside front cover).
The first SDVM*

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*Systron-Donner “smart” DVM

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INFORMATION RETRIEVAL NUMBER 47
Noise generator output measured accurately

A special ac-to-dc converter to measure the output level of a wideband noise generator up to 500 MHz has been developed at the University of Salford in England. The circuit, which is reported to have an accuracy of ±2% over the 500-MHz spectrum and substantially better over smaller ranges is stable. In addition the design overcomes the detrimental effects of diode resistance at low frequencies and of load capacitance.

In the schematic of the circuit the section to the left of the broken line is a constant current source. In this, a low-capacitance BF224 (Motorola S0025) and BC169 (Motorola S0015) form an active load with the 270 Ω, 560 Ω and 1.5 MΩ resistors and the lower 22-μF capacitor. The dc at the BF224 collector is stabilized at about -0.5 V by the three resistors.

For linear performance at low frequencies, the current source has a high resistance, which is achieved in this circuit by an increase in the BF450 (Siemens, U.S.A.) collector resistance by feedback. For high-frequency operation the BF450 and BF224 transistors have low shunt capacitances of about 1 pF.

The HP2835 hot-carrier diode has low capacitance, low leakage and low forward voltage. The HP2835 passes positive half cycles to the load, and the other diode limits the voltage swing at the collector of the BF450.

Iron 'needles' improve magnetic tape s/n

Iron particles formed like minute needles on the surface of magnetic tape respond more effectively than more conventional materials when exposed to tape recording-head signals, according to investigators at Philips Research Laboratories in West Germany. The researchers, led by Dr. K. G. Knauff, determined that iron particles about 0.3 μm long will give tapes a signal to noise ratio as much as four times better than that obtained from most magnetic oxides.

The needles are made in a fluid bed of iron-hydroxide through progressive reduction by hydrogen. Spontaneous ignition of the needles on exposure to air is prevented by forming a passivated layer on the needle surfaces. This is accomplished by passing inert gas over the needles while they are in the fluidized bed and adding small amounts of hydrogen.

Measurements made at 10 to 12 kHz at a tape speed of 4.75 cm/s gave a 12 dB gain in s/n compared with ferrite and 7 dB compared with chrome oxide.

Xenon laser delivers UV pulses at 4 MW

Ultraviolet laser pulses with peak powers of 4 MW at a 3-nsec pulsewidth have been generated in a tunable region between 1690 and 1760 Å by researchers at Imperial College, London. Tuning is accomplished with a prism in the laser cavity. The laser's working medium is xenon gas, compressed and pumped with a relativistic electron beam that delivers orders of magnitude more energy in much shorter pulses than does a flash lamp.

The Imperial researchers have been able to frequency-shift the laser from the visible to the UV in ultrashort, 1 to 10 ps, light pulses. Using this technique, the researchers expect to pump dense plasmas and create population inversions sufficient to lase on X-ray emission lines at wavelengths of less than 100 Å. If this is achieved, it should be possible to create X-ray holograms, they report.
Here's what's new in pots and trimmers from TRW/IRC Potentiometers

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CIRCLE NO. 291

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3/8" Square Type 76 Cermet Trimmers
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3/8" Square Trimmer:
Rated at 0.5W @ 70° C, six basic mounting styles, four with CW and CCW rotation

For additional information, contact your TRW/IRC Potentiometer Distributor or write TRW/IRC Potentiometers, 2801—72nd Street, North, St. Petersburg, Florida 33733 (813) 347-2181

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The GOLD BOOK puts the entire electronics industry at your fingertips. Reach for it first. Distribution began in mid-July — FREE to qualified *Electronic Design* subscribers. Others may order copies while they last for $30 per set domestic or $40 elsewhere.
Lugging excess weight around on service calls under all kinds of environmental circumstances doesn't improve the efficiency or enthusiasm of servicemen. That's why more and more of the purchasing decisions are being influenced by weight besides the price and performance of a portable oscilloscope.

The Philips PM3240, a 50 MHz dual trace oscilloscope, has the facilities you need for the majority of your service applications—generally below 50 MHz. This ultra lightweight (only 18.5 lbs.) dual time base oscilloscope with the bright 8 x 10 cm display has been designed with specific emphasis on ease of use. Every control falls naturally and quickly to hand. The controls are grouped in four vertical sections; \( Y_a \), \( Y_b \), delayed and main time bases—with all the main controls on exactly the same level. In this way, the desired switch is found without even having to look away from the screen, while the clear separation of the two timebases eliminate confusion and a possible source of error. This low priced PM3240 gives the operator full control of the triggering parameters, but uses LED's which immediately indicate when triggering conditions are not correct.

The chances are that before the Philips PM3240 was available, you were forced to buy an expensive instrument more transportable than truly portable—with more bandwidth than was necessary—for more money than you wanted to pay. Aren't you glad you've got a better choice now? To get further information or have a field engineer contact you for a demonstration of the Philips PM3240, utilize our toll free HOT LINE 800 645-3043. New York State residents call collect (516) 921-8880.

Philips Model PM3240 50 MHz/50mV dual trace oscilloscope priced at $1470.00. Philips Model PM3240X includes TV sync separator, priced at $1570.00.

Philips Test & Measuring Instruments, Inc.
400 Crossways Park Drive
Woodbury, N.Y. 11797

PHILIPS FOR DEMONSTRATION CIRCLE 297
FOR SALESMAN TO CALL CIRCLE 298
Electronic Design 17, August 16, 1975
### New Products

#### 3-1/2-digit DPMs consume just 3/4 W

Meterex Corp., 646 Summer St., Brockton, MA 02402. (617) 588-8826. $69 (100); stock-4 wks.

This new line of logic-powered 3-1/2-digit DPMs are built around a CMOS LSI IC. Designated the MX2500 series, these new meters consume only 750 mW and employ an auto zero technique that zeroes both offset voltage and input current. Input current is typically 10 pA. The meters are housed in a die-cast case that occupies less than 4 cu. in. behind the customer's panel. LED displays are used for the readout.

CIRCLE NO. 308

#### 11-MHz function gen carries low price tag

Dana/Exact, 455 S.E. 2nd Ave., Hillsboro, OR 97123. (503) 648-6661. $695; stock.

First in a series of low-cost 11-MHz function generator, Model 516 is a pulse sweep unit. With a dynamic frequency range of 0.001 Hz to 11 MHz, the Model 516 offers sine, square, triangle, ramp and pulse waveforms at 20 V pk-pk open circuit, 10 V pk-pk into 50 Ω. A 20-Hz to 20-kHz range is provided for audio use and sweeping the entire audio range.

CIRCLE NO. 309

#### Slightly over 2 lb, just under $200: it's a DVM

Sencore, 3200 Sencore Dr., Sioux Falls, SD 57107. (605) 339-0100. $198.

Three key features describe the DVM32 DMM: 1. Portability with protection; 2. Automatic 3-1/2-digit LED readout; 3. 0.5% dcV accuracy. The unit uses standard "C" cells, rechargeables, or optional 115/230-V line-cord power. An AUTO-OFF circuit turns the LED off between measurements on any range, when in the Auto position. A specially designed high-impact Cycloac case means that the DVM-32 can take a fall from the top of a service bench and go right on working. This physical protection is backed by electrical protection to 2000 V on all dc ranges and 1000 V on all other ranges, with back-up fuse protection.

CIRCLE NO. 310

#### A/d unit converts in 25 μs, expands easily


A new rack-mounted, a/d conversion system that operates at a 25-μs conversion time has now been added to the company's GM Series. Available with either 10, 12 or 15-bit resolution, this new low-profile unit—the GMAD-4—is completely enclosed in a standard rack-mounted enclosure only 5-1/4-in. high, and includes the a/d converter, front-panel controls for selection of operating mode and multiplexer channels, front-panel indication of multiplexer channel and a/d output.

CIRCLE NO. 320

#### Test set replaces 7 different instruments

3M Co., P.O. Box 33600, St. Paul, MN 55133. (612) 733-2925. Approx. $6000.

Electronic measurements requiring seven different test instruments can be achieved by a single test set said to cost about two-thirds as much. Model 6110 provides precise digital readout for these and other functions: distortion analysis, with automatic frequency tracking (including harmonics) and automatic ranging for percent distortion, fundamentals from 100 Hz to 1 MHz; wideband tunable wave analyzer with push-button selection of measurement bandwidth, 100 Hz to 3 MHz; frequency counting, with automatic ranging, 100 Hz to 10 MHz; voltage measurement, 0.001 to 30 V (rms), with automatic ranging.

CIRCLE NO. 321

#### Counter resolves low frequencies fast

Heath/Schlumberger, Benton Harbor, MI 49022. (616) 983-3961. $630.

SM-109A computing frequency counter measures the elapsed time (T) for a number of periods (N) of the input waveform, then computes the frequency for the relationship, \( F = \frac{N}{T} \). And it does this in much less time than would be required with a conventional counter. For example, a resolution of 0.00001 Hz can be obtained for a 1-Hz input frequency with a total measurement time of only 1 s. A standard counter would require 27.28h for the same measurement.

CIRCLE NO. 322
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It's the very best!
Rugged portable scope aims at industrial use

Tektronix, P.O. Box 500, Beaverton, OR 97005. (503) 644-0161. $1650; 8 wks.

The 455 is a rugged, lightweight portable oscilloscope. Featured are dual-channel operation with 50-MHz bw, vertical sensitivity ranging from 5 mV/div to 5 V/div, delayed sweep, and sweep rate to 50 ns/div (extended to 5 ns/div by a 10X magnifier). Other features include trigger view, lighted deflection-factor indicators (1X or 10X probe attenuation automatically accounted for), probe coding and a full 8 x 10-cm display. The case is made of shock-resistant, reinforced plastic.

CIRCLE NO. 323

Signal source sweeps, pulses, delivers sines

Dana Exact Electronics, 455 S. E. 2nd Ave., Hillsboro, OR 97123. (503) 648-6661. $1895; stock.

A combination pulse/sweep/function generator, Model 7059, combines the features of a general-purpose pulse generator and an 11-MHz sweep function generator. The instrument offers sine, square, triangle, ramp and, in addition, positive and negative pulses with precision control of rep rate, pulse width, and duty cycle. As a function generator, the unit has a frequency range of 0.0001 Hz to 11 MHz and can be triggered or gated externally or from an internal trigger source. Frequency sweep width is 0 to 1000:1. Pulse widths range from 1000 s to 100 ns.

CIRCLE NO. 324
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INTEGRATED CIRCUITS

Single IC drives large LCDs

LSI Computer Systems Inc., 22 Cain Dr., Plainview, NY 11803. (516) 293-3850. $18.20 (100); stock to 8 wks.

The Model C1200 MOS clock circuit can drive large seven-segment LCDs directly. The new chip outputs 40 V ac—80 V pk-pk—from a single Vdd supply of 50 V dc. The circuit presents a 12-hour clock format with leading zero blanking. It can also be used as an elapsed-time indicator, when the clock is reset to zero, by a simultaneous activation of both hour and minute time-set inputs.

CIRCLE NO. 325

CMOS multiplexers avoid 'glitches'

Siltek International Ltd., Aport Industrial Park, Bromont, Quebec, Canada JOE 1L0. (514) 534-2255. $1.40 to $2.92 (100 up); stock.

Three 4000-series-compatible 3-to-18-V CMOS analog multiplexers/demultiplexers eliminate "glitches" due to differential address delays, and they provide a worst-case ON resistance of 300 Ω at 10 V and 175 Ω at 15 V. The SIL4051B is an 8-to-1 line circuit with three-line binary address; the SIL4052B is a dual 4-to-1 line circuit with common two line address; and the SIL4053B is a triple 2-to-1 line IC with three independent channel-select inputs. Off leakage is only 100 pA. Propagation delay from address and inhibit to output is 90 ns at 10-V.

CIRCLE NO. 326

PLL circuit simplifies uses

Exar Integrated Systems, 750 Palomar Ave., Sunnyvale, CA 94086. (408) 732-7970. $8.16 (100 up); stock.

Improved capabilities in an FSK demodulator/tone decoder permit the circuit's use in narrowband communication equipment. The XR2211 has about 10 times the frequency stability and response speed of previous designs, allowing operation at bandwidths as narrow as ±1%. Also the use of any channel requires the selection of only five or six component values. And the XR-2211 is the first PLL system with simultaneous FSK demodulation and tone or FSK-carrier detection capability. Typical frequency stability is 20 ppm/°C over temperature and 0.05%/V for supply drift. Input dynamic range is 2 mV to 3 V rms, frequency range is 0.01 Hz to 300 kHz, adjustable tracking range is ±1% to ±80%, and power supply range is 4.5 to 20 V.

CIRCLE NO. 327

CMOS processor executes PDP-8 set


The IM6100 CMOS single-chip microprocessor executes the instruction set of the popular PDP-8/E minicomputer. The 12-bit IM6100 consists of six 12-bit registers, a programmed logic array (PLA), an arithmetic and logic unit (ALU) and associated gating and timing circuitry. The IC uses a single 5-V supply, has an on-chip crystal-controlled oscillator and comes in a 40-pin DIP. The device operates with standard MOS RAMs, PROMs and FPLAs, with no more than six standard 54/74-TTL packages for interface. To complement the IM6100, Intersil plans to introduce four additional LSI CMOS devices: a UART, a 1-k × 12-bit ROM, a parallel interface element and a 256 × 4-bit RAM. In addition, the company offers three PC boards: 4-k × 12-bit CMOS RAM, CPU/TTF and control panel.

CIRCLE NO. 328
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INTEGRATED CIRCUITS

EPROMs move up to 8-k bits

Intel Corp., 3065 Bowers Ave., Santa Clara, CA 95051. (408) 246-7501. $39.30 to $65.50 (100-999).

An 8192-bit ultraviolet erasable and electrically reprogrammable ROM—the largest yet—increases speed by a factor of two over that of earlier units. Organized 1024 \( \times \) 8-bits, the new Model 2708 has a guaranteed worst-case access time of only 500 ns over the 0-to-70-C temperature range. By contrast, the popular Model 1702A—a 2-k bit EPROM—has a worst-case access of 1 \( \mu \)s. Also, the 2708 typically dissipates 97 \( \mu \)W/bit compared with 292 \( \mu \)W/bit for the 1702A. The dissipation and speed specs of the 2708 can also be obtained in a 4-k bit version, the Model 2704, which is organized as 512 \( \times \) 8-bits. A reprogramming of the new EPROMs can be achieved with a single high-voltage pulse per bit while the new memories maintain operation from standard supplies of \( \pm 5 \) and \( \pm 12 \) V. Typical programming time is 12 ns per bit, or about 100 seconds for the 8-bit EPROM.

CIRCLE NO. 329

1-k bit CMOS RAM aims for 2102 sockets

Siltek International Ltd., Airport Industrial Park, Bromont, Quebec, Canada JOE 1LO. (514) 534-2255.

The 1902A, a fully static CMOS RAM organized 1024 \( \times \) 1 bit, features pin compatibility with 2102-type n-channel MOS RAMs. The 1902A has low battery drain even at 125 C, where standby current is only 200 nA per bit with \( V_{DD} = 5.5 \) V. The circuit offers a typical access time of 450 ns with \( V_{DD} = 5.5 \) V and \( C_L = 50 \) pF.

CIRCLE NO. 330
Two New DIP SOLID STATE RELAYS from CLARE

If you have pcb designs that need fast, long-life switching for DC loads to 250 Volts—or AC/DC loads to 50 Volts—check these new solid-state relays from C. P. Clare & Company. They're DTL/TTL compatible, packaged in full-molded epoxy cases with a standard DIP footprint, and sized to fit 0.5" pcb centers. Rugged...reliable...versatile.

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All Series 233 and 234 models are SPST (N.O.) devices, rated for dielectric withstanding voltage of 1500 Vac and insulation resistance of $10^9$ ohms. Operating and storage temperatures range from $-20^\circ$ C to $+100^\circ$ C. All models are in stock for immediate shipment. For specification data, contact your nearest Clare sales office or distributor. For more comprehensive application information, contact Rick Prieto, C. P. Clare & Company, 3101 W. Pratt Avenue, Chicago, Illinois 60645. Or Phone (312) 262-7700.

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The versatile, lightweight Model PDM-20-500 power divider is extremely useful for such applications as avionics, local oscillator power division, glide slope systems, instrument landing systems, image reject mixers, and antenna couplers. Other key specs include: coupling —3 dB, isolation 25 dB, amplitude balance 0.2 dB, phase balance 2°, and insertion loss 0.7 dB.

Contact Merrimac today for more details on standard and custom versions of Model PDM-20-500.

INTEGRATED CIRCUITS

Enhanced 8080-type processor makes debut

NEC Microcomputers, Inc., 5 Militia Dr., Lexington, MA 02173. (617) 882-8410.

The μCOM-8, an n-channel MOS silicon-gate microprocessor, features pin compatibility with Intel's 8080 processor. However, several enhancements have been built into the new version. It has multibyte interrupt instruction capability, and it can do BCD subtraction as well as addition. Moreover it gives 20% faster register-to-register transfers—just 2 μs. The new processor lists 78 instructions. Support circuits include a 4096-bit dynamic NMOS RAM—the UPD-411D-3—with the fastest available access time of 150 ns. The company also offers a range of hardware and software support as well as documentation.

CIRCLE NO. 331

LOW Phase Noise and FAST Switching Speed

... are two features of GR SYNTHESIZERS that no other 500 MHz synthesizer can match. Phase noise of GR's 1062 is the lowest available at 500 MHz... close to 100 dB down at 10 Hz from the carrier... one reason the 1062 is the popular choice for up-converting and multiplying into microwave-frequency bands. What's more, the 1062's switching speed is under 100 microseconds and guaranteed! Both features are explained in GR Application Notes; request your copies now. Other performance features include:

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INFORMATION RETRIEVAL NUMBER 57
ELECTRONIC DESIGN 17, August 16, 1975
2-k bit TTL PROM reads in 30 ns

_Fairchild Integrated Circuit Group, 464 Ellis St., Mountain View, CA 94042. $20.48 to $51.50 (100-999); stock._

A 2048-bit TTL PROM combines Isoplanar and Schottky technology with fuse-link techniques. The PROM has a maximum read cycle time of 50 ns over the 0 to 75°C temperature range and 60 ns over the full military temperature range. Typical read cycle is 30 ns. The PROM is available in two versions: the 93436 open collector and the 93446 three-state output, in a 16-pin ceramic DIP. The new PROM can replace standard 1024-bit PROMs by a change of one pin from chip select to address.

_CIRCLE NO. 333_

4-bit processor finds alternate source

_National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, CA 95051. (408) 732-5000. $7.50 to $9.95 (100)._

Intended as a replacement for Intel's MCS-4 microprocessor system, the new FIPS (Four-bit Integrated Processor System) features a CPU chip that sells for less than $10 and reduced chip-set power dissipation. In addition to the INS4004 CPU, the chip set includes a combination 256 × 8-bit ROM and 4-bit I/O port (INS-4001), a 320-bit RAM with a 4-bit output port (INS4002) and a 10-bit serial-in parallel-out shift register (INS4003). Other units are an 8-bit address latch-memory interface (INS4008) and 8-bit instruction and I/O transfer device (INS4009). Together they permit the use of the standard MM1702AQ 2048-bit erasable PROM.

_CIRCLE NO. 334_

If you don't require all the electrical performance built into SMA type connectors, why pay for it? Up to 3 GHz for flexible cable assembly and even beyond 6 GHz for semi-rigid assembly, our new JCM series gives you the same electrical performance as the far more expensive SMA connectors. The series includes connectors for both panel and PC mounting. All are interchangeable and intermateable with the standard, expensive SMA connectors. So you can use them without making any changes... and without compromising required performance. There are JCM connectors to accept virtually any miniature size cable, so you don't have to stock a big variety. It's worth looking into, isn't it? All it costs is a stamp.

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INFORMATION RETRIEVAL NUMBER 58
PACKAGING & MATERIALS

Mag-shielding case protects tape cassette

Ad-Vance Magnetics, Inc., 226 E. Seventh St., Rochester, IN 46975. (219) 223-3158. $15 (unit qty); 2 to 6 wks.

Severe electrical storms, nearby radiating equipment or power-generating equipment may partially erase or degrade vital data on cassette tapes. A new cassette data protector, Model CDTP AD-MU, prevents such possible losses. If dropped, the single cassette tape inside each protector remains undamaged. It is impervious to most postal abuse.

CIRCLE NO. 335

Temporary adhesive speeds production

Aremco Products, P.O. Box 429, Ossining, NY 10562. (914) 762-0685. $27.50/package of five sticks; stock.

Crystalbond 509, an acetoneresoluble polymer-based adhesive, can speed production dicing of silicon, glass and alumina substrates. Due to the minimal glue line of 0.001 to 0.002 in. there is excellent adherence and this permits dicing of miniature die with minimal chipping down to 0.005 in. The material can be recycled for further use. Crystalbond 509 does not gum up diamond blades used in dicing.

CIRCLE NO. 336

Ultra-mini connectors have 0.125 in. diameters

Microtech, Inc., Park Square Bldg., 777 Henderson Blvd., Folcroft, PA 19032. (215) 532-3388. From $0.95 (1000-up); stock.

A line of ultra-miniature coaxial connectors and multicontact 4, 7 and 12-pin connectors is designed to meet high density packaging. The co-axial connectors are available in ultra-miniature and miniature sizes with outer diameters of 0.125 and 0.25 in., respectively. Over-all length of the ultra-miniature plugs is less than 0.25 in. and they have outer diameters of 1/4, 5/16 and 7/16 in., respectively. Over-all length of the plugs is less than 0.5 in.

CIRCLE NO. 337

MEMORY SERIES No. 3

SUPER GIVEAWAY: 6 YEARS OF PROM RESEARCH

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INFORMATION RETRIEVAL NUMBER 59

Remote viewing at a price competitive models can't even approach.

This new, low-cost FS-100 Fiberscope with a 24" flexible length can reveal hidden flaws, peer into recesses, and trace vibrations to their source. Built with AO quality throughout, this battery-powered unit features a high resolution fiber bundle with a wide angle fixed focus objective lens, and an adjustable eyepiece. For further information on the entire Fiberscope line, write or call American Optical Corporation, Fiber Optics Division, Southbridge, Massachusetts 01550. Tel. (617) 765-9711 Extension 2445.

Only $295
Model FS-100 Fiberscope

American Optical

INFORMATION RETRIEVAL NUMBER 60
Electronic Design 17, August 16, 1975
Sudden Service on Small Quantities!

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- Standard Resis. Range 10 ohms to 2 meg.
- Multi-element precious metal wiper contact for increased reliability and low noise
- Stand-offs for efficient board cleaning
- Low industrial pricing

Oven stabilizes crystal temperature

Ovenaire, Div. of Walter Kidde & Co., Inc., 706 Forrest St., Charlotteville, VA 22901. (804) 977-8050. $7 (OEM qty.).

Ovenaire Model PCL1-27, a miniature crystal oven for HC-18/U, HC-25/U, HC-42/U or HC-43/U crystals, improves stability by greater than 30 to 1. Power consumption is less than 0.5 W at 25-C ambient and 50-C operating temperature. Size is 0.750-in. dia x 0.562-in. high. The ovens are available with temperature settings from 35 to 95 C and voltages from 5 to 36 V dc. An adjustment temperature control for crystal-frequency optimizing is also available at no additional cost.

CIRCLE NO. 338

Edge connectors feature gold-over-nickel plate

TRW Inc., 1500 Morse Ave., Elk Grove Village, IL 60007. (312) 439-8800. $1.71: 22 position (100 up).

A new line of seven sizes of low-cost edge connectors with contacts on 0.156-in. centers, the Series 90, is available in 6, 10, 12, 15, 18, 22 and 25 position, single and double readout with either solder-tab or dip-solder PC-board terminals. The bellows type, bifurcated contacts are made of a selectively plated copper alloy with 20 microinches of gold over 30 microinches of nickel at the contact area. Nickel provides a barrier to base-metal migration that is a significant improvement, with no increase in price, over copper-underplating, according to TRW. Insulation is glass-filled polyester.

CIRCLE NO. 339


Series 60 upright and inclined panel racks from Bud. Interiors easily accessible from front and rear. 19" panel space. Upright: 14 sizes; clear inside depths, 20½" and 24". Clear inside depth of seven extra-deep units, 29¼". Inclined: three sizes; clear inside depth, 20½". Clear inside depth of three extra-deep units, 29¼". "U" braces. Adjustable mounting rails. Available at your Bud Distributor. For further information, phone —
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Custom-made look, yet standard enclosures.


Available at your Bud Distributor. Four sizes, plus accessory chassis. Also accepts P.C. boards. Body, .050 aluminum; front panel, .090 aluminum. Top and bottom removed easily for access to dust-free interior. Carrying handle used as tilting bail. Handle/bail, front panel and self-adhesive rubber feet included. Finished in mar-resistant, durable Nextel. Compare delivery, value, shipping economies. For further information, phone —
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Electronics Packaging

Handles for enclosures - a complete line

Bud Radio, Inc., 4605 E. 355 St., Willoughby, O. 44094, (216) 946-3200. 33 different types.

Handles plus hardware for electronic enclosures are in stock at your Bud Distributor: chrome plated, silver anodized, brushed chrome recessed and satin chrome lever types, chrome plated catch sets. Fasteners included. Designed for all types of applications. Construction equals that of higher priced counterparts. Range of sizes and configurations. Compare. For further information, phone -

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Low silhouette blowers cool electronic equipment


Six models. Each cools electronic equipment in racks, cabinets, consoles efficiently, economically. Panel heights: 3 3/4", 5 1/2" and 7" - lowest heights, highest CFM output in the industry. Each has 19" panel width, standard E.I.A. notching for rack mounting. Filters removed through front panel; no tools required. Guaranteed for 20,000 hours. For further information, phone -

1-800-321-1764, TOLL FREE IN OHIO, 1-800-362-2265, TOLL FREE

Packaging & Materials

Universal press clip holds flat cable


New Weckesser FCA-15 molded nylon press clips meet the need for a single-sized universal clip to hold any size flexible-flat or ribbon cable. The clips are used along the edges of the cable. They provide flexibility in mounting and allow the stacking of flat cables even if they have varying widths and thicknesses. Adhesive- backing speeds assembly and cuts installation costs. The clips stay permanently once pressed into place, yet cables can be removed and replaced when necessary. Clips should be applied only to clean surfaces that are free from dust and oil.

CIRCLE NO. 340

LEDs and pushbuttons combined on DIP

Illinois Tool Works Inc., 6615 W. Irving Park, Chicago, IL 60634. (312) 282-3040. $4 (OEM qty)

SPST normally-open pushbutton switches are combined with miniature, T-1-sized red LEDs on a standard DIP with 1 x 0.3-in. spacings. Over-all height, from the bottom of the package to the top of the LEDs, is 0.44 in. The pushbutton mechanism has been tested to over 100,000 cycles. Initially, three configurations will be available in the same package size—one switch and four LEDs, five switches and four LEDs and four LEDs only.

CIRCLE NO. 341

Mini heat sinks keep power semis cool

Aham, 968 W. Foothill Blvd., P.O. Box 909, Azusa, CA 91702. (213) 334-5135. From $0.74 (5000-up).

The Series 400/420 heat sink is a highly efficient combination of two heat sinks. The 400/420 offers the user a greater heat transfer of natural convection without sacrificing additional board and space. For TO-3 packages Models 402/423 and 403/425 provide 1.875 x 1.875 x 0.75 in and 1.875 x 1.875 x 1 in., areas, respectively. And, for TO-66 packages the 402/428 and 403/429 provide identical amounts of heat sink areas, respectively.

CIRCLE NO. 342

Potting cups molded from 400-V/mil resins

Precision Paper Tube Co., 1033 S. Noel Ave., Wheeling, IL 60090. (312) 537-4250.

Custom-molded potting cups and lids made of electrical-grade phenolic or alkyd resins can be supplied with holes for lugs or terminals as well as molded-in identifying information. Tooling time is as short as two weeks. Dielectric strength for both resins is 400 V/mil, but the alkyd has a higher tensile strength—9000 compared with 7000 psi for the phenolic. The alkyd also has a heat deflection temperature of 450 F and the phenolic is only 310 F. Sizes and shapes of cups can vary from 1/2-in. diameter up to 5-in. maximum rectangular measurements.

CIRCLE NO. 343

Don't miss an issue. Fill in and return your renewal form today. (See inside front cover.)
TRW/Cinch low profile D.I.P. sockets

Don't let the small size and low cost fool you. These low profile DIP sockets are first string all the way. The unique TRW/Cinch design incorporates many features previously available only in larger more expensive sockets, resulting in improved performance and reduced assembly costs. With a height of only 0.150", these low-profile sockets are high scorers with a high tensile strength contact material that provides 4.0 ounce contact force, pointed terminal tips for easy PC insertion, generous lead-in dimensions and tapered socket entry to align bent DIP leads during automatic insertion. Center slots with cross bars permit air flow under the DIP for more efficient cooling, and the glass-fiber filled SE-0, U.L. rated insulator allows operating temperatures from -65°C to +125°C. The sockets also feature recessed ends for ample removal tool clearance and stand-off bosses for rapid flushing of flux residue.

TRW/Cinch low profile DIP sockets are available in 8, 14, 16 and 24 contact sizes. And a full bench of other sizes will be developed when the need arises. For fast team action, contact your local TRW/Cinch distributor, or TRW/Cinch Connectors, An Electronic Components Division of TRW Inc., 1501 Morse Avenue, Elk Grove Village, Illinois 60007; Phone: (312) 439-8800.
Multichannel data-acquisition systems cut costs but not versatility

Multichannel data-acquisition subsystems are available from several manufacturers—but usually at a high price. Hybrid Systems has slashed costs with its introduction of the DAS-400, eight-channel data-acquisition system. The DAS-400 costs only $199 in unit quantities—about half the cost of the closest competing subsystem.

The DAS-400 multichannel a/d converter system has an accuracy of 0.03% and a throughput speed of 30,000 channels/s. To keep costs down, Hybrid Systems has eliminated some of the features, such as expandability and a sequential address counter, that are available in more expensive units like the MP6912 from Analogic (Wakefield, MA), the SDM8501 from Burr-Brown (Tucson, AZ), the DT1600 series from Data Translation (Framingham, MA), the DAS-16-M12 from Datel (Canton, MA), the MN-7000 from Micro Networks (Worcester, MA) and the 7200 from Zeltex (Concord, CA).

The DAS-400 system handles eight single-ended inputs with a 0 to 10 or -5 to +5 V input range. The range can be electronically switched so that unipolar and bipolar signals can be mixed. The a/d converter delivers a 12-bit data word plus the complement of the most significant bit and a status signal that indicates the start and completion of conversion.

The system has an input impedance of 100 MΩ minimum, a gain tempco of 50 ppm/°C and a linearity tempco of only 15 ppm/°C. With a 1-kHz, 10-V pk-pk input signal, crosstalk is less than 0.5 LSB; the maximum error for a full-scale input swing between successively addressed channels is only 1 LSB, max.

Hybrid Systems has also announced a larger system, the DAS-450, a 16-channel module that can be expanded up to 128 single-ended channels. The DAS-450 can also be expanded to handle 64 differential channels.

The output lines of the DAS-450 are three-state, buffered logic to ease connection to computer interface busses. Fixed input ranges of 0 to 10, -5 to +5 and -10 to +10 V are available and can be altered in the field.

Included in the DAS-450 system is the channel-address logic and all necessary timing logic. With all its features, the DAS-450 still has a unit-quantity price of only $399—about $100 less than other units with similar features.

Typical specs for the DAS-450 include a 1-kHz, 10-V pk-pk input signal, crosstalk is less than 0.5 LSB; the maximum error for a full-scale input swing between successively addressed channels is only 1 LSB, max.
include an acquisition time of 1 μs for a 10-V step in the sample/hold amplifier, an a/d conversion time of 40 μs and a multiplexer addressing time of 200 ns. Gain and offset are adjustable to zero with built-in trim potentiometers.

The DAS-400 eight-channel system is built on two 4.5 × 3.5 in. PC cards and requires +15 V at 25 mA, −15 V at 15 mA and +5 V at 200 mA. The DAS-450 consists of two 3.5 × 6 in. PC cards and requires +15 V at 66 mA, −15 V at 83 mA and +5 V at 723 mA. Both units are available from stock.

For Hybrid Systems
- Analogic
- Burr-Brown
- Data Translation
- Datel
- Micro Networks
- Zeltex

True rms-to-dc converter housed in 14-pin DIP

_Burr-Brown, International Airport Industrial Park, Tucson, AZ 85734. (602) 294-1431. $19 (100-up); stock._

The Model 4341 rms converter, in a 14-pin DIP, has an accuracy of ±0.2% of reading ±2 mV. The response time and the magnitude of output ripple are adjusted by an external capacitor. The offset and gain errors can be removed by the addition of external resistors. The unit has an input impedance of 5 kΩ and can accept ±10 V input signals. The output delivers 0 to 10 V at +5 mA, and has an impedance of 1 Ω, maximum. Bandwidth is 450 kHz for −3-dB response and stability is ±0.1 mV ±0.01% of reading."/C."

_CIRCLE NO. 344_
a little A-300 goes a long way.

In high frequency transmission. RF power generation for industrial and research processes. RFI/EMI and general laboratory applications, too.

The Model A-300 is a totally solid state power amplifier, covering the frequency range of 0.3 to 35MHz with a gain of 55dB. Capable of delivering 300 watts of linear Class A power and up to 500 watts in the CW and pulse mode, the A-300 is the ultimate in reliability.

Although the unit is perfectly matched to a 50 ohm load, it will deliver its full output power to any load (from an open to a short circuit) without oscillation or damage.

Complete with power supply, RF output meter and rack mount, the A-300 weighs a mere 89 pounds and operates from ordinary single phase power.

High power portability goes a long way for $5350. For further information or a demonstration, contact ENI, 3000 Winton Road South, Rochester, New York 14623. Call 716-473-6900 or TELEX 97-8283.

Rms-to-dc converter has ±10 V input range

Intronics, 57 Chapel St., Newton, MA 02158. (617) 332-7350. $60 (1 to 9); 2 wk.

The R401 modular rms-to-dc converter produces an output voltage proportional to the root-mean-square value of the input signal. This unit smoothly performs the rms function on many types of input waveforms. For input signals from -10 to +10 V, the total output error is 5 mV + 0.1% of reading. The scale factor is set at 1 V dc/V rms so that a 10-V peak sine wave will produce an output voltage of 7.07 V dc. For operation at low frequencies (less than 50 Hz) or for a reduction in output ripple, an external capacitor may be connected between the SP and output terminals. When used with an external filter network, operation down to 0.5 Hz can be achieved.

Standard circuit cards hold control system

JC Systems, Box 23445, San Diego, CA 92123. (714) 277-6585. From $55 (unit qty.); stock.

The 'Mini-mod' system line contains modular electronic control system building blocks. Circuits are assembled on two-sided printed circuit cards. A standard card measures 4.5 x 6 in. The front edge of the card has indicators which can display the operational status of the module when in use; the rear edge of the card has fingers for a dual sided printed circuit connector. Functions available include amplifiers, clamps, isolators, motor drivers, time delays and sequencers.

Instrumentation amp housed in TO-8 package

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. (408) 732-5000. 100-up prices: $23.55 (CG); $43.90 (G); stock.

The LH0036G hybrid instrumentation amplifier is a micropower circuit designed for precision, differential-signal processing. A combination of high input impedance (300 MΩ) and high common-mode rejection ratio (100 dB) provide the accuracy. Gain deviation is only 0.3% typ. The power supply operating range is very wide, from ±1 to ±18 V, and the circuit's power demand is only 90 µW at the low end of the supply voltage range. The gain can be programmed from 1 to 1000 with a single resistor. Output bandwidth is also adjustable—from 350 kHz (small signal) to 5 kHz (full power) at unity gain—as is the input bias current. A guard-drive output pin is also provided. The LH0036G is specified for operation between -55 and +125 ºC; an industrial version, the LH0036CG, operates from -25 to +85 ºC. Both parts are housed in hermetic, 12-lead, TO-8 metal cans.

Crystal oscillators are CMOS-compatible

Conner-Winfield, West Chicago, IL 60185. (312) 231-5270. From $20 (10 to 100); 4 wk.

The S14R low-profile CMOS-compatible DIP crystal oscillator is available at any fixed frequency from 4 to 20 MHz. Its frequency tolerance is ±0.01% from -25 to +75 ºC. The unit is housed in a DIP-like package that measures 0.3 x 0.8 x 0.5 in. The oscillator can operate from any supply voltage between +3 and +15 V dc with ±5% regulation and draws a current of less than 5 mA.
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Dialight, the company with the widest choice in switches, LEDs, indicator lights and readouts, looks for needs... your needs... and then they develop solutions for your every application. No other company offers you one-stop shopping in all these product areas. And no other company has more experience in the visual display field. Dialight helps you do more with these products than any other company in the business, because we are specialists that have done more with them. Talk to the specialists at Dialight first. You won't have to talk to anyone else. Send for your free new copy of Dialight's current catalog.
Digital angle converters accept BCD or binary

Computer Central, P.O. Box 804, Gaithersburg, MD 20760. (301) 948-5557. From $525 (unit qty); 6 wk.

The Model 840 rotary digital-difference-to-analog converter (DD/A) is available with BCD or binary input ranges. The inputs cover 359° (to 2^11), 359.9° (to 2^15), 359.99° (to 2^18), and 359.999° (to 2^21) for use in digital instrumentation and control systems. The converter subtracts the two parallel TTL input numbers and converts the difference to a proportional bipolar analog (error) voltage that can be power amplified to control analog motors, servovalves, etc. The sign and magnitude of the rotary DD/A output voltage is continuous through the 359° to 0° transition such that feedback systems are driven through the least angular displacement. The converter is accurate to 1/2 LSD over the full temperature range from 0 to 70 C.

CIRCLE NO. 349

Hybrid active filters have 0.15-dB ripple

General Instrument, 600 W. John St., Hicksville, NY 11802. (516) 733-3000. $12.50 (1000-up); stock to 4 wk.

The D-3 low-pass active filter is designed to be used in both the transmit and receive modes. Some of its specs include: a ±0.15-dB passband ripple from 0 to 70 C, better than 40-dB stop-band attenuation at 4600 Hz, a 3.4-kHz cut-off frequency, less than 2.5-mW power dissipation and a size of 1.9 x 0.9 x 0.25 in. The filter is housed in a single in-line package. These hybrid filters are designed with low temperature coefficient thick-film resistors and NPO capacitors on ceramic substrates.

CIRCLE NO. 350

Signal conditioner linearizes temp sensors

Yellow Springs Instrument Co., Box 279, Yellow Springs, OH 45387. (513) 767-7241. From $130; stock.

Thermivolts are precision temperature-to-millivolt signal conditioners. They convert the temperature sensed by resistance elements to a linear, dc analog voltage. This permits direct connection to computers, digital equipment, indicators, alarms, recorders and other process equipment. Thermivolts are available for use with two types of sensors, platinum RTDs and linear thermistor. They can cover temperatures from -40 to +600 C (-40 to +1112 F). Both encased and open models are available.

CIRCLE NO. 351
Digivue® - a better way to look at it.

Because computer time is valuable to your customers, Digivue display/memory units offer an unforgettable advantage.

The advantage is inherent memory and it's an inherent part of every Digivue unit. This makes Digivue units especially useful for graphic presentations like signature verification since refresh is not required. And Digivue units offer a high-contrast, flicker free display for precise readings with less chance of eye fatigue for people who spend long periods referring to data displays and computer terminals.

There's a lot more to Digivue, too. Our 512-60 models have hard copy and rear projection capabilities. And Digivue panels are flat and thin, allowing precise display and broad equipment design parameters.

As you may have guessed, Digivue display/memory units currently cost more than CRT's. But then, they offer a lot more. For a booklet that explains Digivue more fully, call (419) 242-6543, Ext. 66-415. Or write Electro/Optical Display Business Operations, Owens-Illinois, Inc., P.O.Box 1035, Toledo, Ohio 43666.
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INFORMATION RETRIEVAL NUMBER 74

DATA PROCESSING

Table-top prototyper speeds μP designs


A table-top microcomputer development system, called Intellec 4/MOD 40, simplifies implementation of 4040 CPU (4-bit) systems. The unit has 5-k bytes of memory, expandable to 12-k bytes. The memory is a combination of PROM, data RAM and program RAM available in 4-k byte segments. The system has 60 instructions including conditionals, logicals, binary and decimal arithmetic and I/O. Cycle time is 10.8 μs. A PROM-resident system monitor and a RAM-resident assembler support software development.

CIRCLE NO. 352

Digital cassette drive uses single reel motor

Amilon Corp., 49-12 30th Ave., Woodside, NY 11377. (212) 274-1794. $100 (1000 qty); see text.

The A-7 Series digital transport drive is based on one reel motor and one capstan motor. Elimination of one reel motor is said to reduce tape tension. Salient features include mechanical and electrical interlocks to assure proper cassette use, fail-safe braking and a self-aligning pinch roller. Samples are available from stock.

CIRCLE NO. 353

Electronic Design 17, August 16, 1975
Disc storage for PDP-11 offers 640 mbytes

Advanced Electronics Design, 754 N. Pastoria St., Sunnyvale, CA 94086. (408) 733-3555. From $17,500; 60 days.

A disc storage system with PDP-11 compatibility, the AED 8000, can control as many as eight, 80 mbyte disc packs, and can simultaneously interface with up to four CPUs. A microcontroller replaces the typical hardwired formatter. And the controller can be reprogrammed for a variety of minicomputers. The present unit is plug-compatible with the DEC RP11-C. The drive provides a data transfer rate of 1.2 Mbyte/s with average access of 30 ms.

CIRCLE NO. 354

Photopen device capable of 200-ns response


A solid-state Photopen Device features a 200 ns response time and is capable of operating with either stroke-written or high resolution TV displays. The unit can detect low light levels from CRT phosphors, without false triggering from high ambient light levels or EMI sources. Two TTL-level outputs are provided: pulse and switch. The pulse signal is generated when the unit detects the CRT beam; the switch signal is generated by lightly depressing the pen tip against the CRT display surface.

CIRCLE NO. 355

Floppy-disc memory includes section buffers

Sykes Dotatronics, 375 Orchard St., Rochester, NY 14606. (716) 458-8000. $2691 (10 qty); Sept.

The Sykesdisk, a floppy disc memory, offers IBM compatibility, dual sector buffers and an intelligent controller. The unit can operate asynchronously and does not require an I/O area in the mini. The memory comes with single or dual drives and includes minicomputer interfaces plus software.

CIRCLE NO. 356

THE TRIPLE THREAT
TO HIGH CORE PRICES

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ECOM® Series F-11 offers Unibus™-compatible replacement/expansion core capabilities for DEC's PDP-11 family. Performance is identical and savings substantial when compared with core supplied by the CPU manufacturer.

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Standard has 16K byte and 32K byte memory systems that are completely pin-compatible with your SPC-16, regardless of submodel. Add-ons for your SPC-1830 are also available. Our prices are lower; our shipment immediate!

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Save up to 40% on off-shelf delivery of expansion or replacement core for your Nova 2/4 and 2/10 mainframes. Memory system is identical in form, fit and function to core supplied by the manufacturer. Capacity is 16,384 16-bit words, with all original CPU parameters met or exceeded.
When you achieve it, you can offer true competitive value. That's just what we're doing at USCC/Centralab for 1975. MONO-KAP™ radial, and MONO-GLASS axial monolithic ceramic capacitors are now available to volume users from stock to eight weeks. Our investment and "learning curves" last year guarantee competitive responsiveness — USCC will welcome your specials and non-stock orders. Here's an offer you haven't heard lately — your money is going to buy more at USCC. Cash in on the best values in monolithic ceramic capacitors.

**DISCRETE ASSEMBLY**
MONO-KAP™ radial-leded epoxy coated capacitors are reliable performers; they're rugged enough to work in MIL environments. 4.7 pF to 10 Mfd., 50 to 200 WVDC in 4 dielectrics, including Z5U, in a variety of case sizes featuring meniscus control to 0.032 inches. Large quantity orders from stock.

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MONO-GLASS axials are glass encapsulated, designed for automatic PCB insertion; furnished reel-packed for high volume applications. They're available in 50 and 100 WVDC from 1pF to 1.0 Mfd.; four dielectrics: COG, X7R, Z5U and Y5V.

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DATA PROCESSING

Precision digital plotters offered at reduced price

Data Technology, 4 Gill St., Woburn, MA 01801. (617) 935-8820. $13,400 (qty 2); 90 days.

Designed for medium to high volume drafting operations, the 3454 Series plotters provide accuracy of ±0.004-in., resolution of ±0.0025-in. and plotting speeds up to 1320 in/min. The line quality and operating specs are those usually found on plotters costing $30,000 or more. Two high-torque stepping motors and a proprietary electronics package replace the complex mechanical linkages required on other flatbed plotter designs. The 3454 plotters can be interfaced with any digital data source and offer a standard plotting area of 34 in. by 54 in.

CIRCLE NO. 357

Computer and printer joined by µP device


Two microprocessor-based controllers mate Centronics and ODEC printers as print-only terminals to host computers. The ALS/MPC-3 operates with IBM Bisync protocol or Burroughs polling environment. The ALS/MPC-5 works in an asynchronous or synchronous mode at rates up to 9600 baud. Software changes for other line disciplines will be quoted on request.

CIRCLE NO. 358

DIP package houses 1800-baud modem

Ventel, 1190 Dell Ave., Campbell, CA 95008. (408) 374-1363. $75 to $250 (1-24 qty).

Operating at rates from 0 to 1800 bit/s, these 4-oz devices provide modem functions, supervisory functions and EIA or CCITI interfaces—all with no additional circuits or components. The micro modems are housed in a 36-pin dual in-line package that measures 9.72 square in. A low voltage of ±15 V at 100 mA powers the unit. Modes of operation include originate, originate/auto, auto-answer and originate/auto-answer. Microphone amplifier and speaker circuits are included for acoustic coupling.

CIRCLE NO. 359

Graphics terminal boasts 250-kHz rate

Nuclide Corp., 642 E.-College Ave., State College, PA 16801. (814) 238-0541. $6500; 90 days.

The Dynagraph computer-graphics terminal accepts data at rates up to 250 kHz and is compatible with mini or microcomputers. The flicker-free raster display provides multiple display capability. Other features include hardware vector and/or character generation with internal storage for up to 4k vectors and display storage for 64k addressable locations. Single computer instructions can control the construction and translation of multivector and/or character picture sets as well as control multiple pictures. Storage of vector and control information at the terminal reduces computer storage overhead and permits high-speed data presentations even with conversational languages such as Basic or Focal.

CIRCLE NO. 360

IT TAKES MONTHS to get back on ELECTRONIC DESIGN's qualified subscription list. Keep your copies coming. RENEW NOW (see inside front cover).
Send for these new free lamp information bulletins from General Electric.

GE has added 6 halogen cycle lamps to its low-voltage line.

General Electric now offers over 27 halogen cycle lamps that pack high light output in small packages. (In addition, GE offers 8 sealed beam halogen lamps primarily for aircraft applications.) Bulb diameters range from 3/4" to 3/5". Lengths from .520" to 2.25". Voltages from 3.5 to 28.0 V. And candlepower from 2.15 cd up to 250 cd. They're ideal for applications such as optical systems, instrumentation, illuminators, fiber optics, card readers, displays and aircraft navigation. A variety of terminals are offered.

For complete, updated technical information circle the number below or write GE for Bulletin #3-5257.

INFORMATION RETRIEVAL NUMBER 78

GE ADDS BLUE to its line of color glow lamps.

With our new T2B blue glow lamp you can choose from a broad spectrum of colors for a wide range of indicator, panel illumination, and edge-lighting applications. Red, yellow, orange, green, blue and white are available with just three basic lamps (C2A, G2B, T2B) and the appropriate filters. All three lamps are electrically and physically interchangeable for operation from a standard 120 V, ac line in series with an appropriate current limiting resistor. They offer rugged construction, long life for reliable performance and shock and vibration resistance for use in almost any environment. Send for complete, updated technical information. Circle the number below or write GE for Bulletin #3-5258.

INFORMATION RETRIEVAL NUMBER 79

GE wedge base miniature lamps can save you time, money and space.

These lamps are ideal for applications such as indicators, markers and general illumination where space is at a premium. Their wedge-based construction makes them easy to insert and remove. They don't require bulky, complicated sockets. And the filament, which is always positioned in the same relation to the base, offers consistent illumination from lamp to lamp. There are now more than 25 types of GE wedge base lamps available. Voltages range from 6.3 V to 28 V. Candlepower from 0.03 to 12 cd. Bulb sizes range from subminiature at 6 mm to a heavy-duty bulb at 15 mm. Send for complete, updated technical information. Circle the number below or write GE for Bulletin #3-5259.

For the most up-to-date technical information on any or all of these lamps write: General Electric Company, Miniature Lamp Products Department #3382-L, Nela Park, Cleveland, Ohio 44112.

INFORMATION RETRIEVAL NUMBER 80

DATA PROCESSING

Megabyte mini also has intelligent I/O system

Computer Automation, 18651 Von Karman, Irvine, CA 92664. (714) 833-8830. See text.

Called the MegaByte because of its 1 Mbyte capacity, this 16-bit mini is intended to match wits with the likes of DEC’s PDP 11/45, Data General’s Eclipse and Interdata’s 7/32. The unit features 224 microcoded instructions, multiple hardware stacks and decimal string arithmetic. A flexible interface system consisting of a basic I/O board plus cables with built-in intelligent deuces eliminates special-purpose interfaces for each cable has a microprogrammed processor attached to it and the distributor handles eight cables; each cable in turn attaches to a single peripheral. Cost of the MegaByte ranges from $9600 (32 kbytes; 1.2 µs) to $110,000. Comprehensive software is also available.

CIRCLE NO. 361

Software package aids remote data access

Interdata, 2 Crescent Pl., Oceanport, N J 07757. (201) 229-4040. $2500.

A software package named ITAM provides access to remote terminals or computers as easily as to a local peripheral. The software package offers two levels of communications: a device-independent level, for easy access and a device-dependent level for sophisticated users who wish to provide their own terminal protocols. The device-independent level supports asynchronous terminals such as TTYs, CRTs and remote entry terminals. This level includes asynchronous and binary synchronous program modules that can be integrated to accommodate a variety of facilities, protocols and networks. A minimum ITAM system includes a Model 7/32 with 65 k bytes of memory, OS/32-MT, memory access controller, a real-time clock, a control console and appropriate data set adaptors.

CIRCLE NO. 362
POWER SOURCES

18 models form dc open-frame series

Powertec, 9168 De Soto Ave., Chatsworth, CA 91311. (213) 882-0004. Begin at $24.95; stock.

OEM II is the company's second generation line of open-frame dc supplies. Eighteen single-output models include three new package sizes. Each model provides an epoxy glass circuit board IC, regulation, output screw terminals, remote sensing and programming, metal film resistors, computer-grade capacitors, reverse polarity protection, adjustable current limiting, vacuum-impregnated transformer, hermetic semiconductors, interchangeability with previous models and ac input options.

CIRCLE NO. 363

Bench supply delivers triple outputs

Acopian, Easton, PA 18042. (215) 258-5441. $35; stock.

Model KT7-20 benchtop power supply provides a 0-to-7-V output for digital logic and balanced plus/minus output voltages for op amps or other analog circuits. The 7-V output is rated at 2 A and has a constant-voltage/constant-current crossover characteristic with continuously adjustable current control. Adjustable overvoltage protection is provided. Line and load regulation are ±0.01% each; ripple is 0.25 mV. The balanced outputs are adjustable from ±10 to ±20 V and are rated at 500 mA/output. Line and load regulation are ±0.05% each; ripple is 1 mV.

CIRCLE NO. 364

Converters give 10 W at 60% efficiency

B. H. Industries, 5784 Venice Blvd., Los Angeles, CA 90019. (213) 937-4763. $91.50; 3 wk.

Dc/dc converters with dual 5-to-15-V tracking outputs achieve 10-W output at 60% efficiency. The 2068 series is provided with a plate for mounting to a heat sink. The 10-W output can be taken from one output or it can be split between both outputs. Voltage accuracy is 100 mV and regulation is 10 mV for load and line changes. Size is 3.75 × 2.0 × 0.82 in.

CIRCLE NO. 365

MEMORY SERIES No. 5

WE MAKE ONE FAST RAM DO THE JOB OF NINE

Why string up nine 64-bit RAMs when a single 64x9 package does the same job—at 45ns.

Savings? Obvious: less parts to buy, less power to burn. Quantity stock available now.

Ask for high-speed #82509.

THINK SIGNETICS

WE MAKE ONE FAST RAM DO THE JOB OF NINE

Why string up nine 64-bit RAMs when a single 64x9 package does the same job—at 45ns.

Savings? Obvious: less parts to buy, less power to burn. Quantity stock available now.

Ask for high-speed #82509.

THINK SIGNETICS

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Savings? Obvious: less parts to buy, less power to burn. Quantity stock available now.

Ask for high-speed #82509.
POWER SOURCES

Line regulators aimed at processors & minis

Sola Electric, 1717 Busse Rd., Elk Grove Village, IL 60007. (312) 439-2800. $198.30 to $498.75; stock.

A new minicomputer regulator is designed to prevent malfunction and damage caused by brownouts and other line voltage irregularities. Line voltage can vary from 95 to 130 V and output is stabilized to less than ±3%. Output remains within the standard ±5% even when power line voltages drop to 65% of nominal. Four models offer ratings of 500, 750, 1000 and 2000.

CIRCLE NO. 366

Chassis-mount minis feature terminal strips

Semiconductor Circuits, 306 River St., Haverhill, MA 01830. (617) 373-9104. $69.95 to $107.95; stock-2 wks.

The new CM and LCM series of chassis-mount, miniature encapsulated power supplies buck the plug-in trend by providing a top-mounted, barrier-type terminal strip for easy power entry and exit: four 4-40 × 0.2-in. deep threaded inserts located in the base of each module ensure easy but secure installation. The CM series is powered by connection to two terminals on the barrier strip, the LCM series includes an internally connected 6-foot line cord. Standard models provide single outputs of 5 V dc at 750, 1000, 1500 or 2000 mA, as well as dual outputs of ±12 V dc or ±15 V dc at 100, 200 or 300 mA.

CIRCLE NO. 367

250-W switcher ‘tips’ the scale at 7 lb

LH Research Inc., 4444 Riverside Dr., Burbank, CA 91505. (213) 843-8465. $360.

These 250-W switching-regulated power supplies weigh only 7 lb and measure 3.65 × 5.05 × 12.25 in. The 250 series have 80% efficiency with outputs of 5, 12, 15, 18 or 24 V dc. Standard features include fully regulated output, overvoltage protection, and selectable input voltages, 115/230 V ac, 47 to 440 Hz, simply by changing a jumper on the front-terminal strip.

CIRCLE NO. 368

Open-frame units run cool

Faratron, 280 Green St., South Hackensack, NJ 07606. (201) 488-1140. $31 to $145; stock.

Referred to as “the cooler,” this 5-V, 25-A open-frame supply has a maximum power-transistor temperature rise of 50 C. All OEM open-frame models come with plug-in/self-locking printed-circuit regulators. All models are adjustable ±5% with cermet potentiometers and are supplied with 115/230 V inputs. Input and output connections are made with barrier-strips. The units cover a range of 5 V through and including 28 V dc, with current ranges from 3 to 30 A.

CIRCLE NO. 369
Simplify your equipment design and reduce assembly costs with this broad selection.

1. PCB Terminations can be provided on any conventional Oak rotary switch—the most extensive line in the industry—(1/2" to 2\(\frac{3}{4}\)" diameter sections).

2. Standard PC Board section switches, 12 and 24 position, with PCB terminations are tooled for volume production.

3. Custom designs to meet special applications, including switching built directly into the PC board are readily supplied.

A NEW CATALOG
Detailing Oak PCB switch products and capabilities has just been published. Write for your free copy...or call our toll free number: 800-435-6106.
MICROWAVES & LASERS

Radar transponder outputs 5-W pk

Vega Precision Laboratories, 800 Follin Ln., Vienna, VA 22180. (703) 938-6300.

A compact, X-Band solid-state radar transponder, weighing only 10 oz, combines a sensitivity of -40 dBm with a power output of 5-W pk. Called the Model 229X, it operates with an input voltage of from 22 to 32 V de and draws only 10 mA when quiescent and 80 mA at a prf of 2500 pps.

CIRCLE NO. 370

Laser-diode driver provides fast pulses


The ILC series of laser-diode pulsers provides pulse widths of 10 to 200 ns and rise and fall times as low as 2 ns. Any drive current between 1 and 100 A may be specified and pulse repetition rates of over 1-M PPS can be obtained with low-current models. An internal clock is provided for pulse rates to 20-k PPS. Temperature compensation is standard in all models. Operation is from 6 to 28 V dc. Sizes range from 1 to 1-1/2 in. dia. by 2 to 4 in. long.

CIRCLE NO. 371

Linear amp delivers 1 W with 3-dB NF

FG Engineering, Black Canyon Stage, Box 506, Phoenix, AZ 85020. (602) 465-7735. $75; 4 wks.

The Model R-160-40 linear amplifier has 30 ±3-dB gain, with a maximum noise figure of 3 dB. And it delivers a minimum of 1-W output at the 1-db compression point. Bandwidths from 7 to 70% can be provided anywhere from 10 to 200 MHz with a 20/3-dB shape factor of 6:1. Units can also be supplied with recovery times down to 100 ns. The amplifier can be used in repeater-station front ends to prevent receiver overloading by the transmitter.

CIRCLE NO. 372

MEMORY SERIES No. 10

GIANT 4K PROMS EVEN PRODUCTION CAN AFFORD.

Take the large economy size to prototype OR production. 4096 bits at 60ns secures patterns faster; 512 x 8 organization shrinks board space, boosts reliability—saves parts.assembly costs. speeds the line. Write #825115, in volume stock.

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PERSONALIZED TRANSFORMERS

No matter what function.
Pulse, isolation, matching, converter, etc.

No matter what specs.
Tough electrical, environmental, or both.

No matter what package.
DIP, substrate, header, conventional, or...

Technitrol has engineered transformers and transformer packages to meet the most stringent electrical and environmental requirements. Transformers have been produced mounted singly or in multiples in a broad spectrum of configurations.

Call Bill Chamberlin at 215-426-9105 or write. State your application; we’ll put over 25 years of transformer know-how to work for you.

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Specialists in pulse transformers and completely transfer molded, welded DIP delay lines under 3/8" high — to 250 ns.

INFORMATION RETRIEVAL NUMBER 85

INFORMATION RETRIEVAL NUMBER 86

ELECTRONIC DESIGN 17, August 16, 1975
Cramer is the center of the universe*

Microprocessor Seminar Series
These high-level, three day seminars are presented by Microcomputer Technique and give you step-by-step coverage on how to design your own systems, using the newest advances in microprocessors. The seminars will be held in 11 American cities during 1975 with even more to come in '76. For cost and location information call your local Cramer service center. You'll want to reserve your space now. Attendance is limited.

New Logic Notebook
Cramer is offering subscriptions to the New Logic Notebook, the most comprehensive monthly microprocessor information service available anywhere. Written by Microcomputer Technique, leaders in microprocessor application, each monthly monograph gives you in-depth coverage of the latest design techniques. Call your nearest Cramer location and ask for a complimentary copy. This publication is a must to keep pace with this new technology.

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Cramer has complete in-house equipment for the design, programming and testing of all your microprocessor needs. This includes an assembling service for converting your programs to machine language as well as debugging, simulation and final test capabilities for both your software and hardware. We can also program your PROMS from program cards, punched tape, truth tables or master ROM.

In addition, Cramer has inaugurated a technical information service to supply answers to all of your microprocessor design questions. You can call and receive programming and application manuals for every line of microprocessor that we sell and have your highly technical questions answered by our special consultants at Microcomputer Technique. Use this service to prove your design before you buy.

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Keep in touch with Cramer for some revolutionary microprocessor developments about to be announced; developments designed to make it even easier for you to build your own microcomputer.

*The universe, that ever expanding world of microprocessors. Cramer plans to be the pioneer in helping you meet exciting "universal" microprocessor challenges. For more information contact your nearest Cramer distribution center.

Design and Delivery
Industry standards...
Seven cermet trimmers that can

How?
- Through design versatility
- Fast delivery
- Excellent quality

Necessary Decisions:
1. Single vs. multiturn
2. Sealed vs. not sealed
3. Size
4. Resistance
5. Pin spacing
6. All-important, PRICE

Take a close look before you select your next trimmer. Call your local Beckman Helipot distributor for free evaluation samples, or immediate technical literature. For fast response, call (714) 871-4848, Ext. 1776.

Single-turn

Model 91
- High quality - low price
- Unique brush contact
- Excellent setability
- 100% inspected
- Protective dust cover
- Top or side adjust
- Screwdriver or hand adjust
- Standoffs prevent rotor binding and permit board washing
- Small 3/8" dia. size
- 12 pin configurations
- Wide resistance range: 10Ω to 2 megΩ

Price: $0.42

Model 72
- Sealed for board washing
- Available in VALOX 420-SEO housing
- Top or side adjust
- Brush contact
- Excellent setability
- Only 2 ohms of end resistance
- 3/8" square
- 100% inspected
- 7 pin configurations
- 19 resistance values

Price: $0.54

Model 82
- Lowest profile trimmer in industry
- ¼" dia. by 0.150" max. height
- Sealed for board washing
- Flame-retardant design
- 82P - top adjust
- 82PA - side adjust
- 100% inspected
- Brush contact provides excellent setability
- A cermet benefit that wirewound can’t approach: resistance range 10Ω to 1 megΩ

Price: $1.12

★ Still waiting for delivery on trimmers from another manufacturer?
Call your local Beckman Helipot distributor for a convenient cross reference from stock.
handle 95% of your applications.

**Multiturn**

**Model 64**
- Miniature, sealed trimmer
- 22 turns of adjustment
- Operates with 0.25 watt at 85°C derating to zero watts at 150°C
- 100% inspected
- 18 resistance values: 10Ω to 1 megΩ
- ¾” square size is excellent for P.C. board packaging
- Uses Beckman’s unique brush contact design
- Adjustability—voltage ratio within 0.01%

**Price:** $4.20

**Model 66**
- Low-cost, multiturn with benefits of more costly trimmers
- Sealed for board washing
- 20 turns for adjustment accuracy
- Compact ¾” square housing
- Brush contact
- 3 pin styles for efficient space utilization
- Broad resistance range: 10Ω to 2 megΩ
- Operates with ½ watt at 25°C
- 100% inspected

**Price:** $2.70

**Model 89**
- Our lowest cost multiturn
- Sealed for board washing
- ¾” rectangular trimmer just 0.250” high
- Needs no O-ring because of our unique ultrasonic sealing technique
- Only 2 ohms of end resistance
- 15 turns for accurate and quick adjustment
- 4 pin styles including in-line for mounting versatility.
- Panel mount available
- 100 ppm/°C tempco
- 19 resistance values available
- 100% inspected

**Price:** $1.05

**Model 78**
- Military performance at industrial prices
- 1¼” rectangular only 0.195” wide
- Sealed
- 3 terminal styles:
  - Flex leads
  - Printed circuit pins
  - Solder lugs
- Panel mount available
- Power rating 0.75 watt at 70°C
- 100% inspected
- 22 turns of adjustment
- Resistance range: 10Ω to 2 megΩ
- 100 ppm/°C tempco

**Price:** $2.28

*1,000-piece price*
Outstanding performance from logic levels to ¼ amp

• Compare design...Grayhill's self-cleaning wiping contacts outperform butt contact or snap action types.

• Compare selection...Grayhill has both momentary or alternate action; SPST, SPDT, and DPDT circuitry; front-panel bezel or sub-panel mounting; square or round button shapes in wide choice of colors.

• Compare panel appearance...Grayhill provides a compact, attractive panel...and a unique design-coordinated line of matching unlighted switches and indicator lights.

• Compare service...Grayhill's expert technical assistance, prompt quotations, and speedy deliveries save you time and money.

• Compare price...Grayhill lighted switches cost no more than other brands with equivalent ratings.

Start the comparison process NOW, by asking Grayhill for Lighted Switch Catalog #252 and information on our free sample offer.

MICROWAVES & LASERS

Thin-film amps cover 2 to 5.4 GHz

Varian, 611 Hansen Way, Palo Alto, CA 94303. (415) 493-4000. 60 days.

Covering the frequency range from 2 to 5.4 GHz, a family of compact, thin-film amplifiers is intended for airborne and tactical-system applications. Typical is the VSG-7420G for ECM use. The amplifier has a minimum power output at the 1-dB gain compression point of 5 dBm, and the unit measures 0.44 x 1.0 x 2.77-in. Maximum noise figure is 8.5 dB.

Flatpack holds rf switch

Olektron Corp., 6 Chase Ave., Dudley, MA 01570. (617) 943-7440. $125 (1-9); 4-6 wks.

Model FP2-1S-100 miniature rf switch covers the 2-to-500-MHz range with switching speeds of less than 10 ns. Supplied in a flatpack case, the unit's package measures 5/8 x 5/8 x 0.125-in. exclusive of leads. The switch has an impedance of 50 0, a VSWR of 1.5:1 max (ON state), an insertion loss of 2.0 dB max, an isolation of 50 dB min and a suppression control of -30 dB. The drive required for the ON state is 30 mA; for the OFF state, it's 10 V.

Ka band rotary joint specs 2 kW

Kevelin Manufacturing Co., 26 Conn St., Woburn, MA 01801. (617) 935-4800.

A Ka-band rotary joint can operate at 2-kW cw without auxiliary cooling. VSWR equals 1.5 maximum with insertion loss at 0.35 dB maximum. The unit has an over-all length of 3.5 in. with the outside diameter measuring 2 in. Operating temperature range is -40 to +160 F.
COMPONENTS

Rotary switches built to metric specs

Grayhill, Inc., 561 Hillgrove Ave., La Grange, IL 60525. (312) 354-1040.

For the international marketplace and to prepare for metrication in the US, miniature enclosed rotary switches in its Series 71 are built to metric specifications. The 17 mm dia, 0.25-A switches, with shaft and bushing dimensions conforming to IEC Document 390 (4-mm dia shaft, M7 x 0.75 bushing), are available in the 10 or 12-position versions with one-to-six-poles per deck—up to 12 decks. A wide range of options include concentric shafts, PC terminals out one side and adjustable stops.

Resistor networks have tolerance of ±2%


Pyrofilm is tooled for 14 and 16-pin resistor-network DIPs with maximum capabilities of 24 and 28 resistors per package. The resistance range covers 10 Ω to 1 MΩ with a standard tolerance of ±2%. Tolerances of 0.5% are available on request. Tolerance-ratio match can be as low as 0.5%.

Available temperature coefficients are 100 ppm/° C and 300 ppm/° C. Standard temperature-coefficient tracking is 50 ppm/° C, but 25 ppm/° C is available.

Film resistors handle kVs in kMΩ values

Dale Electronics, Inc., P.O. Box 74, Norwalk, NE 68701. (402) 371-0080. $3.66; EI 1511, 10% tol, 1 kMΩ (1000 up).

Type EI is a new series of film resistors for high voltage and power. They provide a wider resistance range than previously available, according to Dale. Power rating is 5 W and in close tolerance ranges (Type EI 1510) —0.5%, 1% or 2%—they have a working voltage of 14 kV with resistance values to 300 MΩ. Looser tolerance models (Type EI 1511) handle to 20 kV with up to 20 kMΩ resistance. Construction incorporates either metal or metal-oxide film on a ceramic core. Environmental protection and insulation resistance is provided by a double sleeving of flame-retardant irradiated polyolefin.

Optical switches tailored to fit.

Clairex® offers a choice of standard and custom switches with hermetically sealed components.

• Standard widths of .100 in. or .250 in.
• Special sizes and widths to your designs.
• Hermetically sealed components for long life.
• Glass lenses and windows reduce dust pickup.
• Pretested to assure performance.
• No friction wear, contact bounce or switching noise.

Come to the leader in opto-electronics. Tell us the problem. We'll develop the solution.

8192 BITS-NO EXTRA PIECES NEEDED.

3K MOS ROM #2608.
Use this big fast memory (1024x8 at 650ns) without costly supportive parts. TTL compatible: no interface required. Static logic: no clocks. Single +5V means no extra power supplies. Volume stock now.

MOS ROM #2608

THINK

Name

Premier

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Ext
An integrated bridge rectifier in a miniature dual in-line package

**DUAL IN-LINE BRIDGE**

- 4-pin, low-profile DIP
- Leads on standard .10" (2.54 mm) grid
- Compatible with automatic testing, handling and inserting
- 1 Amp at 40°C (10)
- 25V to 1000V (Ve)
- Call Lee Miller 214/272-4551, Ext. 206 for more information.

**VARO SEMICONDUCTOR, INC.**

P.O. BOX 676, 1000 N. SHILOH, GARLAND, TEX. 75040 (214) 272-4551 TWX 910-860-5178

INFORMATION RETRIEVAL NUMBER 92

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**COMPONENTS**

**Flexed-spring operates small, lighted switch**

Illuminated Products Inc., 207 S. Helena St., P.O. Box 4011, Anaheim, CA 92803. (714) 535-6037.

Lighted pushbutton switches, the new series 650, feature both double-throw and alternate action. The new switches pack the same functions into units that usually require twice the space, according to the manufacturer. Its Marcoflex, single flexed-spring mechanism uses few parts, but provides the characteristics associated with larger units: wiping action, multiple point contact, snap action, tactile feel and high contact force. The switches mount in a standard 0.625-in. square hole and the contacts are rated at 1 A, 30 V dc and 0.25 A, 115 V ac. A choice of seven pushbutton colors can be custom engraved. Eight lamp styles are available—from 5 to 125 V and unbased T-1-3/4 or AIC neon. Mounting choices include snap mounting clips with solder terminals for 1/16 to 1/8 in. panels and PC terminals.

**CIRCLE NO. 380**

**Bellows pushbutton operates remote switch**


A small air-bellows pushbutton, connected by flexible tubing to a pressure switch, sends a low-pressure air pulse through the tubing to activate the switch. The switch, in a variety of configurations, can handle to 15 A. Applications include foot controls and switching from areas containing combustibles.

**CIRCLE NO. 381**
YOUR **FREE** SUBSCRIPTION TO Electronic Design HAS EXPIRED

With business prospects brighter in '76 you won't want to miss a single issue of Electronic Design. Some of our readers have to pay as much as $80 per year for this magazine and our GOLD BOOK. They're yours FREE if you qualify.

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DON'T PUT IT OFF. Once you're off our list it takes months to get back on again.

RENEW NOW! See inside front cover
COMPONENTS

Incremental volt divider has fine-tuning pot


A knurled potentiometer on the least-significant decade of a Thumbpot incremental voltage divider permits ultra-fine adjustments without sacrifice of the fast setting advantages of the divider decades. The dividers are available with incremental steps as small as 1 part in 10,000. These incremental voltage dividers can replace 10-turn pots when front panel in-line readout is desired.

CIRCLE NO. 382

Thermistor flakes claim 'mini' title

Victory Engineering, Victory Rd., Springfield, NJ 07081. (201) 379-5800. Single flake about $6 (quant.). “Thinistor” flakes are just 1/2 mm × 1/2 mm in size and come in resistances from 25 kΩ through 1 MΩ. They are said to be the smallest available in the industry and, because of their size, thermal and infrared time constants are drastically reduced and infrared sensitivity is improved. Typical thermal time constants now available are 20 ms and typical infrared time constants are 160 ms. A chief advantage of the new flakes is that they can be used at higher chopping frequencies (10 to 20 Hz) because of the smaller time constants.

CIRCLE NO. 383

Solid-state temp probe has two-point limits

Control Products Inc., East Hanover, NJ 07936. (201) 887-9400.

A dual-temperature thermal switch is capable of sensing both upper and lower temperature limits. Designed for operation on 20 to 28 V dc, the switching unit features solid-state circuitry. The unit is available in two configurations: a 2-1/2 × 3-1/2 × 1-1/2-in. package with a single sensing probe connected via a cable, or a version with electronics and probe in one package. The user may specify the temperature points, which are then pre-set by CPI. An output signal compatible with CMOS or TTL logic is provided for each set point.

CIRCLE NO. 384

LOGIC SERIES No. 1

WHAT'S A BI-DI I/O PORT?

Double value in a single package. This 8-bit latch with 2 sets of Bidirectional I/O's performs high-speed standard interface between processor, bus & peripherals. #8T31 saves 6 parts plus pre-test & manufacturing costs.

Rush data sheet on #8T31, your 8-bit Bi-Di I/O Port.

Name

Tel.

Ext.

Clip coupon to letterhead.

SIGNETICS

811 E. ARQUES, SUNNYVALE, CALIF. 94086

INFORMATION RETRIEVAL NUMBER 101

Multi-Bath Test Stand for efficient production line testing

For chilling charpy specimens, calibration, shock testing and other special test requirements, rely on CSZ Multi-Bath test stands. Stainless steel chambers, liquid agitation, immersion heaters for high temperature operation, mechanical refrigeration systems for low temperature operation. Eye level indicating controllers and switches for each chamber. Caster mounted units for portability.

Write for literature kit

CINCINNATI PRODUCTB INC.

2612 Gilbert Ave., Cincinnati, Ohio 45206

Phone: (513) 751-8810

INFORMATION RETRIEVAL NUMBER 102

ELECTRONIC DESIGN 17, August 16, 1975
A GOLD MINE OF INFORMATION & DATA

- 520 CATALOG PAGES ON ICS & SEMICONDUCTORS
- 300 CATALOG PAGES ON INSTRUMENTS
- 290 CATALOG PAGES ON POWER SUPPLIES
- 210 CATALOG PAGES ON WIRE & CONNECTOR PRODUCTS
- 150 CATALOG PAGES ON SWITCHES
- 2800 CATALOG PAGES ALL TOLD IN 52 PRODUCT CATEGORIES

Electronic Design's GOLD BOOK puts the entire electronics industry at your fingertips. Use it for product search, selection, specification and purchase. It's the most thorough industry master catalog & directory ever compiled.

When you need Information . . . Electronic Design's GOLD BOOK IS THE PLACE TO LOOK

DISCRETE SEMICONDUCTORS

Npn power transistors complement older units

RCA, Route 202, Somerville, NJ 08876. (201) 722-3200. From $1.14 (100-up); stock.

Two npn power transistors, types 2N6465 and 2N6466, are complements of the previously announced pnp types 2N6467 and 2N6468, respectively. Type 2N6465 is a 100-V ($V_{CEO,sus}$) 40-W device with a dc beta of 15 to 150 measured at a 1.5-A collector current. The 2N6466 offers the same device-dissipation rating and dc-beta range, but at 120 V $V_{CEO,sus}$. Both types may be obtained with heat radiators for printed-circuit board applications on special order. They are normally supplied in hermetic TO-66 packages.

CIRCLE NO. 385

PC board mount LEDs made in four styles

Data Display Products, 5428 W. 104 St., Los Angeles, CA 90045. (213) 641-1232. From $0.49 (100-up); stock to 2 wk.

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CIRCLE NO. 386

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The PH2310 driven by the company's PH2304, when operated at 22 V will produce 10 W of broadband power over the 2 to 2.3 GHz band with an input drive level of 500 mW. The PH2012 driven by the PH2304 will produce over 11 W over the 1.7-to-2-GHz band, with an input drive level of 500 mW. The common base transistors have gold metalization and individual emitter finger ballast resistors.

Zener diodes cover 3.3 to 200 V

Siemens Aktiengesellschaft, D-8000 Munchen 1, Postfach 103, West Germany.

A line of zener diodes is designed for entertainment equipment, professional electronics and control engineering applications. The BZY 97 series has a wide variety of versions housed in plastic cases. The diodes have a power dissipation of 1.32 W and the zener voltage range extends from 3.3 V to 200 V, arranged in steps as per the international series E-24. The diodes are housed in DO-41 plastic cases with axial connecting leads. The zener voltages have a tolerance of ±5%, and zener currents are as low as 4.8 mA for the upper voltage value and as high as 276 mA for the lower voltage. These values apply for ambient temperatures up to 45 C.

Press-fit & stud-mount triacs handle to 40 A

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A line of triacs in 0.5 in. press fit and 0.5 in. stud mount packages is designated the TE series, an electrically isolated stud mount; the TD series, a nonisolated press-fit package and the TF series a nonisolated stud mount. All three series are available with V_{D(RM)} from 50 to 600 V and in 10, 15, 30 and 40 A rms on-state current ratings. The 0.5 in. series chips are center-gated and heavily glass-passivated for improved critical and commutating dv/dt ratings and high in-rush di/dt capability. All terminals have flags for standard Faston 0.11 in. and 0.187 in. fasteners. A third terminal is available as an option on the nonisolated series.
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Application Notes

Capacitors
“The Secret Life of Capacitors” covers the imperfections of capacitors and what to do about them. ECD Corp., Cambridge, MA

Heating elements
The many and varied instrumentation applications for flexible silicon rubber heating elements are described in a four-page reprint. Electro-Flex Heat, Bloomfield, CT

VCM removal process
A new method of removing VCM monomer from PVC compounds during the dry blending operation is covered in a four-page brochure. Werner & Pfleiderer, Waldwick, NJ

IC interconnects
Things you've always wanted to know about IC interconnection devices (but had no one to ask) are covered in a guide. Robinson-Nugent, New Albany, IN

Vibration control system
Digital control of random vibration tests in the environmental laboratory is the topic of a brochure. Time/Data, Palo Alto, CA

Cooling equipment
How to select cooling equipment for electronics subject to hostile environments is the topic of a four-page guide. Kooltronic, Princeton, NJ

Video scanners
The selection of video scanners for use with image analyzing computers is discussed in a newsletter. Imanco, Monsey, NY

Evaluation Samples

Circuit board accessories
Three sizes of circuit board standoffs and cable clips are molded in red nylon and are designed to be mounted on panels or chassis ranging from 0.060 to 0.098 in. in thickness. Vero Electronics.

Pushbutton switch
A new pushbutton-switch design allows users to customize from the basic standard product. The switch is designed for positive panel mounting or front removal and is rated at a 25,000-cycle minimum life. Various button colors and hot-stamping legends are available along with different bezel colors. Molex.

Soldering aid
Solderwax 550F is a white wax developed for use in continuous soldering operations. It is supplied in flaked form. Solderwax Chemical.

HV silicon rectifiers
Miniature, fast recovery, high-voltage silicon rectifiers are available in peak reverse voltages from 3000 to 12,000. Current is 25 mA, peak at 150 mA, and 300-ns recovery. The diodes are 0.4-in. long by 0.1-in. sq. with 0.3-in. minimum leads. Electronic Devices.

Epoxy tubing
Centrifugally cast epoxy tubing comes in sizes ranging from 0.137 in. O.D. to 2 in. O.D. and larger, in almost any wall thickness required. The tubing comes in lengths up to 56 in. without I.D. or O.D. taperings. Samples are available in black, clear and colors. A telephone call or request on company letterhead gets you the samples. Resdel Corp., Bldg. No. 22, County Airport, Rio Grande, NJ 08242

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**New Literature**

**Transistors**

A 40-page condensed transistor catalog includes JFETs, photosensitive FETs and bipolar transistors. Teledyne Crystalonics, Cambridge, MA

**Impedance converters**

Specifications and drawings of the series 300 impedance converters are given in a four-page brochure. Eltec Instruments, Daytona Beach, FL

**Thermistors**

Technical questions relative to thermistors are answered in a 12-page catalog. Resistance deviations beta tolerance tables, tempco tables and resistance temperature conversion tables are included. Fenwal Electronics, Framingham, MA

**Data conversion products**

Modular data conversion products, systems and accessories; logic and line powered digital panel instruments and accessories; and industrial digitizing systems and instruments are described in a 40-page catalog/handbook. Analogic, Wakefield, MA

**Terminal blocks**

A 12-page brochure covers 300-V and 600-V terminal blocks. The brochure shows in pictorial form how to assemble and mount both types of blocks. Allen-Bradley, Milwaukee, WI

**Integrated circuits**

High-reliability integrated circuits intended for military, aerospace and critical industrial applications are illustrated in a 28-page brochure. RCA Solid State Div., Somerville, NJ

**Communications equipment**

Antennas and ground communications equipment for single channel per carrier, television receive-only, shipboard terminal and tracking, telemetry and command systems are described in a catalog. Scientific-Atlanta, Atlanta, GA

**Potentiometers and dials**

Sixty pages of photographs, specifications, dimensional drawings and user-oriented applications information are found in "Precision Potentiometers and Dials." Beckman Instruments, Helipot Div., Fullerton, CA

**Microcomputer courses**

A six-volume, 700-page programmed learning course covers the concepts, uses, design criteria and implementations of microprocessor-based systems. More than 1700 self-tests, hundreds of illustrations and detailed information on four microcomputers—Intel's 4004, 4040, 8008 and 8080—are included. The course costs $124.50 for Volumes I through VI, design aids and the Microcomputer Applications Handbook. Iasis, 770 Welch Rd., Suite 154, Palo Alto, CA 94304

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STANDARD MODELS (partial listing)

<table>
<thead>
<tr>
<th>Model</th>
<th>Control Voltage</th>
<th>Output Voltage</th>
<th>Output Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA-1201</td>
<td>3-7 VDC 90-140VAC</td>
<td>.75 A</td>
<td></td>
</tr>
<tr>
<td>ME-1201</td>
<td>7-15 VDC 90-140VAC</td>
<td>.75 A</td>
<td></td>
</tr>
<tr>
<td>MD-1201</td>
<td>90-140 VAC</td>
<td>.75 A</td>
<td></td>
</tr>
<tr>
<td>MA-1202</td>
<td>3-7 VDC 90-140VAC</td>
<td>2.0 A</td>
<td></td>
</tr>
<tr>
<td>MA-0602</td>
<td>7-15 VDC 10-60VDC</td>
<td>2.0 A</td>
<td></td>
</tr>
<tr>
<td>MB-0602</td>
<td>10-60VDC</td>
<td>2.0 A</td>
<td></td>
</tr>
<tr>
<td>MA-0604</td>
<td>3-7 VDC 10-60VDC</td>
<td>4.0 A</td>
<td></td>
</tr>
</tbody>
</table>

* Add "S" suffix to Model Number for 500 microampere Control Sensitivity

If you have a difficult switching problem, please tell us about it... we can probably help.

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NEW LITERATURE

Microcontroller system

A 59-page application guide opens with a description of the SMS MicroController system and its various elements and presents 14 programming examples and six system applications. Circle the number to receive another descriptive folder with a form letter that offers the application guide if requested on letterhead. Corning, Corning, NY

CIRCLE NO. 473

Electron tubes

The 1975/76 EEV/M-OV electron tube catalog is available in five separate parts or as a single publication. For Part A—Products for Broadcasting and Communications Equipment

CIRCLE NO. 474

For Part B—Products for Radar Equipment

CIRCLE NO. 475

For Part C—Products for Electro-optical/TV Equipment

CIRCLE NO. 476

For Part D—Products for Industrial and Scientific Equipment

CIRCLE NO. 477

For Part E—Comprehensive Equivalent Index

CIRCLE NO. 478

For entire publication

CIRCLE NO. 479

Microprocessors

The MP12 microprocessor, a digital computer designed for dedicated control applications, is described in a two-page brochure. Fabri-Tek, Minneapolis, MN

CIRCLE NO. 480

Relay proceedings

Proceedings of the 23rd annual National Relay Conferences cover technical information on electro-mechanical relays, solid-state relays and other related switching devices. The conference was cosponsored by the National Association of Relay Manufacturers. Copies of the proceedings may be purchased at $10 each from NARM, P.O. Box 1649, Scottsdale, AZ 85252

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Power Physics Corp.'s npn-pnp epitaxial base power transistors are available in the following JEDEC types: 2N5632 through 2N5634, 2N6229 through 2N6231, 2N5879 through 2N5886 and 2N6029 through 2N6031. Devices in the families can handle from 5 to 10 A and have $V_{CEO}$'s from 40 to 140 V. Power dissipation ranges from 117 to 200 W.

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A software package from Tektronix, the Plot-10/Terminal Control System implementation for PDP-11 DOS users with 24 k of core memory, supports all of the company's 4010 family of terminals.

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Fifteen circuits have been added to the standard CD4000B series of CMOS ICs by RCA Solid State Div.

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**Advertiser's Index**

<table>
<thead>
<tr>
<th>Advertiser</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMP, Incorporated</td>
<td>50, 51</td>
</tr>
<tr>
<td>AMP, Incorporated, Capitron Divisions</td>
<td>139</td>
</tr>
<tr>
<td>Abbott Transit Laboratories, Inc.</td>
<td>6</td>
</tr>
<tr>
<td>Adar/Spectrum Dynamics</td>
<td>128</td>
</tr>
<tr>
<td>Alco Electronic Products, Inc.</td>
<td>108</td>
</tr>
<tr>
<td>American Optical Corporation</td>
<td>100</td>
</tr>
<tr>
<td>American Technical Ceramics</td>
<td>127</td>
</tr>
<tr>
<td>Amperite Co., Inc.</td>
<td>94</td>
</tr>
<tr>
<td>Auto-Swage, Inc.</td>
<td>115</td>
</tr>
<tr>
<td>B &amp; K Products of Dynascan Corporation</td>
<td>140</td>
</tr>
<tr>
<td>Beckman Instruments, Inc., Helipot Division</td>
<td>120, 121</td>
</tr>
<tr>
<td>Bourns, Inc., Trimpot Products Division</td>
<td>15</td>
</tr>
<tr>
<td>Bud Radio, Inc.</td>
<td>101, 102</td>
</tr>
<tr>
<td>Capacitor Specialties, Inc.</td>
<td>138</td>
</tr>
<tr>
<td>Cincinnati Sub-Zero Products, Inc.</td>
<td>126</td>
</tr>
<tr>
<td>Circuit Technology, Incorporated</td>
<td>105</td>
</tr>
<tr>
<td>Clairex Electronics, A Division of Clairex Corporation</td>
<td>123</td>
</tr>
<tr>
<td>Clare &amp; Co., C. P.</td>
<td>97</td>
</tr>
<tr>
<td>Computer Conversions Corp.</td>
<td>139</td>
</tr>
<tr>
<td>Continental Specialties Corporation</td>
<td>137</td>
</tr>
<tr>
<td>Control Products Division, Ameacor Corporation</td>
<td>34, 35</td>
</tr>
<tr>
<td>Crystals Electronics</td>
<td>119</td>
</tr>
<tr>
<td>Crystaltronics, A Teledyne Company</td>
<td>139</td>
</tr>
<tr>
<td>Dale Electronics, Inc.</td>
<td>122</td>
</tr>
<tr>
<td>Delco Electronics, Division of General Motors Corporation</td>
<td>16B, 16C</td>
</tr>
<tr>
<td>Des Tek Industries</td>
<td>138</td>
</tr>
<tr>
<td>Dialight, A North American Phillips Company</td>
<td>107</td>
</tr>
<tr>
<td>Douglas Electronics, Inc.</td>
<td>134</td>
</tr>
<tr>
<td>Dynascan Corporation</td>
<td>141</td>
</tr>
<tr>
<td>EMR Telemetry, Weston Instruments, Inc.</td>
<td>135</td>
</tr>
<tr>
<td>Elco Corporation</td>
<td>17</td>
</tr>
<tr>
<td>Electro-Techniques</td>
<td>138</td>
</tr>
<tr>
<td>Electronic Design</td>
<td>46, 125, 138</td>
</tr>
<tr>
<td><em>Electronic Design</em></td>
<td>18</td>
</tr>
</tbody>
</table>

**Advertiser's Index**

<table>
<thead>
<tr>
<th>Advertiser</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic Navigation Industries</td>
<td>106</td>
</tr>
<tr>
<td>Erie Technological Products, Inc.</td>
<td>33</td>
</tr>
<tr>
<td>Fluke Mfg. Co., Inc. John</td>
<td>16</td>
</tr>
<tr>
<td>General Electric Company, Miniature Lamp Products Department</td>
<td>114</td>
</tr>
<tr>
<td>General Radio Company</td>
<td>98</td>
</tr>
<tr>
<td><em>Gold Book, The</em></td>
<td>97, 120, 121</td>
</tr>
<tr>
<td>Gold Book, The</td>
<td>88, 89</td>
</tr>
<tr>
<td>Gould Inc., Instrument Systems Division</td>
<td>141</td>
</tr>
<tr>
<td>Graybill, Inc.</td>
<td>122</td>
</tr>
<tr>
<td>Harris Semiconductor, A Division of Harris Corporation</td>
<td>83</td>
</tr>
<tr>
<td>Hewlett-Packard</td>
<td>1, 4, 5, 27, 80, 81</td>
</tr>
<tr>
<td>ILC Data Devices Corporation</td>
<td>73</td>
</tr>
<tr>
<td>Illuminated Products Co.</td>
<td>134</td>
</tr>
<tr>
<td>Instruments for Industry, Inc.</td>
<td>105</td>
</tr>
<tr>
<td>Intech, Incorporated</td>
<td>104</td>
</tr>
<tr>
<td>Interdata, Subsidiary of Perkin-Elmer</td>
<td>12, 13</td>
</tr>
<tr>
<td>Interdata, Inc.</td>
<td>113</td>
</tr>
<tr>
<td>International Electronic Research Corporation</td>
<td>124</td>
</tr>
<tr>
<td>International Rectifier</td>
<td>11</td>
</tr>
<tr>
<td>Johansson Manufacturing Corp.</td>
<td>26, 138</td>
</tr>
<tr>
<td>Johnson Company, E.F.</td>
<td>99, 141</td>
</tr>
<tr>
<td>Keithly Instruments</td>
<td>14</td>
</tr>
<tr>
<td>Kepco, Inc.</td>
<td>42</td>
</tr>
<tr>
<td>MCG Electronics</td>
<td>40</td>
</tr>
<tr>
<td>Martin Research</td>
<td>139</td>
</tr>
<tr>
<td>Merrimac Industries, Incorporated</td>
<td>98</td>
</tr>
<tr>
<td>Micro-Line, Division of Bausch &amp; Lomb</td>
<td>107</td>
</tr>
<tr>
<td>Mineo Division/General Time Corp.</td>
<td>101</td>
</tr>
<tr>
<td>Mini-Circuits Laboratory, A Division of Scientific Components Corp.</td>
<td>21</td>
</tr>
<tr>
<td>Mini-Software</td>
<td>138</td>
</tr>
<tr>
<td>Mini-Systems, Inc.</td>
<td>39</td>
</tr>
<tr>
<td>Modular Power</td>
<td>39</td>
</tr>
<tr>
<td>Molex, Incorporated</td>
<td>144</td>
</tr>
<tr>
<td>Monsanto, United Systems Corporation Subsidiary</td>
<td>131</td>
</tr>
</tbody>
</table>

**Advertiser's Index**

<table>
<thead>
<tr>
<th>Advertiser</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorola Semiconductor Products, Inc.</td>
<td>8, 9</td>
</tr>
<tr>
<td>National Cryptologic, Inc.</td>
<td>132</td>
</tr>
<tr>
<td>Nichicon Corporation</td>
<td>133</td>
</tr>
<tr>
<td>Norland Instruments, A Subsidiary of Cordis Corporation</td>
<td>31</td>
</tr>
<tr>
<td>Nortek American Philips Controls Corp.</td>
<td>38</td>
</tr>
<tr>
<td>Oak Industries, Inc.</td>
<td>117</td>
</tr>
<tr>
<td>Optron, Inc.</td>
<td>7</td>
</tr>
<tr>
<td><em>Philips Industries, Test and Measuring Instruments Dept.</em></td>
<td>22, 23</td>
</tr>
<tr>
<td>Philips Test &amp; Measuring Instruments Inc.</td>
<td>90</td>
</tr>
<tr>
<td>Piezo Technology, Inc.</td>
<td>130</td>
</tr>
<tr>
<td>Premier Metal Products Company</td>
<td>139</td>
</tr>
<tr>
<td>Powecon Applied Research Corp.</td>
<td>136</td>
</tr>
<tr>
<td>Princeton Electronic Products, Inc.</td>
<td>135</td>
</tr>
<tr>
<td>Protolab</td>
<td>133</td>
</tr>
<tr>
<td>RCA Electronic Instruments</td>
<td>59</td>
</tr>
<tr>
<td>RCA Solid State</td>
<td>Cover IV</td>
</tr>
<tr>
<td>RCS Associates, Inc.</td>
<td>138</td>
</tr>
<tr>
<td>Raytheon Company, Industrial Components Operation</td>
<td>93</td>
</tr>
<tr>
<td>Remtron Electronics</td>
<td>18</td>
</tr>
<tr>
<td>Rovan Corporation</td>
<td>95</td>
</tr>
<tr>
<td>Rogers Corporation</td>
<td>110</td>
</tr>
<tr>
<td>Schauer Manufacturing Corp.</td>
<td>116</td>
</tr>
<tr>
<td>Semtech Corporation</td>
<td>16A</td>
</tr>
<tr>
<td>Signetics Corporation</td>
<td>14, 38, 40, 59</td>
</tr>
<tr>
<td>Sony</td>
<td>68, 69, 100, 108</td>
</tr>
<tr>
<td><em>Soros Corporation</em></td>
<td>115, 118, 123, 126</td>
</tr>
<tr>
<td>Simpson Electric Company</td>
<td>79</td>
</tr>
<tr>
<td>Sorenson Company, A Unit of Raytheon Company</td>
<td>74, 75</td>
</tr>
<tr>
<td>Spectral Dynamics Corporation</td>
<td>140</td>
</tr>
<tr>
<td>Spectra Electronics Corporation</td>
<td>41</td>
</tr>
<tr>
<td>Sprague Electric Company</td>
<td>10</td>
</tr>
<tr>
<td>Stacowitch, A Staco Inc. Company</td>
<td>137</td>
</tr>
<tr>
<td>Standard Grubhy, Inc.</td>
<td>13</td>
</tr>
<tr>
<td>Standard Memories, Incorporated</td>
<td>111</td>
</tr>
<tr>
<td>Styrson-Donner</td>
<td>85</td>
</tr>
<tr>
<td>TRW Cinch Connectors, An Electronic Components Division of TRW, Inc.</td>
<td>103</td>
</tr>
<tr>
<td>TRW/IRC Potentiometers, An Electronics Components Division of TRW, Inc.</td>
<td>87</td>
</tr>
<tr>
<td>Technitrol, Inc.</td>
<td>118</td>
</tr>
<tr>
<td>Tektronix, Inc.</td>
<td>45, 47</td>
</tr>
<tr>
<td>Teledyne Relays, A Teledyne Company</td>
<td>2</td>
</tr>
<tr>
<td>Teledyne Semiconductor</td>
<td>48</td>
</tr>
<tr>
<td>Texas Instruments, Incorporated</td>
<td>22, 23</td>
</tr>
<tr>
<td>Theta-J Relays, Inc.</td>
<td>135</td>
</tr>
<tr>
<td>Topaz Electronics</td>
<td>138</td>
</tr>
<tr>
<td>Tripler Corporation</td>
<td>77</td>
</tr>
<tr>
<td>Trompeter Electronics, Inc.</td>
<td>131</td>
</tr>
<tr>
<td>USCC/Centralab Electronics Division, Globe-Union, Inc.</td>
<td>112, 113</td>
</tr>
<tr>
<td>Union Carbide, Components Department</td>
<td>61</td>
</tr>
<tr>
<td>United Systems Corporation, A Subsidiary of Norland Instruments, Inc.</td>
<td>131</td>
</tr>
<tr>
<td>Universal Data Systems</td>
<td>Cover III</td>
</tr>
<tr>
<td>Varo Semiconductor, Inc.</td>
<td>124</td>
</tr>
<tr>
<td>Victor Electric Wire &amp; Cable Corp.</td>
<td>96</td>
</tr>
<tr>
<td>Vishay Resistive Systems Group</td>
<td>129</td>
</tr>
<tr>
<td>Weston</td>
<td>92</td>
</tr>
<tr>
<td>Weston Components</td>
<td>107</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Category</th>
<th>Page</th>
<th>IRN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRTs</td>
<td>93</td>
<td>151</td>
</tr>
<tr>
<td>capacitor kits</td>
<td>127</td>
<td>104</td>
</tr>
<tr>
<td>capacitors</td>
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<tr>
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<td>377</td>
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<tr>
<td>switch, pushbutton</td>
<td>124</td>
<td>381</td>
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<td>switch, remote operate</td>
<td>117</td>
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<tr>
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### Data Processing

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<thead>
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<th>Category</th>
<th>Page</th>
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<td>109</td>
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<td>interface, printer</td>
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<td>358</td>
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<td>359</td>
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<td>253</td>
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<tr>
<td>plotter, digital</td>
<td>113</td>
<td>357</td>
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<tr>
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<td>111</td>
<td>355</td>
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<td>110</td>
<td>352</td>
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<td>362</td>
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### Discrete Semiconductors

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<tr>
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<td>38</td>
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<td>128</td>
<td>388</td>
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### Integrated Circuits

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<tr>
<td>ECL III</td>
<td>39</td>
<td>285</td>
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<tr>
<td>I/O port</td>
<td>126</td>
<td>101</td>
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### Microwaves & Lasers

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### Modules & Subassemblies

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<th>Category</th>
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<td>348</td>
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### Packaging & Materials

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<td>knobs</td>
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<td>53</td>
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<td>341</td>
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<td>PC boards</td>
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<td>115</td>
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<td>potting cups</td>
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<tr>
<td>racks and panels</td>
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<td>15</td>
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<td>sockets, DIP</td>
<td>103</td>
<td>162</td>
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<td>terminal blocks</td>
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<td>test stands</td>
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<td>102</td>
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### Power Sources

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<th>Category</th>
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<td>365</td>
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<tr>
<td>dc power supplies</td>
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<td>31</td>
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<tr>
<td>encapsulated units</td>
<td>116</td>
<td>367</td>
</tr>
<tr>
<td>line regulator</td>
<td>116</td>
<td>366</td>
</tr>
<tr>
<td>open-frame source</td>
<td>115</td>
<td>363</td>
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<td>116</td>
<td>369</td>
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<td>116</td>
<td>368</td>
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