VOL. 20 NO.

Electronic Design 22

FOR ENGINEERS AND ENGINEERING MANAGERS

OCT. 26, 1972

New industrial test systems give sophisticated aquisition, display and analysis of data. The demand for such complex performance has been stimulated by Federal crackdowns on pollution, noise and hazardous product defects. A new generation of rugged test equipment is emerging in plants around the country. See page 26.

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

BUY LAMBDA LX SERIES

Choose from 7 packages, 39 models
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"3" PACKAGE
DUAL OUTPUT . . . $85
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SINGLE OUTPUT . . . $85
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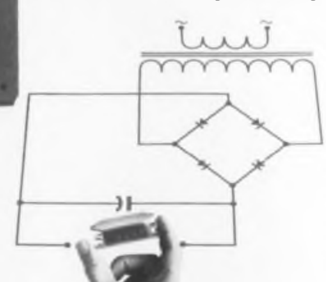
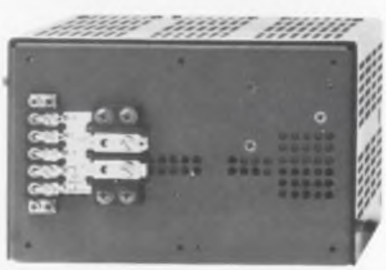
DUAL OUTPUT . . . $235
±15 TO ±12 VOLTS 4.0 AMPS



"D" PACKAGE
SINGLE OUTPUT . . . $235
5 VOLTS 27.5 AMPS (with O.V.)

DUAL OUTPUT . . . $280
±15 TO ±12 VOLTS 6.2 AMPS

TRIPLE OUTPUT . . . $375
±15 TO ±12 VOLTS 3.1 AMPS
5 ± 5% VOLTS 12 AMPS
(with O.V.)



Line regulation 0.1% Load regulation 0.1%
Ripple and noise 1.5 mV RMS, 5 mV P-P with either positive or negative terminal grounded
AC input 105-132 VAC; 47-440 Hz
All 5-volt models include built-in overvoltage protection.
For information on other models up to 28 VDC, send for catalog.

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INFORMATION RETRIEVAL NUMBER 241

First we made them easy to use. Now we've made them easy to get.

Yes, we now have distributors. The best there are around the world. These distributors have in stock our complete line of LED displays, LED lamps, isolators and photo-detectors.

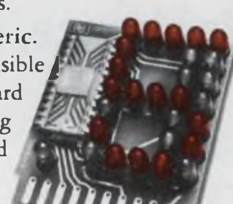
Easy to use. All these products are solid-state and directly DTL-TTL compatible. And they are all designed for ease of application.

A complete LED lamp family. Our LED lamp family offers a complete selection of lens, lead and light output combinations. Our new T-1 Mini-LED is just 0.125" in diameter. This device offers high brightness over a wide viewing angle. And you have a choice of lenses: red diffused, clear, or clear diffused. This little gem, known as the 5082-4480, costs just 45¢ in 1,000 quantities. The T-1 ¾ long lead wire wrappable 5082-4880 lamps start at 55¢ each in 1,000 quantities; the short or bent lead 5082-4440 LEDs start at 49¢ in 1,000 quantities. Higher volume prices on all these devices are even more attractive.

A new low-cost isolator. At 5 MHz bandwidth, it's 25 times faster than any other isolator on the market. It has a high DC isolation voltage of 2500 volts, and a high common mode rejection of 10 volts at 2 MHz, making the 5082-4350 ideal for eliminating ground loops in digital or analog line receivers, floating power supply and feedback networks. Prices start at $2 each in 1,000 quantities.

A low-cost LED display. Our numeric and hexadecimal displays have simplified your designs with on-board electronics, standard package configuration, and categorized light outputs. Best of all, the 5082-7300 numeric has a new low price of $8.25 in 1,000 quantities.

A new 1.5" LED numeric. This new LED display, visible from 60 feet, has on-board electronics, wide viewing angle, and is designed for edge mounting in a standard PC board socket. Solid-state reliability makes the 5082-7500 ideal where dependability is important. The price is $23.50 each in 500 quantities.



Small character LED displays. The 5082-7405 is a 5 digit end stackable display. It minimizes power consumption and offers ease of implementation with a standard 14 PIN DIP package. At only 7 mW per digit, this display is ideal for calculators, portable instruments and anywhere that low power and high brightness are important. The 5082-7405 is priced at $3.20 per digit in 1,000 quantities.

Easy to get. Call the distributor nearest you for immediate delivery. Or write us for more information. Hewlett-Packard, Palo Alto, California 94304.

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The Light Source

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Liberty Electronics/Northwest
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6 Frankfurt 1, Myliusstrasse 54, Germany
Tel.: (0611) 72 04 16/8

INFORMATION RETRIEVAL NUMBER 2

Electronic Design 22
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FOR ENGINEERS AND ENGINEERING MANAGERS
OCT. 26, 1972

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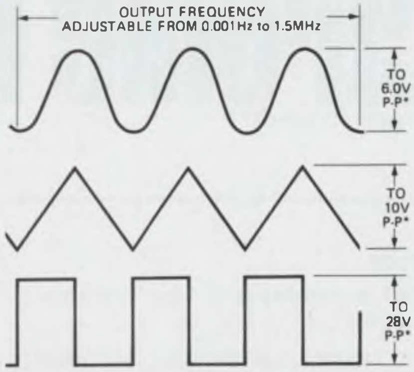
Cover: Photo by Mike Ketchum, Courtesy of Tektronix, Inc.

ELECTRONIC DESIGN is published biweekly by Hayden Publishing Company, Inc., 50 Essex St., Rochelle Park, N. J. 07662. James S. Mulholland, Jr., President. Printed at Brown Printing Co., Inc., Waseca, Minn. Controlled circulation postage paid at Waseca, Minn., and New York, N. Y., postage pending Rochelle Park, N. J. 84,392 copies this issue.

1. Simultaneous high-level output waveforms



* MINIMUM LEVELS WITH V_{CC} = 30V
ALL OUTPUTS MAY BE TTL COMPATIBLE

A versatile, stable, priced-right VCO.

2. Frequency drift with temperature

DEVICE	TYPICAL DRIFT	MAXIMUM DRIFT
8038AC	**10ppm/°C**	**50ppm/°C**
8038BC	**20ppm/°C**	**100ppm/°C**
8038CC	**50ppm/°C**	**Not guaranteed**
NE562	600ppm/°C	Not guaranteed
NE565	100ppm/°C	Not guaranteed
HA2800	250ppm/°C	Not guaranteed
HA2820	250ppm/°C	Not guaranteed
XR205	300ppm/°C	Not guaranteed
XR215	300ppm/°C	Not guaranteed
MC4024	N/A	Not guaranteed
MC4324	N/A	Not guaranteed
CD4046	500ppm/°C	Not guaranteed

3. Pricing

DEVICE	STABILITY	PRICE (100 pcs)
* 8038CC•	50ppm/°C typ.	2.50
8038BC•	100ppm/°C max.	4.00
8038AC•	50ppm/°C max.	9.00
8038BM•	100ppm/°C max.	7.00
8038AM•	50ppm/°C max.	18.00

•C = 0 to +70°C temperature range.
M = −55 to +125°C temperature range.

4. The 8038 Waveform Generator/ Voltage Controlled Oscillator from Intersil

Sample,* anyone?

It's new and different.

The Intersil 8038 is an IC waveform generator and VCO with high-level sine, square and triangular-wave outputs tunable from 0.001Hz to 1.5MHz. The outputs can be swept or FM modulated up to 100kHz, or the frequency can be digitally programed with resistors or capacitors. The square wave duty cycle is adjustable from 2% to 98%.

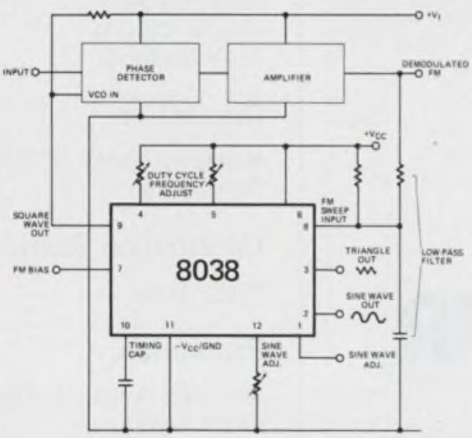
Stable, accurate, easy to use.

It's uniquely stable. Guaranteed temperature drift (8038A version) is 50ppm/°C maximum. Linearity is 0.1%; total harmonic distortion (THD) no more than 1%.

The 8038 can be TTL compatible. It works with any 10V to 30V or ±5V to ±15V power supply. Practically all vital components — including thin-film resistors and Schottky-barrier diodes—are on-chip, so the external part count is reduced at least 50%. It's available in military (−55 to +125°C) or commercial (0 to +70°C) temperature ranges, packaged in ceramic or plastic DIPs.

A low temperature-drift phased-lock loop.

An ideal application. Use the phase detector and amplifier from another IC (MC4344, NE562, HA2800, etc.). You'll get a clean 6V sinewave output with frequency identical to that of the input, and with the low temperature drift of the 8038. Send for application notes and complete specs. From Intersil, 10900 No. Tantau Avenue, Cupertino, CA 95014.



Get a sample here.

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U.S. Representatives in all major cities.

Intersil

INFORMATION RETRIEVAL NUMBER 4

across the desk

Relaying a complaint on reed-relay article

I have read "Focus on Reed Relays," by Morris Grossman, in the July 6 edition (ED 14, p. 50) and believe that it may have deluded the uninitiated into believing that reeds are the answer to a "maiden's prayer." Having been intimately involved with this relay type for many years, I feel that certain facts must be brought to the forefront.

First, you don't decide on the relay type and then prepare the detailed performance specification. Actually the reverse should be the road to reliable application; first look over your characteristic requirements, noting those that are critical, and then decide on the relay type.

Second, Table 1 indicates a reliability status of the three relay types. I believe this number assignment is meaningless without the statement of what is required. If you are talking about the reliability of relays requiring a life in excess of one million cycles, your estimate may be correct. But for applications in the tens or hundreds of thousands, I question the rating. The table indicates reed relays superior to the electromechanical type, and yet in the second column of your article you mention the susceptibility of reed to vibration. With regard to coil power, a reed relay has yet to be produced that is equivalent in contact configuration to the every-day sensitive electromechanicals. There are other questionable categories, and I therefore would give that table a thorough examination before using it as a selection tool.

The fact that reed plating has been the greatest factor of uncertainty in reeds, the fact that the iron bars have gold and silver migration problems, the fact that the magnetic materials contain encaptured oil (from the working processes) that find their way to the contact interface and are a contaminating influence are all important detriments but seemed to have been overlooked.

Arthur Siegel
Senior Applications Engineer
Deutsch Relays, Inc.
65 Daly Rd.
E. Northport, N.Y. 11731.

The author replies

Though Mr. Siegel's tone suggests argument with the essence of the article, the content of his letter contains rather little disagreement. He says the reed relay is not the answer to a "maiden's prayer;" the article says essentially the same thing. He says "you don't decide on the relay type and then prepare the detail performance specification;" the article says repeatedly that the engineer should first check the special requirements of his application before picking a relay type, and only worry about detailed relay specifications.

Table 1 is not a reliability rating but includes reliability as only one of 13 parameters for consideration. The table represents the weighting offered by one manufacturer, as the text points out. The article also makes it clear that other observers might place different ratings on some of the items. Mr. Siegel's conclusion that the table should receive thorough examination before use as a selection tool is therefore valid and is in accordance with the intent of the article.

(continued on page 10)

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

Announcing a remarkable for 3-year-old

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

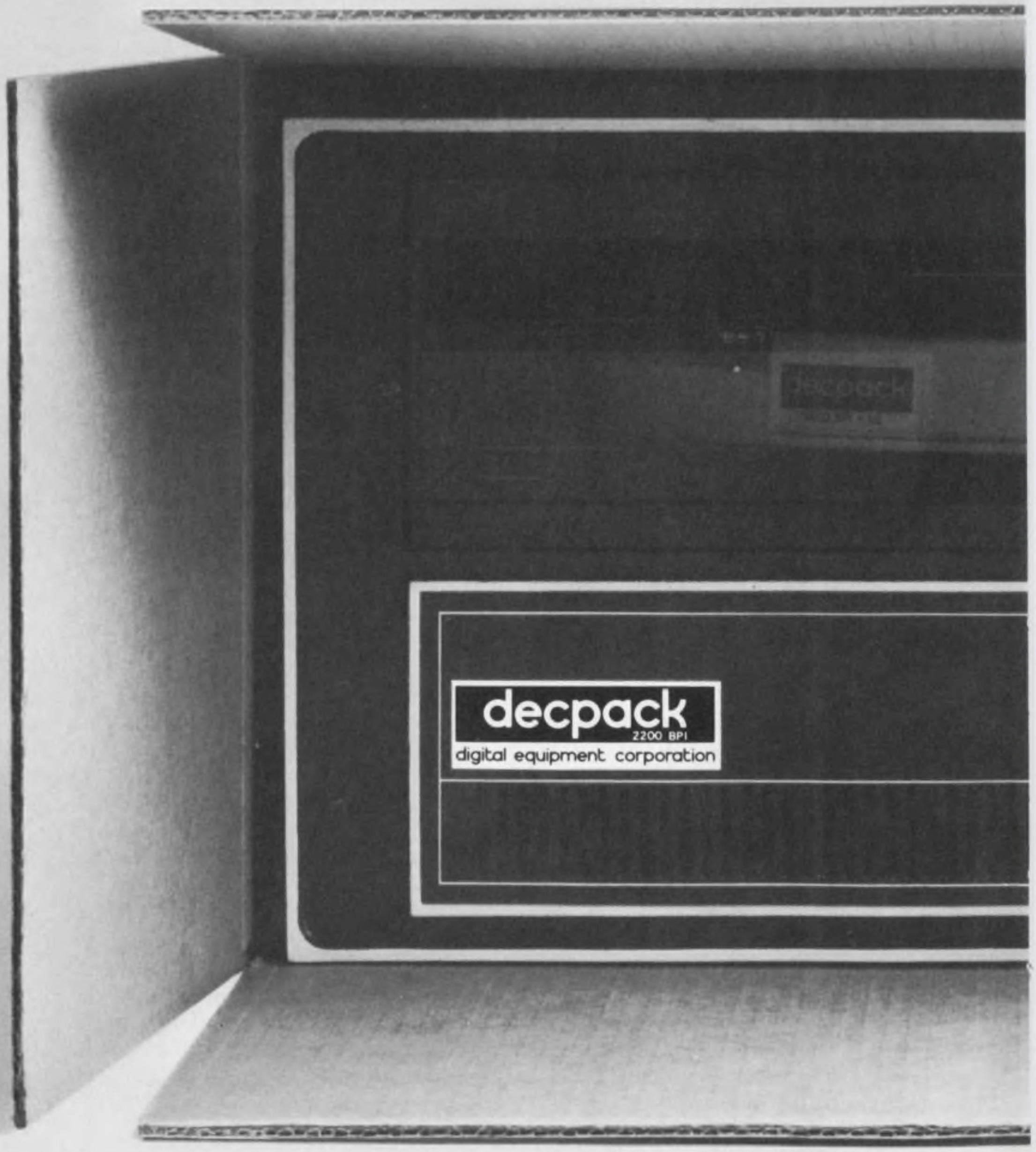
We couldn't help but notice how many people with our PDP-8's, 8/I's, and 8/L's really wanted to do more.

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

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

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

It makes them act just like they had



INFORMATION RETRIEVAL NUMBER 7

ACROSS THE DESK

(continued from p. 7)

And, now, a word from Phoenix Data

The Aug. 3 issue ran an article under New Products titled "Almost 16-Bit D/A Converter Is Industry's Fastest, Most Stable, Least Expensive" (ED 16, p. 65). At Phoenix Data we were slightly offended at not being considered a part of the industry.

The article discusses the Analogic 16-bit d/a converter (MP-1916A) and compares its performance and price with that of the Analog Device Model DAC-16QM. We feel that any discussion of 16-bit d/a converters would not be complete without including the Phoenix Data Model DAC167OR.

On price and full-scale settling time, we would agree the MP-1916A is at least equal to the DAC-167OR. They both sell for $595, with storage register and settling time specified at 20 μs to 1 LSB.

We can readily understand the writer's reluctance to claim a 16-bit d/a converter when one examines the "fully" specified temperature coefficient of the MP-1916A. We further appreciate the reluctance to specify the total temperature coefficient for a bipolar voltage mode converter. If one is pessimistic (we always are on our converters), the sum total of the specified temperature coefficient of gain, linearity, reference and offset is 15 ppm/°C, or 0.0015%/°C. The discussion of long-term stability becomes somewhat academic when one considers that one degree C can cause an output error of 1 LSB (1 LSB in a 16-bit d/a = 0.0015%).

We made no claims to being the industry's most stable 16-bit d/a converter (there are probably some around we haven't heard of). However, the DAC167OR has a specified maximum "total" temperature coefficient of 5 ppm/°C. For the moment, that makes the DAC-167OR three times as stable with temperature as the MP1916A.

Robert Nelson
V.P. Marketing

Phoenix Data, Inc.
3384 W. Osborn Rd.
Phoenix, Ariz. 85017

CIRCLE NO. 280

Fluke problem solvers

Introducing the Fluke 8100B. At $595, you'll wonder how we did so much in a 4½ Digit Multimeter.

The new version of Fluke's most successful DMM, Model 8100B, gives you the most value for your money ever offered in a quality digital voltmeter.

With a basic dc accuracy of 0.02%, the Fluke 8100B measures ac and dc volts in four ranges from 100 microvolts to 1200 volts and resistance from 100 milliohms to 12 megohms. With an optional ac/dc current shunt accessory, it measures from 10 nanoamperes to 12 amps in six switched ranges.

Features include an active 2-pole switchable filter and automatic polarity indicator. All functions are push-button selectable.

For $100 extra, a rechargeable battery pack can be added to give the user complete portability with up to eight hours continuous operation. Other options include RF and high voltage probes, switched ac/dc current shunts, data output and a ruggedized case.

Demonstrated MTBF is over 10,000 hours, to make the instrument the most reliable available. The 8100B has tough environmental specs to ease your workload. Fully backed by Fluke's no-nonsense 12-month guarantee and service policy, here's an instrument that will meet your greatest expectations.

Call your local Fluke sales engineer for a demo and details. In the contiguous U.S., get his location by dialing our toll free number, 800-426-0361. Otherwise, address one of the locations listed below.

Fluke, P.O. Box 7428, Seattle, Washington 98133. Phone (206) 774-2211. TWX: 910-449-2850. In Europe, address Fluke Nederland (N.V.), P.O. Box 5053, Tilburg, Holland. Phone 13-670130. Telex: 884-55237. In the U.K., address Fluke International Corp., Garnett Close, Watford, WD2, 4TT. Phone, Watford, 33066. Telex: 934583.

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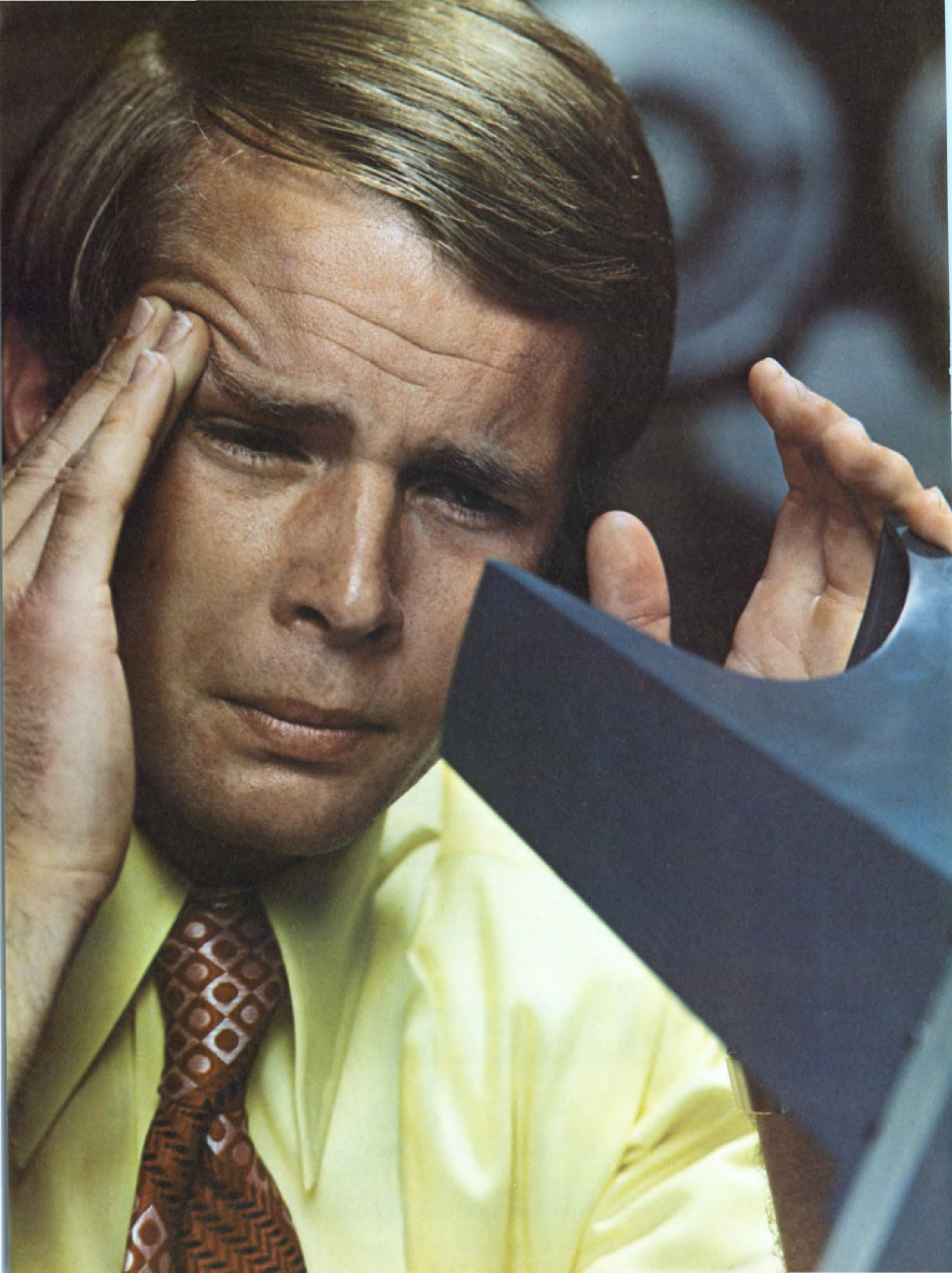


Think Twice:

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

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

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

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

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

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

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

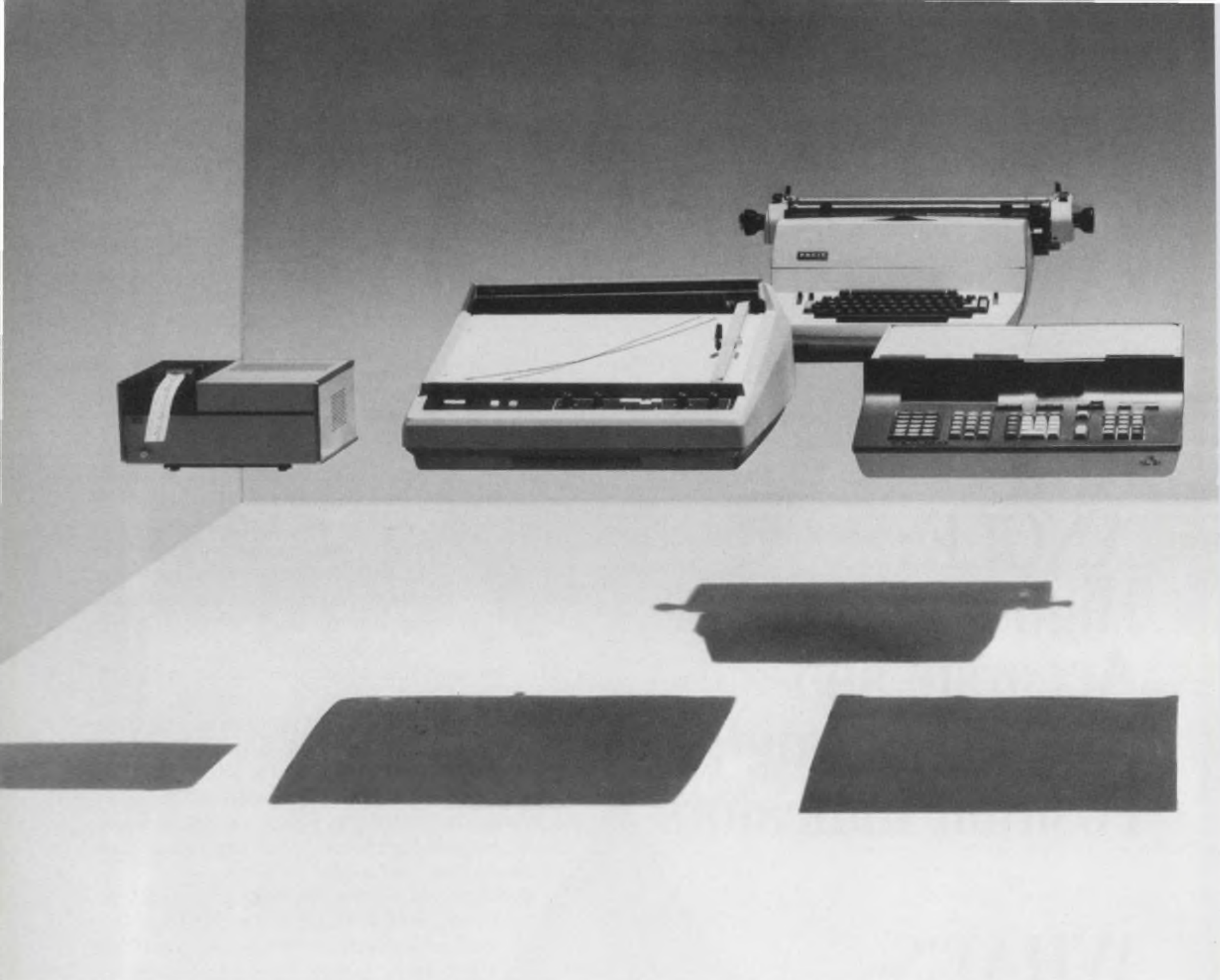
Burn-Resistant CRT's. HP placed variable-persistence in many of its scopes including the 181A, 1702A, and 1703A storage units. And now HP has developed, for its current line of storage instruments, carefree CRT's so highly burn resistant they require little more care than conventional CRT's. The new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

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

Scopes Are Changing; Think Twice.

HEWLETT *hp* PACKARD

OSCILLOSCOPE SYSTEMS

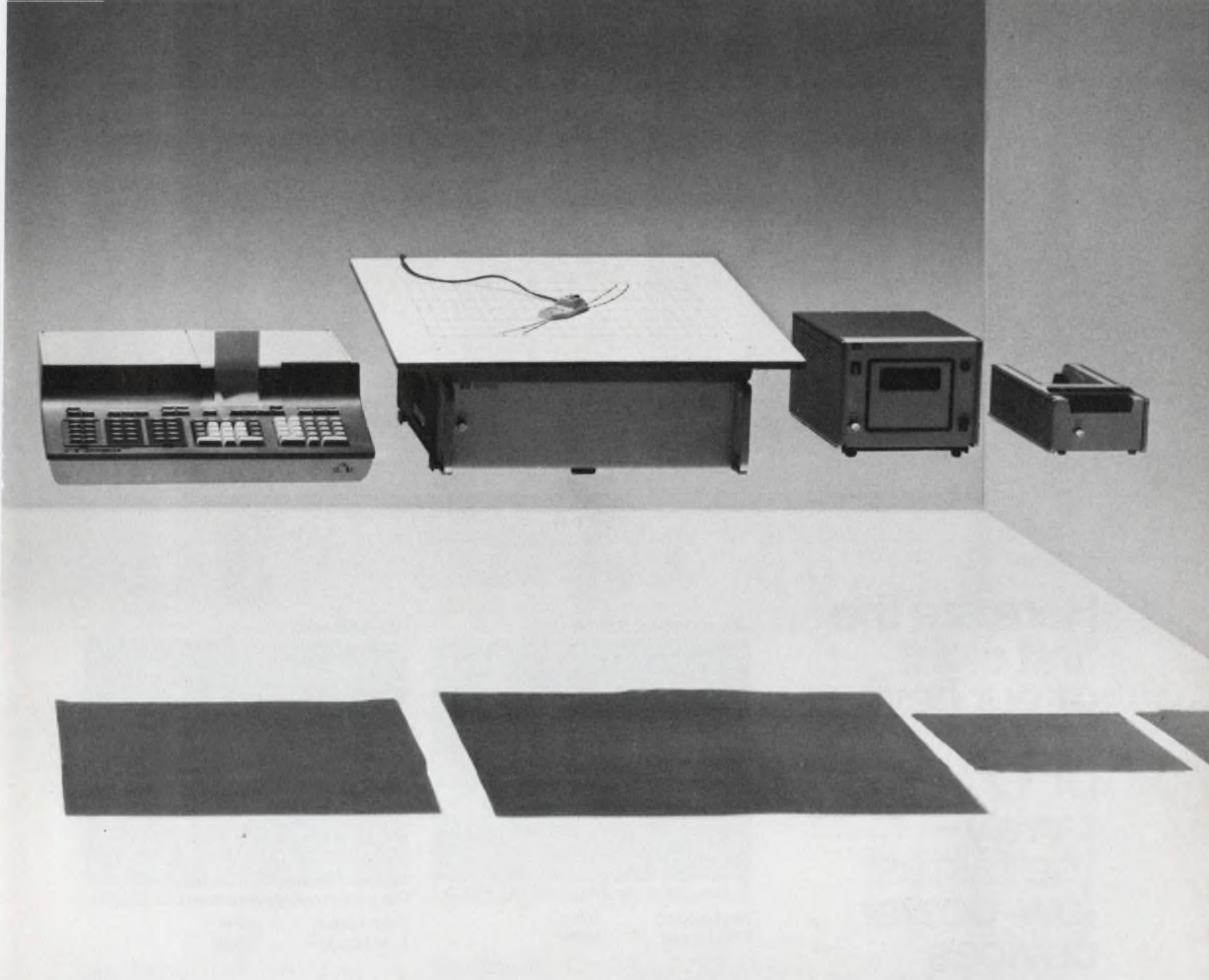


Hewlett-Packard Series 9800. The Name And Number Mean More Than Calculators.

Computing Power Is One Thing. The most striking example of computing power, that we know about, is our HP-35 Calculator. At nine ounces, this *shirt-pocket powerhouse* marvelously challenges a computer in handling problems from simple arithmetic to complex mathematics. And costs $395.

If we can package that much power in a shirt-pocket, imagine what our Series 9800 Model 10 and 20 can do:

Model 10. The one for doing repetitive problems (statistics, quality assurance, or surveying, to name a few). It comes with an LED Display, 50 registers *and* 500 program steps of memory. Coming in at under $3,000, the Model 10 can both perform a complete regression analysis, and solve 10 simultaneous equations. You can add



special functions, memory and printer with or without alphanumerics.

Model 20. The one for a lot of on-the-spot programming of complex problems. You get the best of both worlds: Very fast operation internally, with direct communication between you and the calculator. You key in your problem just as you'd write it—in Algebra and English. It gives you instructions and labeled solutions that you readily understand through its unique alphanumeric display and printer. Add to this Model 20's extensive error detecting and correcting features and its whopping memory—and you'll quickly find that it'll take you from concept to solution faster than any other system around.

What's more, with the Series 9800, you're not limited to the data formats of the Calculator. For input, you have your choice of Marked Card Reader, Paper Tape Reader, or Digitizer; for storage, the Tape Cassette; and for output, a Typewriter, or our X-Y Plotter that both draws and writes.

Support Is Another Thing. We're in a unique position to help you. It's the aggregate of our experience in virtually every discipline of science and engineering that does it for us. Not just with products but with people. People like your HP Field Engineer. Chances are, he'll bring the solution to your problems with him. If not, he'll put you in touch with someone who will. The point is, he can talk your language. So you do get the most from your investment. Save time in the beginning. And money in the end.

Service Is A Third. With over 170 field service centers in 65 countries, service is available regardless of where you are. For most, it takes only a phone call.

Product Line Is A Fourth. You probably already know us as one of the world's leading designers and manufacturers of precision electronic measurement equipment. To that end we build over 2,000 products for scientists, engineers, doctors, and businessmen.

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INFORMATION RETRIEVAL NUMBER 102

Harris

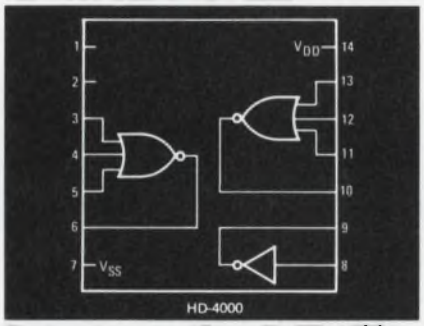
Here are the first eight of our new growing DI/CMOS family— the fastest low-power devices of their kind available today.

If you're joining the big move to CMOS, we've got your device. Or soon will have. Because we've committed ourselves to dielectrically isolated CMOS (DI/CMOS) development on a major scale. The first eight are available now. These devices offer speeds twice as fast any comparable ICs, typically 10ns with 10-volt power supplies. They also offer a wide power supply range (3 VDC to 18 VDC), while providing large noise immunity, typically 45% of supply voltage. In terms of chip reliability, our engineers currently report more than 230,000 device hours at +125°C without failure.

All of the new devices are available in 14-pin dual in-line packages except the HD-4009 and HD-4010, which come in 16-pin packages. Because of their compatible pin-out configurations these circuits will replace or interface with the CD 4000A series. For details see your Harris distributor or representative.

1

HD-4000 Dual 3 NOR Gate



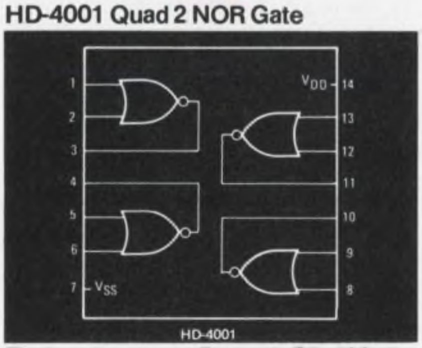
Pin for pin compatible with CD 4000A.

High speed	**10ns**
Low power	**1nW**

	100-999 units
−40°C to +85°C	**$1.00**
−55°C to +125°C	**$3.10**

2

HD-4001 Quad 2 NOR Gate



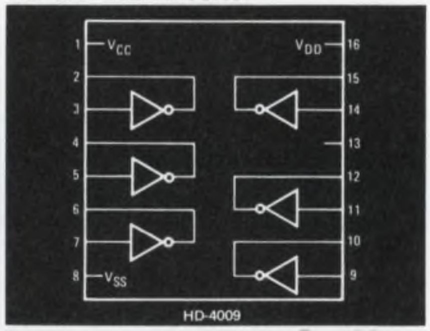
Pin for pin compatible with CD 4001A.

High speed	**10ns**
Low power	**1nW**

	100-999 units
−40°C to +85°C	**$1.00**
−55°C to +125°C	**$3.30**

3

HD-4009 HEX Inverter



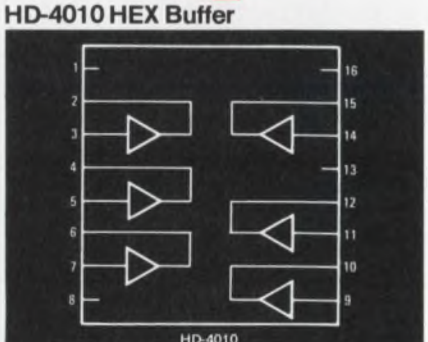
Pin for pin compatible with CD 4009A.

High speed	**10ns**
Low power	**50nW**

	100-999 units
−40°C to +85°C	**$2.20**
−55°C to +125°C	**$5.25**

4

HD-4010 HEX Buffer



Pin for pin compatible with CD 4010A.

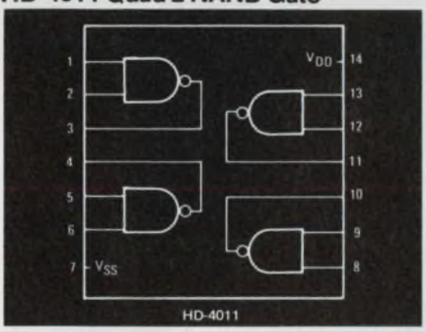
High speed	**10ns**
Low power	**50nW**

	100-999 units
−40°C to +85°C	**$2.20**
−55°C to +125°C	**$5.25**

CMOS:

5

HD-4011 Quad 2 NAND Gate



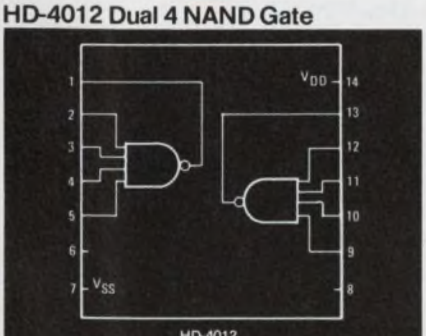
Pin for pin compatible with CD 4011A.

High speed	10ns
Low power	1nW

	100-999 units
−40°C to +85°C	**$1.00**
−55°C to +125°C	**$3.30**

6

HD-4012 Dual 4 NAND Gate



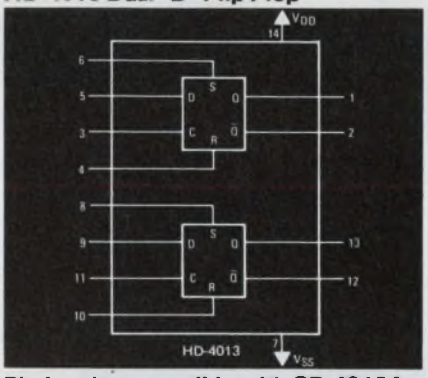
Pin for pin compatible with CD 4012A.

High speed	10ns
Low power	1nW

	100-999 units
−40°C to +85°C	**$1.00**
−55°C to +125°C	**$3.45**

7

HD-4013 Dual "D" Flip Flop



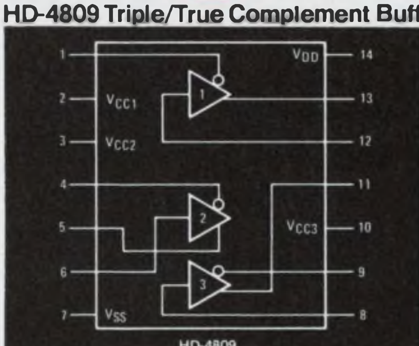
Pin for pin compatible with CD 4013A.

High speed	18MHz typical toggle rate
Low power	50nW

	100-999 units
−40°C to +85°C	**$2.10**
−55°C to +125°C	**$4.75**

8

HD-4809 Triple/True Complement Buffer



A Harris proprietary device.

High speed	10ns
Low power	50nW

	100-999 units
−40°C to +85°C	**$2.25**
−55°C to +125°C	**$5.30**

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INFORMATION RETRIEVAL NUMBER 103

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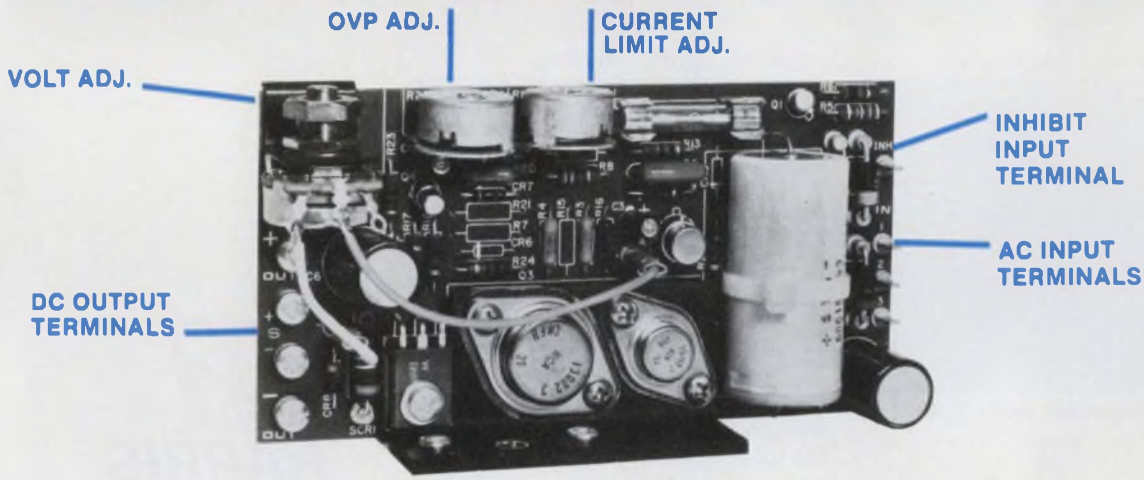

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MODEL	−100		−200		−300		−400		−500		PRICES*
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22A	1.0A	.875A	.725A	.625A	.575A	.500A	.475A	.450A	.425A	.400A	$15.00
22B	3.0A	2.5A	2.2A	1.9A	1.7A	1.5A	1.4A	1.3A	1.2A	1.1A	18.00
22C	6.0A	5.2A	4.4A	3.8A	3.4A	3.0A	2.8A	2.6A	2.5A	2.3A	25.00
22D	12.0A	10.4A	8.8A	7.6A	6.8A	6.0A	5.6A	5.2A	5.0A	4.7A	35.00
22E	18.0A	15.6A	13.2A	11.4A	10.2A	9.0A	8.4A	7.8A	7.5A	7.1A	40.00

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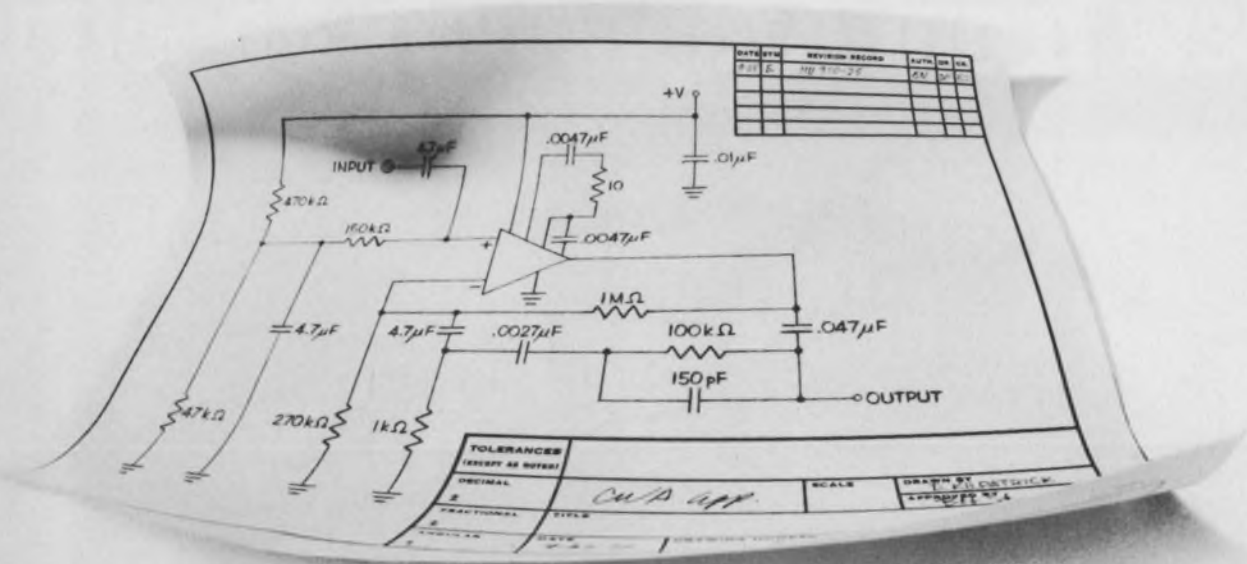

Designing a hybrid circuit shouldn't be all work and no play.

If you want to make sure the circuit you've designed really plays, you need to do more than see a schematic of it.

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And that's what the new KEMET® Hybrid Circuit Chip Kit allows you to do.

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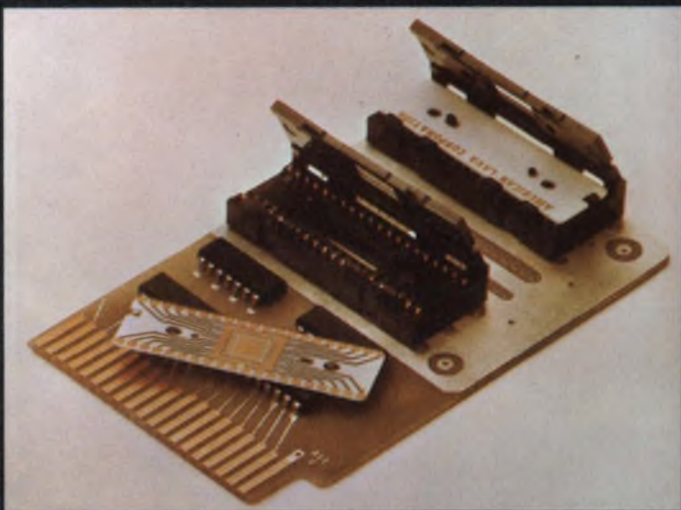
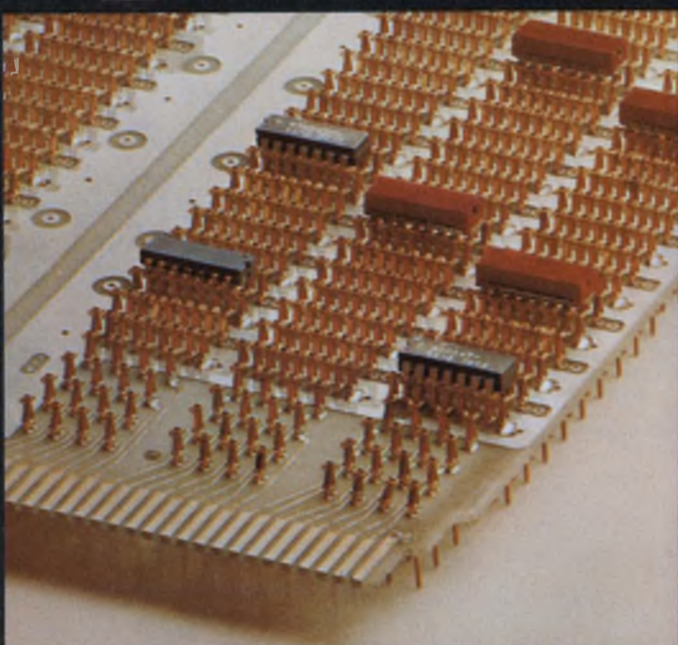
INFORMATION RETRIEVAL NUMBER 13

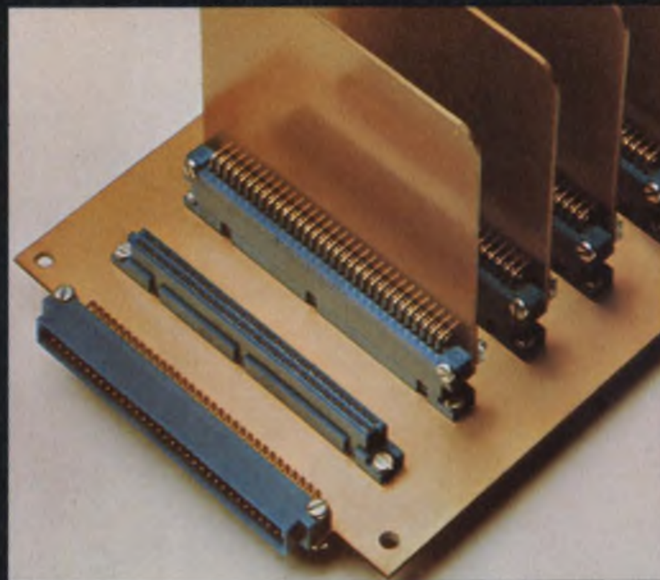
New from Amphenol's Spectrum



level 1

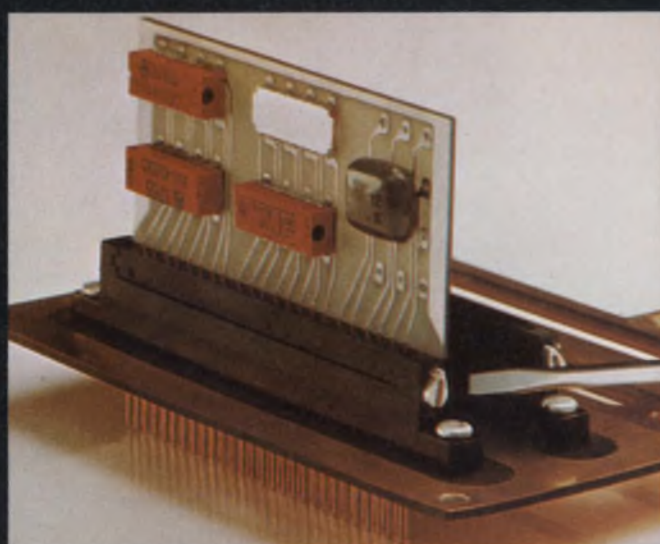
MOS/LSI Planar Plug-In connectors (above) for leadless, flat mount ceramic substrates. Permits fast, easy replacement of IC package, no screws, has snap-down lid. ■ Free-standing terminal (below) terminates IC's to PC boards for lowest total systems cost.





level 2

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



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

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

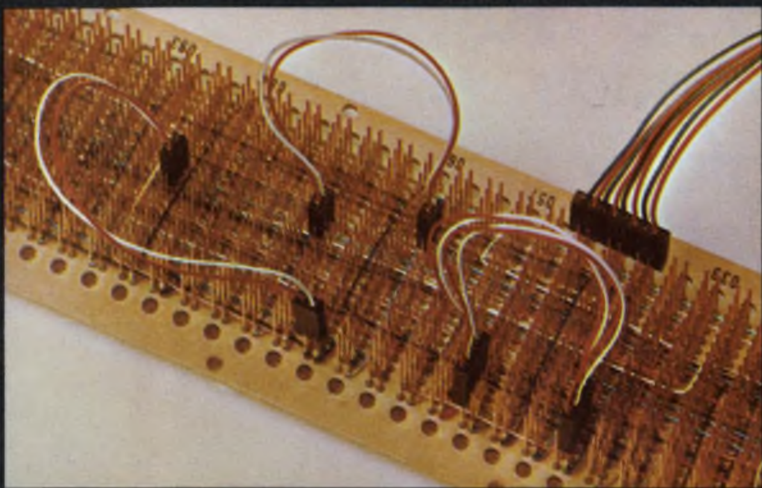
Level 1 . . . DEVICE TO BOARD OR CHASSIS. We offer interconnections for components such as tubes, relays, transistors, IC packages, trimmers, resistors or capacitors to a PC board or chassis.

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

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

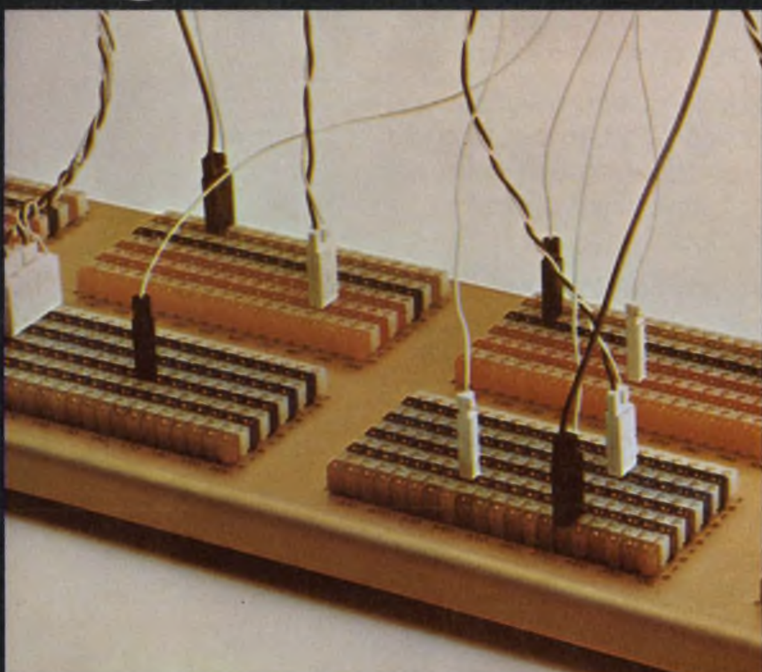
Level 4 . . . INPUT/OUTPUT CONNECTIONS. We offer interconnections for power and signals to and from a system. This interface may be between sub-assemblies within the same enclosure or between individual units.

# of interconnections.



level 3

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



level 4

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

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

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

Amphenol can fulfill your total interconnection requirements because we are not limited to specifics such as one or two product lines, one or two levels.

Therefore we approach your interconnection needs with complete open-mindedness.

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

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Action you'll get!

Miniature—Five different types with U.L. rating up to 15 amps. Four terminal styles. Choice of actuators—straight lever, roller lever, simulated roller lever.
Sub-miniature—Four basic types with U.L. rating up to 10 amps. Four terminal styles. Same actuator choice as above.
Sub-subminiature—Four basic types with U.L. rating up to 7 amps. Four terminal types. Actuators—a variety of lever, leaf and roller lever types.

Switch to No.1

More than just switches; prompt availability, field help, innovation, quality assurance, too.

INFORMATION RETRIEVAL NUMBER 16

CONTROL

CUTLER-HAMMER

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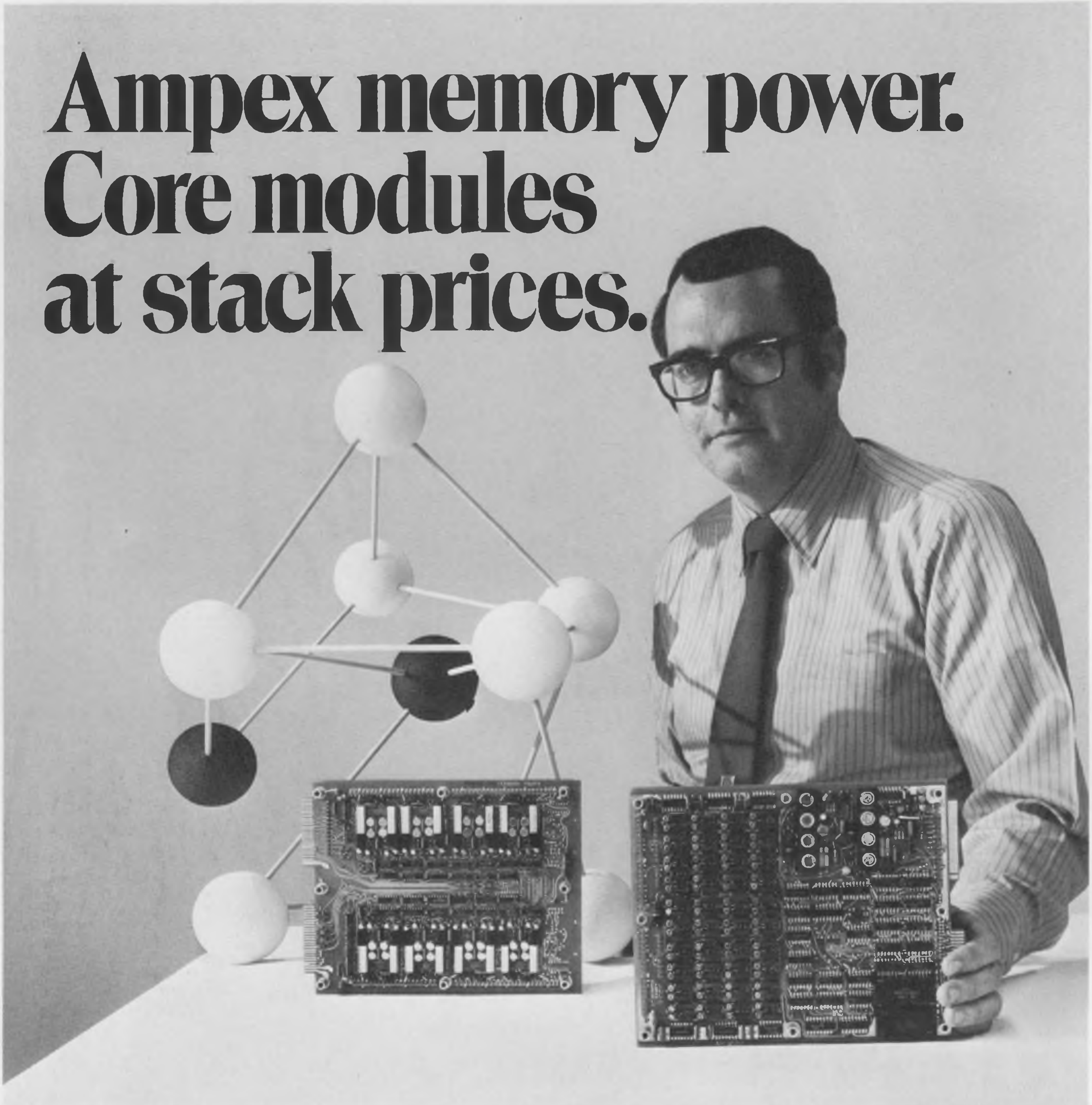
Ampex memory power. Core modules at stack prices.



So why design your own memory?

Ampex 1800 memory modules make real economic sense in both performance and design. No longer any need to design around purchased stacks.

The compact 1800 series modules give you twice the memory in half the space. Up to eight thousand 18 bit words in just 170 cubic inches. Combine any number of modules for the capacity and word length you need. High performance, too: access times of 250 and 340 nanoseconds.

For effortless design, all 1800 modules have decoding circuits, buffered data outputs, require only two voltages, need no temperature compensation or power sequencing. In other words, no external logic required.

Ampex 1800 modules were the first of their kind . . . and are still the best, and, of course, they come with Ampex worldwide service.

For details on how to get best memory module performance with least design effort, call your Ampex computer expert. He can fill you in on Ampex tape and disk drives, too. Or write.

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INFORMATION RETRIEVAL NUMBER 17

news scope

OCTOBER 26, 1972

5 kW in S band achieved by Navy lab's helix TWT

A broadband power output of 5 kW, continuous-wave in the S band—about twice that of other octave-bandwidth microwave tube amplifiers under development—has been demonstrated in a fluid-cooled helix-type traveling-wave tube.

A variation of the design can also operate as a high-power microwave attenuator.

The tube was designed at the Naval Research Laboratories in Washington, D.C. Its prime advantages, according to Lester Winslow, head of the laboratories' TWT section, include these:

- The tube can produce a high average or peak power output because of efficient cooling.
- The tube can deliver high peak-power outputs without oscillation—unlike competing designs—because of its unique characteristics.

The design, Winslow explains, is basically that of a hollow helix structure. Each turn of the helix is supported by two hollow ceramic tubes, each brazed to holes in opposites of each turn. There are 80 ceramic tubes.

The coolant, which was water in most of the Navy tests, is pumped into 40 inlet tubes and removed from the corresponding outlets. As a result, Winslow points out, each turn of the helix is cooled by flow of the coolant across the turn—at right angles to the helix axis.

The large volume of coolant flow across the helix turns provides highly efficient cooling of the design. But this feature is also responsible for the introduction of rf circuit losses in the water—a factor that permits outputs of high average and peak powers without oscillations in the tube.

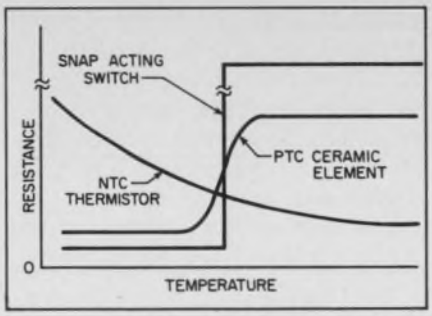
James Burgess, head of TWT research and development for Varian, Inc., Palo Alto, Calif., calls the new tube "an impressive development." But he does not see the design adapted to civilian use in the near future.

At present high-power tubes are used in communications systems, he notes, and the klystrons and coupled-cavity tubes now available have enough bandwidth for present needs.

Low-cost sensor made for industrial controls

By improving barium titanate—a compound developed at Bell Telephone Laboratories in the mid-1950s—Texas Instruments has come up with an inexpensive positive-temperature-coefficient ceramic element that appears headed for broad application in industrial-control systems.

The potential applications include these:



The new ceramic element's resistance-temperature characteristic is compared with a thermostatic snap acting switch and a negative temperature coefficient (NTC) thermistor.

- A self-limiting heater.
- Motor overheating protection.
- Current limiting.
- Time-delay relays.
- Detection of loss of fluid or cooling air.

The new device, developed at TI's plant in Attleboro, Mass., is made from doped barium titanate that can be formulated to change its conductivity abruptly from very high to very low levels at a predetermined (Curie or anomaly) temperature anywhere from 60 to 180 C.

The advantages of the new device, according to Andrew Loughlin, senior product specialist for TI, include its versatility and low cost—less than a dollar for each device in volume. The barium-titanate element can be used both as a heating element and as a thermal switch whose resistance changes four to six orders of magnitude at the anomaly temperature. The anomaly temperature is determined by the impurities added to the ceramic.

As a low-power, self-limiting heater, the new device can be used to replace wire-wound heating coils. In operation, the ceramic element starts out in its low resistance state, passes a high current and heats up. When the element reaches its anomaly temperature, it switches from the low to the high resistance state, limiting the current—and thus controlling the temperature. When the temperature goes below the anomaly point, the device heats up again, and a constant temperature is maintained.

Overheating protection and current-limiting applications require that the element operate in its low-resistance mode normally and switch to its high-resistance mode when too much heat is being produced and too much current drawn.

According to Loughlin, the new element can be manufactured in a wide variety of shapes and sizes.

New CMOS offering 4-to-1 area reduction

Two-layer microcircuit technology, a high-density CMOS, will supplant TTL and conventional PMOS and CMOS logic, one of its developers predicts.

Now used primarily for 1-V electronic watch circuits, the high-density technique gives at least a 4-to-1 reduction in area compared with conventional CMOS circuits, according to John H. Hall, president of Micropower Systems, Inc., Santa Clara, Calif. Hall collaborated with John Marshall, a vice president of the company, in developing two-layer microcircuit technology.

The high-density technique uses two layers of active devices, both having nitride passivation. In addition an outer layer of soft glass further protects the circuit against handling.

The secret of the new technique, Hall says, lies in two factors: the method used to deposit a two-layer metal interconnect and the use of high-value, thin-film resistors from 1000 to 100,000 Ω per square.

These resistors, Hall notes, can be deposited with a ratio match as close as 0.05% for a 10-bit a/d ladder network. The circuit densities, he says, are comparable to those of PMOS but show an improvement in speed-power performance. Parasitic capacitances associated with the conventional type of P-well diffusion interconnects are much less with the metal interconnect, Hall points out.

The speed of the high-density CMOS is high, with 5-V propagation delays of less than 40 ns and 10-V delays of less than 20 ns.

The unit cost per logic function approaches that of PMOS, Hall says, but the power-supply requirements are down by as much as a factor of 10 compared with those for TTL and PMOS.

RCA endows 2 chairs at MIT and Harvard

Two chairs for the teaching and research of modern technology management will be endowed by RCA in the Sloan School of Management at the Massachusetts Institute of Technology and in the Harvard School of Business. The data resulting from the research are to be made available to all corporations and other potential users.

The grant, totaling $2-million over 10 years, is a tribute to the late David Sarnoff, long-time chairman of RCA.

Announcement of the joint program was made by Robert W. Sarnoff, RCA's present chairman, at an MIT luncheon in Cambridge, Mass. Dr. Jerome B. Wiesner, president of MIT, said that the teaching would focus on "the assessment of technological processes and transfer, the management of innovation, the creation of complex yet reliable systems, and the interaction of technology, business and society."

The two professorships will be held by Dr. Richard S. Rosenbloom of Harvard, whose specialty is "the management implications of social and technological change," and Dr. Donald G. Marquis of MIT, who has headed the school's research program in science and technology management.

Hall-effect transducer replaces resolvers

A new Hall-effect gimbal angle transducer described by a Raytheon project manager may replace conventional resolvers assemblies in some applications.

Described at the recent National Electronics Conference and Exhibition in Chicago, the device is said to offer a 7-to-1 cost advantage over conventional resolvers and a 3-to-1 decrease in size.

In a paper entitled "The Hegat (Hall-effect gimbal angle transducer)—A New Concept in Angular Measurement," Barry N. Levitt, project manager at Raytheon's Missile Systems Div., Bedford, Mass., presented details of the transducer. He said it could provide all the functions of electromechanical resolvers with an accuracy of 10 minutes of arc over a range of 360 degrees. Until now Hall devices have been used in gyro pickoffs, and a range of only about ±1 degree was required.

The Hall-effect gimbal angle transducer was developed for the Air Force for use in low-cost inertial platforms, Levitt said, but it should also find application in gimbal antennas and missile-control systems. It may also replace potentiometers in many applications, he added, because it is much more reliable.

Further research due on organic solar cells

Solar cells are the prime power source for many spacecraft, but their high cost so far has made them impractical for general use. Scientists at the University of Pennsylvania's Energy Management and Power Center in Philadelphia hope to change that. They have received a grant from the Air Force Cambridge Research Laboratories to conduct further research into the potential of solar cells made of organic materials.

The concept is not new. In the last decade the Cambridge Research Laboratories, RCA, Esso Research and others have investigated the possibility of using organic semiconductor materials as solar cells. The idea was to make them as easy to manufacture as plastic films—and as cheap as the films. But although such devices have been made, their performance has been poor.

In describing the goals of the new research, Martin Wolf, associate professor at Penn's Energy Management and Power Center says: "Many organic materials are cheaply available now and can be easily rolled out in films. The hope is that maybe we can make a solar cell just about like we make a cheap polyethylene film."

News Briefs

Agreement on terms for a jointly owned company to provide nationwide satellite communication services has been announced by the Communications Satellite Corp., Lockheed Aircraft and MCI Communications Corp. Each of the three corporations will have a one-third interest in the new company. Copies of the agreement have been filed with the Federal Communications Commission. The agreement is subject to the commission's approval.

According to industry sources, **Texas Instruments is getting ready to introduce a line of CMOS integrated circuits.** It is not yet clear what approach TI will take, but speculation is that the company will produce devices that are compatible with the RCA CD 4000, Motorola 14500 and National 54/74 C series. Questioned about the CMOS rumor, TI officials refused to comment.

news

Assembly-line test systems stop the defects before they're built in

Industrial electronic test systems—for product design, machine-tool controls and process controls—are making increasing use of digital techniques and sophisticated computer-controlled acquisition, display and analysis of test data.

The reason? A rising need for systems that can conduct multiple tests simultaneously and provide test results of greater accuracy, unbiased by human evaluation. Among the factors that have created this need are these:

- Crackdowns by governmental bodies on air and water pollution, noise and product-defect hazards.
- The rapidly rising cost of labor, forcing manufacturers to reduce labor and yet increase productivity.
- Consumerism and its demands that manufacturers make good on any shortcomings in their products.

From kitchen appliances to automobiles, manufacturers are resorting to exhaustive testing to spot potential trouble before it leads to governmental curbs or excessive warranty costs.

Mutiple test stands at Ford's Allen Park facilities use computers and magnetic tape storage to acquire and process test results. Each of the test stalls is operated and monitored from its own control console.

Auto industry automates

Many of the new computerized test systems are emerging in the automotive industry, some with partial computer control of the tests, others with fully automatic control. Tests that formerly took days to conduct and evaluate manually are now being done in minutes.

Both automotive manufacturers and testing services for the auto industry are using complex, multiple-sensor computer-controlled systems, like those produced by Process Computer Systems, Inc., of Flint, Mich. This company's systems, which are controlled by Hewlett-Packard 2100 computers, perform government and state certification tests on auto bodies, transmission and drive trains, and engines.

One type of installation is being used for exhaust-gas analysis during engine development. The computer, according to Gary Johnson, marketing manager for Process Computer Systems, provides programmed instruction for the test.

The exhaust-monitoring system automatically calibrates, averages and linearizes the digitized analog outputs of the gas analyzer system used to detect the pollutants. A test report is provided by computer readout as soon as the test cycle is completed.

The advantage of this type of system, Johnson says, is that it not only provides test-passing or test-failing data, but also reduces the data to a form that permits the engineers to analyze the reasons for failure.

The rapid growth in application of these systems can be judged from the fact that Process Computer installed its first three test systems—which range in cost from \$40,000 to \$200,000—in 1968. Last year the company set up 20 new installations, and this year it expects to install 25 more.

Portable testers developed

The Ford Motor Co., according to Paul Brenton, senior research engineer at Emission Test Laboratories, Allen Park, Mich., is developing a new concept in portable exhaust-analysis equipment. Individual analyzer systems are being mounted in upright consoles that can be readily moved—or altered, or assembled in a group—at a test site. Previous installations were fixed.

Ford's new emission test systems use the latest chemiluminescent detectors to measure nitrous oxides and ionization detectors to measure hydrocarbons, says Brenton.

Jim McDermott
Eastern Editor

Portable on-board instrumentation is used for tractor testing. This Honeywell multiple-channel Visicorder is recording cylinder-head temperature, exhaust temperature and tractor-frame dynamics to check the suspension.

Hewlett-Packard airport monitor checks jet noise levels fast enough to warn pilots of excessive levels.

Previous analysis equipment was fully manually controlled, Brenton points out. The newest systems have sufficient computer control to reduce test-stand labor, requiring only limited manual control (see photo).

"We're designing our latest equipment so that it can all be computer-interfaced," Brenton reports, "and our trend is to eventual total computer operation. We're about three-quarters of the way there and expect to see computer operation within a year."

At present, Brenton explains, Ford has two multiple-station test laboratories—one in Dearborn and the other in Allen Park—about two miles apart.

The outputs from exhaust analyzers at each laboratory are fed into a Xerox Sigma 3 computer for central processing.

I. David Long Jr., manager of technical process systems planning for the Chrysler Corp., Detroit, says:

"Our big interest here is in testing to reduce both in-plant and warranty costs. We use the computer-controlled test systems because they do a better job of testing with less manpower."

A good example, he points out, is a computer-controlled test for automatic transmissions at the Chrysler transmission plant in Kokomo, Ind. This system, he says, uses twin General Electric 420 computers as redundant systems to avoid shutdowns.

Growing interest in fatigue analysis for equipment is demanding new portable test equipment, says William A. Buck, marketing manager for EMR-Instruments, Sarasota, Fla., not only for private and sporting vehicles but also for tractors and earth moving equipment. The high cost of vehicle recall, Buck says, makes it attractive for major manufacturers to make sophisticated multichannel fatigue studies of such components as rear axles, engine mounts and other vehicle elements.

These tests require programmed shaking, pushing and twisting actions. For this purpose, EMR test systems can generate a digital fatigue profile—a punched tape that represents a road surface or other dynamic forces that a vehicle will encounter. From the digital tape, analog signals are generated for driving the load frames on which the equipment is tested.

Another trend, Buck notes, is replacement of the umbilical cord in vehicle test-track work with a telemetry system. Particular interest is being shown by manufacturers of recreation vehicles, such as minibikes, motorcyles and snowmobiles. The problems of monitoring the dynamics of strain, torque, vibration, temperature and other functions with a test vehicle bounding over rough terrain and through woodlands can't very well be done any other way than by telemetry, Buck notes.

EMR vehicle telemetry systems, he says, can transmit multiple channels of data over distances up to 1.5 miles, leaving the vehicle free to maneuver without restriction. These systems apply the analog outputs of the on-board transducers to voltage-controlled oscillators, which generate frequency-modulated, multiplexed signals for transmission from the vehicle to a mobile receiving station (see photo).

For the 1.5-mile system, up to 14 data channels are available, Buck says, each with a maximum data response of 1000 Hz. These signals are transmitted in the 215-to-220-MHz band.

In water-pollution monitoring, Buck notes, there is an increasing need for reliable telemetry to link remote stations, where the sensing is done, to a central station, where there are display, recording and data-processing facilities.

On-board monitoring, too

Allen Tucker, director of marketing for the Honeywell Test Instrument Div. in Denver, describes another approach. Honeywell provides a complete on-board monitoring and recording system that produces a visual record of the tests without the need for telemetering. It has produced a generation of rugged instruments called Visicorder Data Systems.

These instruments are of light weight with durable frames and shock-mounting of sensitive components to protect against vibrations from the vehicle or device under test. Typical applications, says Tucker, have been in monitoring outboard-motor performance and in recording test data on garden tractors (see photo).

To study and evaluate noise—from the loud sounds of jetports to the smaller sounds of car fans or windshield-wiper motors—new generations of computer-operated spectral-analysis equipment are being produced. For example, a system by Hewlett-Packard—the Model 80500A Aircraft Noise Monitor (see photo)—measures the noise level of jet engines at several points around an airport. The sound is picked up and its intensity measured by monitoring terminals controlled by an HP 2114A or 2115A digital computer. The evaluation is a complex function of the sonic frequencies present, as well as of the bandwidths and frequency separation of the sound com-

Measurement of waste-water pH with Leeds & Northrup tester gives a check for water-treatment operation.

EMR telemetering system on board the minibike transmits field test data to the portable station at left.

ponents.

The system works fast enough for airport personnel to communicate with a pilot as soon as excess noise is detected.

Without the computer system, Honeywell estimates that a six-terminal monitoring system requiring perhaps six to eight people would be needed to collect and analyze the same data over extended periods of time.

Some five or ten years ago, says Henry J. Bickel, president of Federal Scientific Corp., New York, noise produced by consumer products such as vacuum cleaners, fans and blenders was considered to indicate their power and also of the fact that they were in good working order. Not so today, he insists.

Noise is now recognized, Bickel says, as a source of lost power. But more important, analysis of the noise can provide an indication of immediate or potential failure.

The use of spectral analysis instruments to measure noise is increasing at the rate of some 20% to 25% per year, Bickel says. This, he points out, is considerably greater than that of the electronic instrument field in general, which is about 10% per year.

Verification of machine-tool tapes

Many of the newer electronic industrial test systems are designed for highly specialized applications. One is the Tektronix 1791 Numerical Control Program Verifier (see cover photo). This machine verifies whether or not a numerical-control tape has been programmed with the correct machine-tool motions along the various axes.

While the concept of numerical control for machines is sound, Glen Dower, marketing manager of the machine-tool group at Tektronix, says that considerable human error exists in the computer programming. It is not unusual, he says, for a tape to be sent back and forth from four to six times between the programmer and the production department while the tape is verified on the machine tool. This is time-consuming, he notes, and the machine tool is unproductive in this interval. Even more important, he adds, there is the possibility of costly damage to the machine during the verification like this, if the tool tears into the machine table or the side of a part because of tape error.

To verify a numerical-control tape, the Tektronix 1791 shows the path of the tool on a storage-tube display. The tape can be read at 500 characters per second or at a slower rate. The operator watches for errors and identifies the portions of the tape that must be reprogrammed. The tool path plot can be displayed in any of five formats: three-dimensional oblique, plan views in the X-Y plane, in the X-Z plane, in the Y-Z plane, or lathe. ■■

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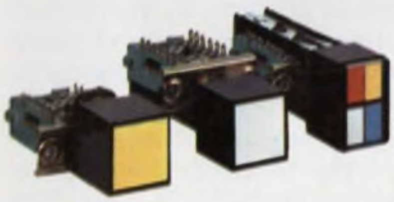

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INFORMATION RETRIEVAL NUMBER 19

Nixon vs McGovern

Two views of engineering issues

In this election year electronics engineers want to know how the candidates stand on issues that affect the engineer's welfare, his career and his profession. ELECTRONIC DESIGN wrote to both President Nixon and Senator George McGovern, inviting their views on a number of questions that concern the electronics engineer and the industry. Both responded with lengthy position papers. Here are questions that were asked and key excerpts from the candidates' responses.

If elected, what steps will your Administration take to stabilize, once and for all, the cyclical unemployment in major sectors of the electronics industry? What can be done with the thousands of unemployed and underemployed electronics engineers as a result of the recent recession?

NIXON: The actions taken to reorient and re-employ displaced aerospace and defense-industry engineers, scientists and technicians—including specialists in electronics—include the following:

1. Assistance and retraining programs were authorized in such fields as pollution control, city and urban management, and transportation technology.

2. The Civil Service Commission established a program to assist individuals being terminated from government as a result of the defense and aerospace cutbacks; the Defense Dept. took similar action to assist displaced civilian employees.

3. The Dept. of Labor set up job information banks throughout the country to match local job opportunities with available labor.

4. In April, 1971, Labor Secretary James Hodgson announced a multimillion-dollar Technology Mobilization and Re-employment Program specifically to assist in the re-employment of scientists, engineers and technicians.

McGOVERN: The unemployment crisis among electronics engineers arose from a failure to plan realistically for the impact of the present recession, the decline in aerospace and military spending, and the huge number of technically trained people that our colleges and universities have been producing. In order to solve this crisis, it is necessary to vastly increase Federal spending on research and development directed toward civilian needs. We should promote an atmosphere more favorable to independent enterprises launched by individual electronics engineers. Similarly we should be prepared to subsidize the trial employment of unemployed engineers and scientists by private firms in order to bridge the gap between the unemployed technologist and the firm that could use his talents.

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

NIXON: The electronics industry today is considerably less dependent on defense spending than in the past. For instance, the electronic components industry, which manufactures the building blocks of all electronics products, has shown a marked increase in the dollar volume of these components going to the nondefense sector. In 1961 nearly 39% of the $2.4-billion in components

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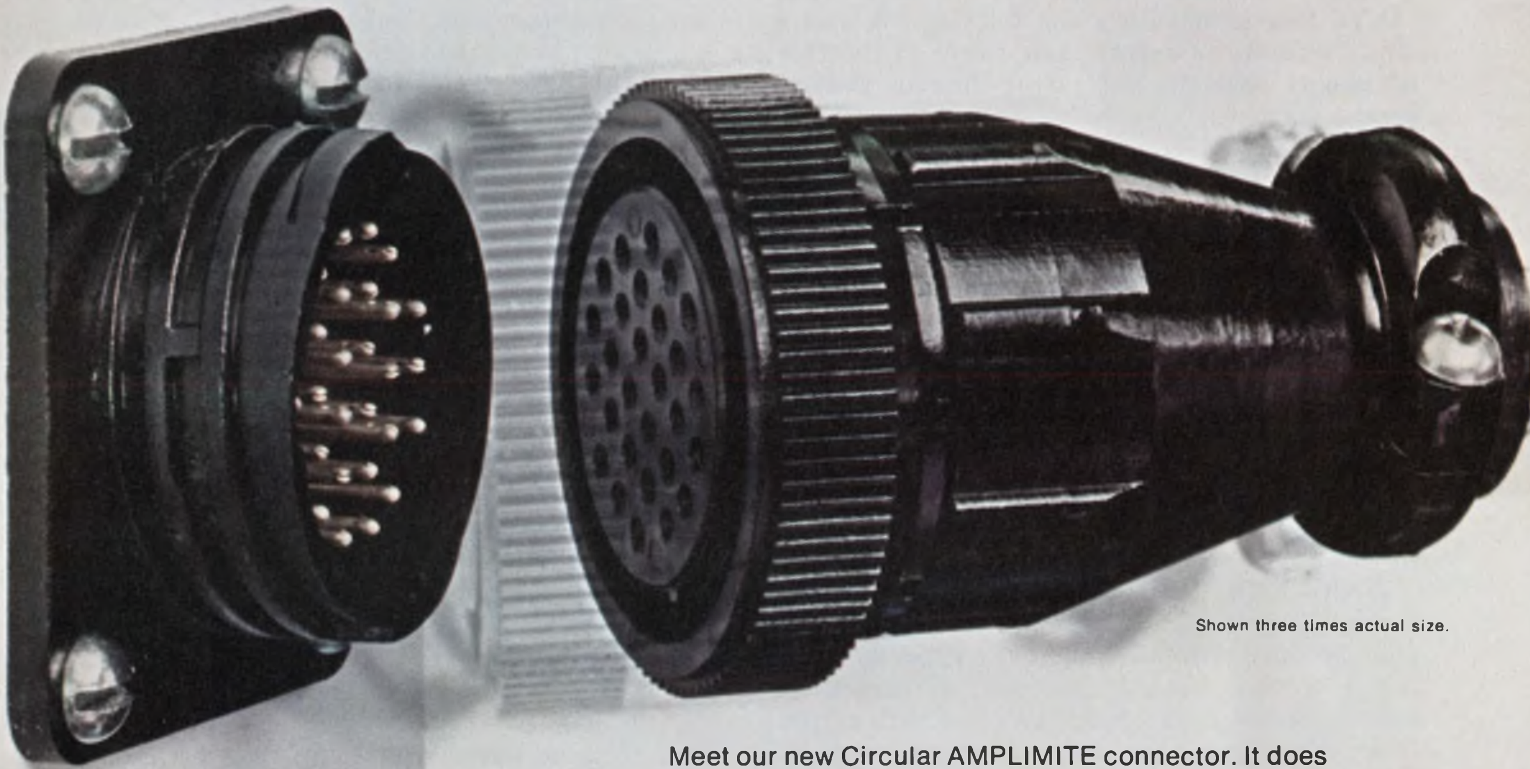

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152 PLEASE SEND LITERATURE—POSSIBLE FUTURE INTEREST.

manufactured were shipped for defense use. By 1971 the defense share was only 18% of the nearly $5.4-billion of such shipments.

McGOVERN: By trimming the defense budget as I have proposed—eliminating needless waste and overkill, while maintaining a credible and lean attack force—our nation can better use its financial and technical resources toward meeting its domestic needs. Thus electronics workers and others will no longer be dependent on fluctuations of defense spending but rather will earn their livelihood through work directed at social progress. There will always be new frontiers to explore and greater social problems to solve.

What do you intend to do about the import imbalance in consumer electronics? In fact, what can be done to make it easier for U.S. electronics manufacturers to export their wares in the face of import obstacles set up by foreign governments, particularly Japan?

NIXON: In 1971, exports of all electronic products exceeded imports by $434-million. Yet in consumer electronics there are problems, and the Administration is doing something about them:

- We are attempting to expand our trade opportunities overseas and stop unfair foreign competition, such as dumping, in domestic markets.
- We are working with other nations to prevent the erection of nontariff barriers.
- At the moment the U.S. is negotiating with Japan to lift quotas on imports of integrated circuits—a move that could open a sizable market to the American electronics industry.

McGOVERN: Trade between Japan and the United States in consumer electronics is biased and one-sided. While we allow the Japanese total access to our domestic markets on almost all commodities, our exporters are faced with an unbelievably complicated maze of controls and administrative restrictions in attempting to sell in Japanese markets. Moreover the administrative collusion between the Japanese Government and Japanese industry redoubles the difficulty faced by American exporters.

There are several things we can do. First, we can insist that if trade is going to be open, it will also have to be fair. This means compelling the Japanese to give American exporters more equal access to Japanese markets. Second, we can enforce vigorously the antidumping provisions of current laws so as to prevent American markets from being flooded illegally with foreign commodities at prices below their costs.

Since research is the key to maintenance of technical superiority, what are your plans to keep the U.S. on top via consistent Government support of research and development?

NIXON: The nation will spend about $28-billion this year in goods and services associated with R&D. The FY '73 Federal budget calls for R&D expenditures of $17.8-billion an 8% increase from last year. Defense Dept. and NASA research contracts account for more than half of the Federal outlays.

It should be pointed out that the character of the Federal budget has been changed over the past few years, signaling a change of priorities in our nation. In 1970, for the first time in two decades, spending for human resources exceeded defense spending in the Federal budget. Human resources spending received 42% of the 1971 Federal budget; defense, 35%.

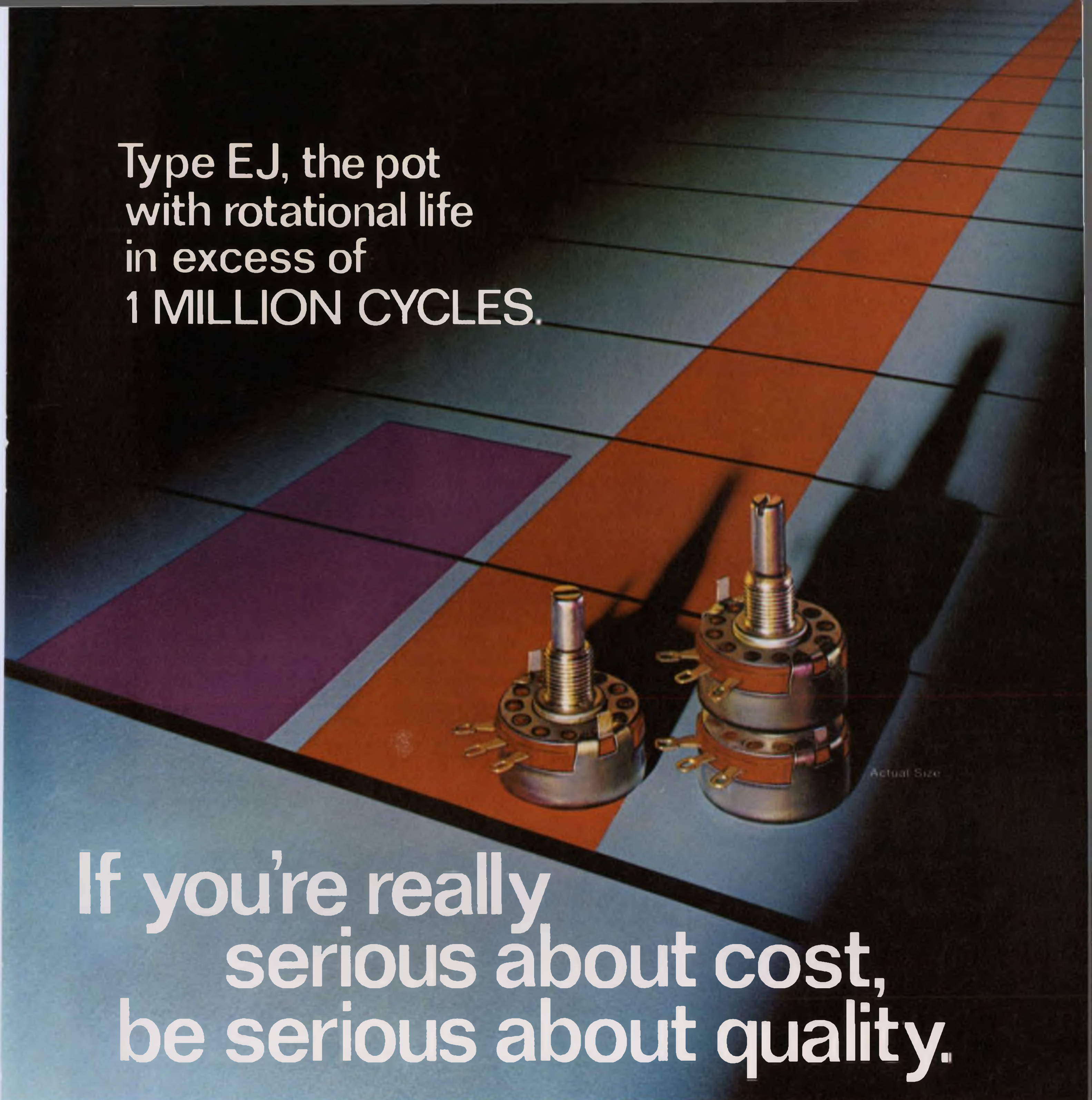
McGOVERN: If we are to finally meet some of our unmet domestic needs—in areas of housing, mass transportation, medical care, pollution abatement, and public safety, to mention only a very few—we must dramatically increase our Federal commitment to civilian research and development. At present the United States spends only 1.1% of its Gross National Product on research and development directed toward economic growth. This is literally one-half of the commitment made by the major Western European nations and Japan—presently at an average of 2.2%. Moreover our export of technology-intensive products is presently only 50% greater than our import. In 1960 it was four times as great.

Do you have any plans to modify the winner-take-all method of awarding Government contracts, with its disastrous effects upon both the losing company and its geographic region?

NIXON: First, let's establish the fact that when there are competing bidders, whether Government or industry is calling for bids, somebody has to lose out as prime contractor. But the practice of "winner-take-all," as you call it, particularly in large Government contracts, is rare.

For example, North American Rockwell, the prime contractor in NASA's space shuttle orbiter program has indicated that more than 50% of the multibillion-dollar contract will go to some 10,000 subcontractors, possibly including Grumman, McDonnell Douglas and Lockheed Aircraft Corporation, losers in the contract bidding to read-contract bidding.

McGOVERN: In awarding contracts, the Federal Government must take several criterion into consideration. For example, the industry which possesses the best means of producing a given product should normally receive the contract. However, with conversion as an added problem, contracts may have to be awarded on the basis of geographical location, at least initially. Areas hard hit by military cutbacks would receive assistance through civilian contract awards and aid to displaced workers. ■■



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Optical communications links are successfully demonstrated

The promise of optical communications has brightened with two major demonstrations in New York City.

In one a color television picture was beamed over a three-quarter-mile zigzag link between the Columbia Broadcasting System Building and the New York Coliseum. It was the first public demonstration of laser transmission of color TV signals.

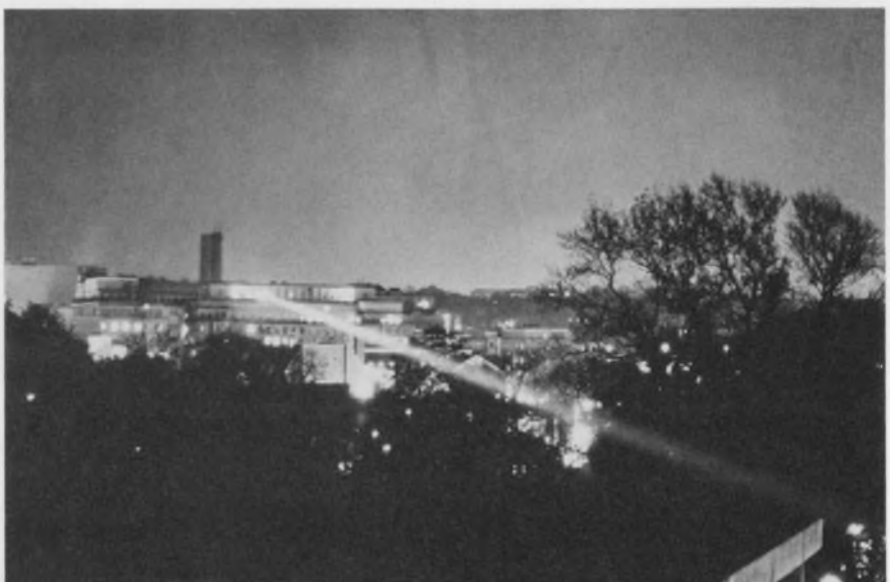
In the other demonstration, closed-circuit monochrome signals were transmitted over a 15-foot fiber-optics link. It was a successful test of the feasibility of sending broadband vhf signals optically.

The TV color pictures, which were of high quality, drew standing crowds at an exhibit put on by Laser Communications, Inc., at the Electro-Optical Systems Conference in the Coliseum. The pictures shown were those of regular CBS-TV programming.

CBS provided the video and audio signals that were fed to a laser transmitter—the LCI-203, developed by Laser Communications—atop the CBS Building. Because buildings blocked a direct view to the Coliseum, the laser signals were relayed to a nearby receiver and from there to the Coliseum.

The transmitter, according to David M. LaFleur, general manager of Laser Communications, was a 1-mW helium neon laser radiating at 6328Å. Modulation was provided by a Pockels type of crystal with a bandwidth of 10 MHz.

Jonathan Freeman, marketing manager of Laser Communications, says the reliability of the system has been demonstrated to be better than 99% over four miles. "We've successfully maintained transmission through rain and heavy snow," he reports, "but heavy fog is our worst enemy." However, he points out, where poor weather conditions are known to exist, the laser beam can be expanded to pro-



Two-way TV communications system carrying pictures and voices between surgery in one hospital and anaesthesia department in other, by Laser Communications, Inc., provides facilities for sharing professional skills.

vide spatial diversity. Although snowflakes, raindrops or fog particles interfere with part of the beam, the remainder will carry redundant information, resulting in no loss of signal, Freeman says. Further reliability, he adds, is guaranteed by the fact that the links have a fade margin of greater than 40 dB.

Fiber optics replaces coax

In the fiber optics demonstration a 56-mil Crofon optical fiber substituted for coaxial cable in carrying the broadband information. The bandwidth of the optical signal was that of Channel 2—54 to 60 MHz. The immunity of the system to electrical noise was demonstrated by running a spark tester alongside the fiber.

The demonstration, which also took place at the Electro-Optical Systems Conference was sponsored jointly by DuPont of Wilmington, Del., maker of Crofon, and Electro Fiberoptics, Inc., Boylston, Mass., designers of the optoelectronics system. The system used the modulated output of a 2-mW power helium-neon laser to transmit the Channel 2 optical signal down the fiber.

The output of the TV camera was applied to a video-carrier generator, according to Paul Dobson, project engineer at Electro Fiberoptics. The generator produced a 3-W rf carrier at a frequency of 55.25 MHz.

The sound signal was used to modulate a sound carrier at 59.75 MHz. The two signals were then combined and applied to the laser modulator. The modulator was a 45° Y-cut, four-element ADP crystal. It produced a low-level modulation index of about 2% for the demonstration setup.

The modulated output of the laser was applied to one end of the Crofon fiber. At the opposite end, the optical signal was demodulated with a low-noise pin diode and applied to a broadband amplifier with a gain of 40 dB.

The demodulated Channel-2 signal was connected to a standard 17-inch black-and-white monitor.■■

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technology abroad

An acidity/alkalinity meter and control system that can be used in all types of effluent-treatment systems has been designed by a Finnish company. The low-voltage output from pH electrodes is connected to a high-impedance preamp, amplifier and chopper. The transmitter output is a 44-to-20-mA current proportional to an input value of ±1400 mA. Current ranges of 10 to 50 mA and 0 to 20 mA are also available, each corresponding to pH measuring ranges of 0-14. The design is by Ulmaelektro Oy of Helsinki.

CIRCLE NO. 441

A quick inspection system for printed-circuit boards and other complicated work pieces has been produced by Temco Tools of Bucks, England. Called the Mirror Viewer, the system has a glass screen that is partly covered with mirror strips through which the operator sees the workpiece reflection and the master diagram simultaneously. A special light-table arrangement permits the printed-circuit boards to be inspected for missing, partly obscured, wrong-sized or incorrectly placed holes. Bad holes appear to wink at the inspector as the work piece is compared with the diagram.

CIRCLE NO. 442

Improved methods of protection for 1-MV high-voltage transmission lines are under study by the French Electricity Board, Montroy, France. One solution, by Compteurs Schlumberger, consists of making measurements at the very-high-voltage line level and transmitting the results to the ground by means of optical fibers and infrared-emitting diodes. The ground data are processed by a computer that is programmed to indicate the nature and the position of the fault. Further research is being carried out to improve the accuracy of the protection system. An accuracy of 0.5% at rated currents of 50 and 1300 A is expected. To achieve this, the company is studying a Faraday-effect magneto-optical current transformer that uses rotation of the polarization plane of a light beam by transmission-line current.

CIRCLE NO. 443

A two-dimensional array of semiconductor cells in the form of a toroid promises to give much larger semiconductor memories than are currently available, according to K. J. Dean of South East London Technical College, London, England. The toroid configuration, he says, will allow recirculation of data in either a circular or helical path around the device. In concept, the memory can be expanded to any size, because every memory cell can be connected iteratively to its neighbors. In practice, some additional cells could be connected to a rim for use as a solid-state disc storage. Several of these rims might be used to reduce the data reading time.

CIRCLE NO. 444

A rugged, high-capacity disc memory with a storage capacity of 93-Mbits is being developed under a contract awarded to Process Peripherals, Ltd., Berkshire, England. The project calls for a disc memory that can operate in hazardous environments. It is expected that the memory will incorporate a single disc with 400 tracks of information written by two independently controlled servos, one on each side of the disc. The second stage of the project is expected to be completed in 1973 and will be aimed at increasing the storage capacity of the disc to some 370 Mbits of data.

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INFORMATION RETRIEVAL NUMBER 25

washington report

IBM antitrust suit reported near settlement

The Justice Dept.'s three-and-a-half-year antitrust suit against International Business Machines charging monopolization of the computer market reportedly is near settlement, although the terms of an agreement probably will not be disclosed until after the Nov. 7 election to avoid accusations that the Administration is playing politics with its antitrust actions.

Justice Dept. lawyers reportedly would like to take the giant computer company into court and force it to divest itself of some of its operations, but top-level administrators in the Government indicate they may settle out of court, which probably would mean a more favorable outcome for IBM.

East-West trade barriers lifted further

Trade barriers between the Communist blocs and the Western world are diminishing rapidly, the latest movement being a liberalization of export controls set by nations in the NATO Coordinating Committee. A number of electronic items have been struck off the committee's list, State Dept. officials report, but the nations involved are still hassling over computer standards. Meanwhile the Commerce Dept., under Congressional direction, is weeding out items from its own even more restrictive list, and it will give industry the word soon.

Defense budget heads for Senate-House conference

The Senate had some good news and some bad news for the Defense Dept. as it voted the fiscal 1973 defense appropriations preparatory to final conference action on Capitol Hill.

On the good-news side the Senate restored these funds cut by the House: $127-million for procurement for the advanced airborne national command post program; $132-million so the Navy can buy Lockheed S-3A antisubmarine-warfare aircraft; $25-million for the Navy's F model Sparrow Air-to-Air missile; $20-million of a House reduction of $36-million for the F-15 fighter aircraft, built by McDonnell Douglas; $42.5-million for the Minuteman command-data buffer electronics program, and $33.5-million for a new Army helicopter program to replace the canceled Lockheed Cheyenne.

As for the bad news, the Senate voted to make these reductions in the budget: $104-million from the Navy's request to buy P-3C land-based

ASW aircraft from Lockheed; $83.2-million from the A-7D aircraft program made by LTV, and $30-million from the General Dynamics F-111 aircraft fund.

The Senate also agreed to House reductions in the Vietnam electronics sensor program; the DD-963 destroyer program; the Trident missile program, and the airborne warning-and-control program (AWACS). The Senate's concurrence in these cuts spells the end of any appeal on them from the Pentagon, but the other points of difference in the bill must be settled in a Senate-House conference before the Pentagon gets any money.

Laser standards under review

The Dept. of Health, Education and Welfare's Bureau of Radiological Health will ask some 40 to 60 experts in laser engineering and biology for advice about wide differences in proposed laser-power safety standards between the bureau and the American National Standards Institute. The Bureau recently came up with power standards which in some cases would be some 1000 (one thousand) times lower than that ANSI would permit. BRH officials say industry representatives have expressed disagreement with both extremes. A meeting is planned in December.

U.S. to open antidumping hearings

The Federal Tariff Commission will hold hearings beginning Nov. 28 on alleged Japanese dumping in the United States of color TV tubes. The FTC must determine whether domestic industry is being hurt by the lower prices charged by some Japanese suppliers. The issue is complicated by the fact that some American manufacturers use Japanese tubes, so that higher duties would drive up prices for that segment of the U.S. industry.

Airline anti-hijack sensors demanded by Congress

Pressure for better anti-hijack screening devices is being generated by both houses of Congress in a bill (S 2280) calling on the administrator of the Federal Aviation Administration to see that all passengers and all property intended to be carried in aircraft cabins be screened by weapon-detecting devices. The bill says the FAA must furnish devices within the U.S. and would provide $5.5-million for their purchase.

Capital Capsules: The Federal Communications Commission has proposed a rule to permit **splitting of channels in the aeronautical radio navigation band** because of frequency shortages in congested areas. Most aircraft avionics would work in a 50-kHz environment under the new rule, the Federal Aviation Administration says, except for glide-scope receivers, which would have to be replaced. . . . The House Committee on Science and Astronautics has issued a new report on **spinoff dividends from space.** It's available from the committee, Rayburn Building, Washington, D.C. 20515. . . . The Pentagon says no decision has yet been reached on whether to **accelerate the Trident-missile submarine program,** despite charges by Sen. William Proxmire (D-Wis.) that the planned number has been increased from 10 to 16.

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INFORMATION RETRIEVAL NUMBER 26

Endangered Species

(Watch out punched tape, here comes a better alternate)

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Save yourself from the slow, noisy, messy punched tape bird today. Go CartriFile.

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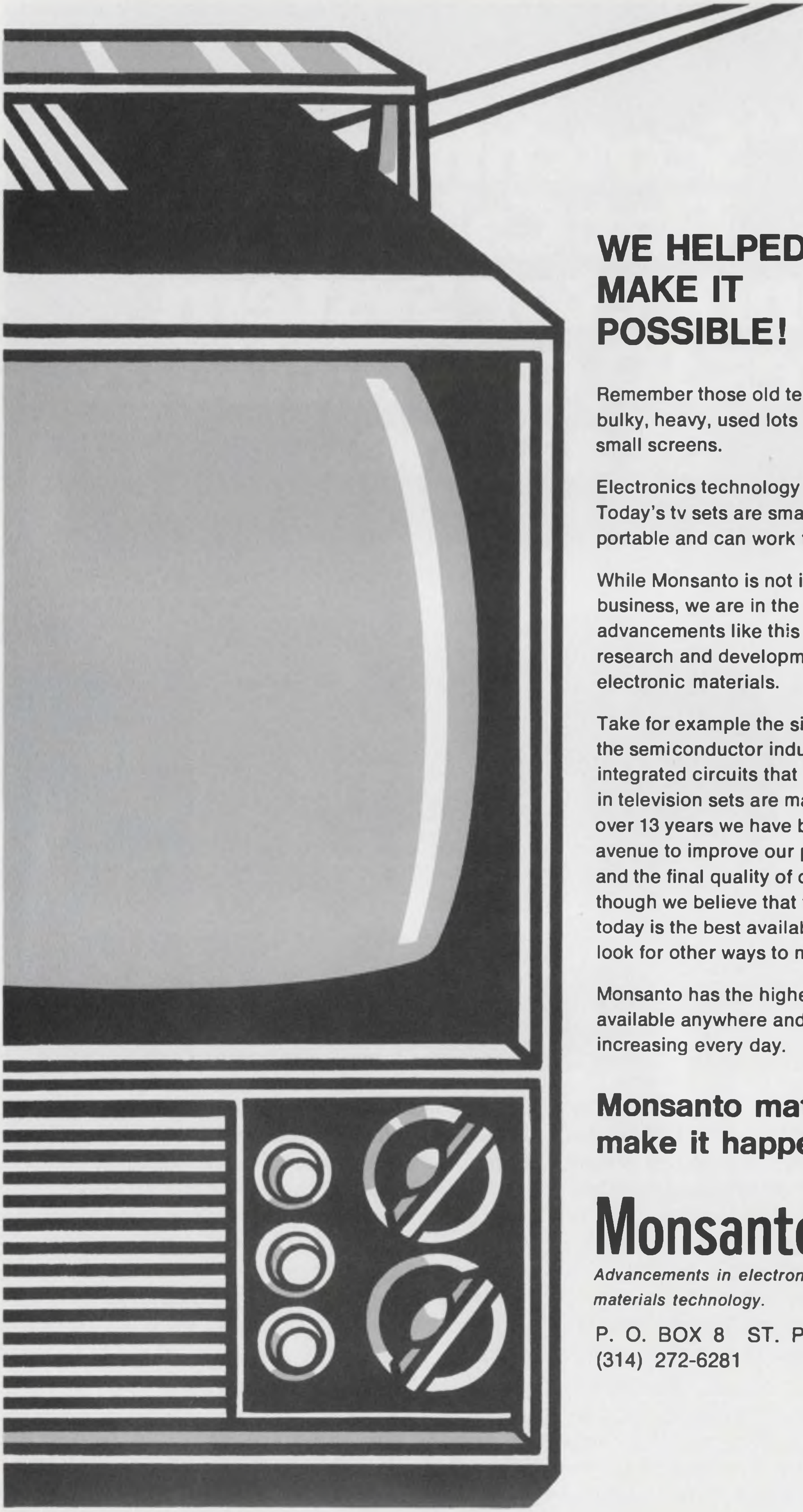

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It can become four different systems.
It can go anywhere you do.
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It can make buying and maintaining a counter less expensive than ever before.

Meet the Hewlett-Packard 5300, the snap-together counter that's not much bigger than the palm of your hand. It has six digit accuracy, solid-state display and autoranging. It'll make period, frequency, time interval and ratio measurements, operate on its optional snap-on battery pack and drive a printer. Rugged dust-proof aluminum case resists almost any bumps it might get in the field. Prices start at only $540 for one of the most amazing counters you've ever owned.

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10 MHz frequency module. Model 5301A, $145.

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100 ns time interval module with: unique "time holdoff" feature, dc coupling, slope and trigger level controls, and period and frequency measurements to 10 MHz. All the functions you'd pay $1200 for in a universal counter. Model 5304A, $325.

Rechargeable battery pack module works with any of the other modules for cord-free operation. Model 5310A, $195.

The 5300 is one system you have to use to appreciate. If you've ever needed to accurately measure frequency or time interval, you owe it to yourself to call your nearby HP field engineer for further information. Or write Hewlett-Packard, Palo Alto, California 94304; Europe: P.O. Box 85, CH-1217 Meyrin 2, Geneva, Switzerland; Japan, Yokogawa—Hewlett-Packard, 1-59-1, Yoyogi, Shibuya-Ku, Tokyo, 151.

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Frequency	dc to 160 MHz	1 MHz to 160 MHz	10 kHz to 110 MHz
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Output Level	+20 dBm	+13 dBm	+13 dBm
Spurious	−80 dB	−70 to −100 dB	−80 dB
Phase Noise	−63 dB	−60 dB	−50 dB
A-M, FM Capability	standard	no	optional
Search-Sweep	standard	no	optional

Data current as of August, 1972

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For computer-controlled systems or in applications that require special controls, often remote from the instrument, who needs a panel full of knobs? In systems that already include a standard reference oscillator, why buy another one? Where a resolution of only 5 digits is required, why pay for 10?

Of course one man's ornament may be an other man's necessity, so we offer an array of options to tailor the 1061 to **your** needs: a full control panel, two different internal reference oscillators, resolution to 10 digits, and phase-modulation capability. We don't offer, as options, search-sweep, a-m and fm capability, wide frequency range, fast switching speed, complete programmability, high output, and low spurious and phase-noise levels — they're all standard, starting at $4700.

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Built better. Performs longer. Costs less.

Wire windings are OUT, conductive plastic is IN for high performance audio controls. With its new Series 300 SLIDELINE™, Duncan Electronics replaces noisy, rough and "grainy" wire elements with smooth, noise-free RESOLON® conductive plastic which actually *improves with use!*

RESOLON elements and precious metal wipers used in all Series 300 controls bring consistent low-noise operation and superior performance to linear motion faders for broadcast and recording. *And, the cost is less than many high grade wirewound controls of the past!*

Series 300 is offered in 6 different stroke lengths and features longer life of 10 million traverses minimum, infinite resolution and linear, audio and constant impedance outputs for every audio need!

Dual channels can be contained in a standard single housing only 13/16" wide — *the most compact dual attenuator available to the industry.* Two dual units can be coupled and driven by a common knob to create 4 channels for master controls or quadrasonics.

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INFORMATION RETRIEVAL NUMBER 32

editorial

When the competition isn't the problem

One of the ironies of business is that companies often get themselves in more trouble than any their competition can cause. Internal bickering and poor planning have probably hurt some electronics companies more in the marketplace than the other fellow's product.

No company, of course, is going to operate indefinitely without a hitch. But a few problems common to electronics companies are open to solution if management will take the time to assess their potential danger. They include these:

- **Unbending company tradition that alienates engineers and dissipates their contribution.** Broad solution: Flexible company procedures that complement employees' abilities.
- **Engineers who work independently of company goal's.** Broad solution: The setting of company priorities, with guidelines for engineers.
- **Allowing a project to continue past the point of profitability.** Broad solution: Development by manager and the marketer of the art of knowing when to kill a project. And recognition by the engineer that he is not a scientist, whose function is to push forward the frontiers of knowledge; he makes things that people can use and that will sell.
- **Manufacturing departments that accept designs as gospel.** Broad solution: A requirement that designers prove the worth of their designs instead of imposing them on manufacturing.
- **Managers who feel they must be technically superior to their staff.** Broad solution: Recognition that the manager's main function is that of a catalyst to stimulate project members. He brings to the project more over-all experience than any other staffer. He need not feel that to motivate his people he must be more technically competent than they are.
- **The assumption that a company merger will solve all major problems.** Broad solution if it doesn't: Recognition that the merged companies may have different goals. Selling a capability and selling a product, for example, require totally different approaches to marketing, project management and engineering. Use of a management committee to air grievances can be helpful in this case.

There are many more problems certainly, but you get the idea. Usually the key to their solution is taking the time to talk it over, to see if company policy is keeping pace with the times. One of the managers interviewed by ELECTRONIC DESIGN put it this way: "You can waste a lot of time doing things right, when you should be looking for the right things to do."

Richard L. Turmail

RICHARD L. TURMAIL
Management Editor

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If you've been designing with 54/74 series TTL (standard or low-power) and would now like to design with CMOS, we've greatly eased the procedure.

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CMOS, NATIONAL STYLE

Part Number	Function	Availability
MM74C00/MM64C00/MM54C00	Quad 2-Input NAND Gate	Now
MM74C02/MM64C02/MM54C02	Quad 2-Input NOR Gate	Now
MM74C04/MM64C04/MM54C04	Hex Inverter	November
MM74C10/MM64C10/MM54C10	Triple 3-Input NAND Gate	Now
MM74C20/MM64C20/MM54C20	Dual 4-Input NAND Gate	Now
MM74C74/MM64C74/MM54C74	Dual "D" Flip-Flop	Now
MM74C73/MM64C73/MM54C73	Dual J-K Master-Slave Flip-Flop	October
MM74C76/MM64C76/MM54C76	Dual J-K Master-Slave Flip-Flop	October
MM74C107/MM64C107/MM54C107	Dual J-K Master-Slave Flip-Flop	October
MM74C95/MM64C95/MM54C95	4-Bit Parallel-In/Parallel-Out Shift Register	December
MM74C160/MM64C160/MM54C160	Synchronous Decade Counter	November
MM74C161/MM64C161/MM54C161	Synchronous 4-Bit Binary Counter	November
MM74C162/MM64C162/MM54C162	Fully Synchronous Decade Counter	November
MM74C163/MM64C163/MM54C163	Fully Synchronous 4-Bit Binary Counter	November
MM74C195/MM64C195/MM54C195	4-Bit Parallel-Access Shift Registers	November
MM74C173/MM64C173/MM54C173	Quad Latch	December
MM74C151/MM64C151/MM54C151	8-Bit Data Selections/MUX with Strobe	December
MM74C157/MM64C157/MM54C157	Quad 2 Line to 1 Line MUX	February
MM74C42/MM64C42/MM54C42	BCD-to-Decimal Decoder	December
MM74C154/MM64C154/MM54C154	4 to 16 Line Decoder Demultiplexer	January
MM74C192/MM64C192/MM54C192	Synchronous Up/Down Decade Counter	February
MM74C193/MM64C193/MM54C193	Synchronous Up/Down 4-Bit Binary Counter	February
MM74C164/MM64C164/MM54C164	8-Bit Parallel-Out Shift Register	January
MM74C165/MM64C165/MM54C165	Parallel-Load 8-Bit Shift Register	February
MM74C123/MM64C123/MM54C123	Retriggerable Monostable Multivibrator	January
MM74C200/MM64C200/MM54C200	256 Bit RAM	2nd Qrtr 1973
MM4601A/MM5601A	Quad 2-Input NOR Gate	Now
MM4602A/MM5602A	Dual 4-Input NOR Gate	Now
MM4609A/MM5609A	Hex Inverter Buffer	Now
MM4610A/MM5610A	Hex Non-inverter Buffer	Now
MM4611A/MM5611A	Quad 2-Input NAND Gate	Now
MM4612A/MM5612A	Dual 4-Input NAND Gate	Now
MM4613A/MM5613A	Dual "D" Flip-Flop	Now
MM4623A/MM5623A	Triple 3-Input NAND Gate	Now

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FOCUS on Comparator ICs

A halfway IC—linear at its input and digital at its output—the voltage comparator (not to be confused with the digital comparator) shares problems with both worlds. In its simplest form it accepts two analog inputs and delivers a ZERO or ONE output, depending on which input is larger. It can be regarded as a basic, one-bit, analog-to-digital converter, and thus finds itself in a broad range of circuits.

It appears, for example, in a/d converters, sense amplifiers, pulse shapers, line receivers, lamp and relay drivers, logic converters and—in the analog world—peak, zero-crossing, threshold and other level detectors, discriminators and oscillators.

It's almost as universal as the operational amplifier. And therein lies one of its problems. The choice between the two may not be simple. In low-speed applications, the op amp, generally a lower-cost component, can replace the comparator. But cost savings are often wiped out by additional components needed to interface with logic circuits.

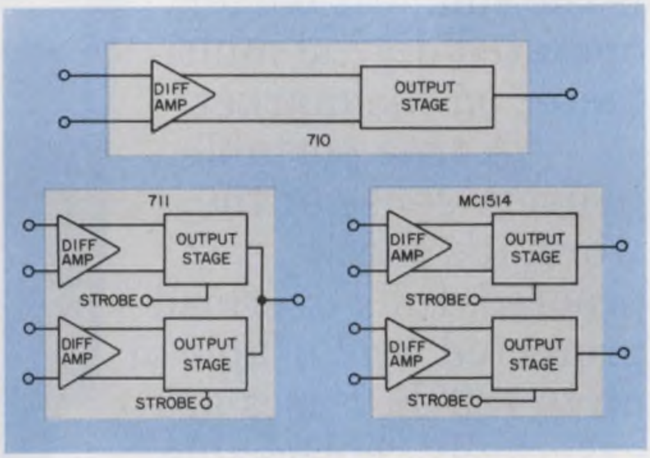
Op amps vs comparators

In some cases the op amp, often frequency-compensated for stability, is a better choice, because comparators—which are generally wideband, high-gain devices designed for speed—have an unpleasant tendency to produce rf oscillations. A tiny stray capacitance can cause instability.

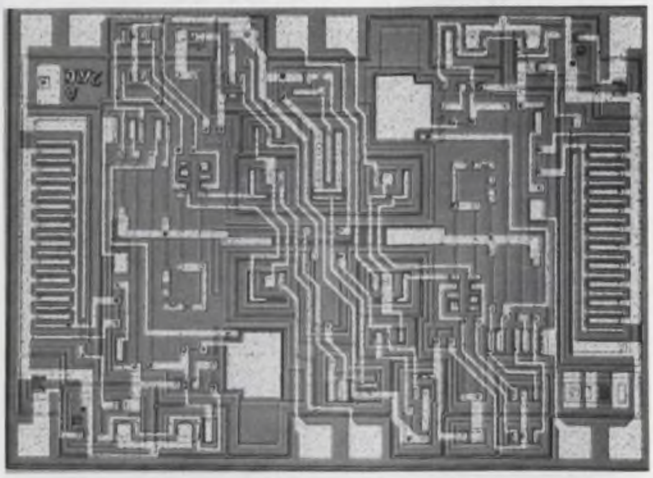
So the op amp is sometimes a better choice, sometimes worse. There are some key differences between the two devices:

- Comparators are designed primarily for open-loop operation. Op amps are usually internally compensated for operation with various

Michael Elphick
Managing Editor



Dual versions of the popular 710 comparator can be strobed on either channel independently. The 711 has a wired-OR output, while Motorola's MC1514 is a true dual with separate outputs for each channel.



National Semiconductor's new LM119 is a dual precision comparator. It has faster response than the LM111 and lower input currents than the μA710. Unlike other dual comparators, it can operate from a single +5-V supply or from symmetrical positive and negative lines.

amounts of negative feedback.

- Comparators usually have larger bandwidths and smaller propagation delays than op amps.
- Comparators have output stages designed for logic compatibility or, in some cases, for driving single-ended loads, such as relays and lamps. Op amps provide large linear and bipolar output swings.
- Comparators usually have greater input dynamic range than op amps.
- Comparators frequently have larger input-offset voltage and current drifts than op amps do.
- Comparators, especially the very fast ones, usually have lower input impedances and higher bias currents than op amps do.
- Comparators often require awkward, asymmetrical, power-supply voltages and, in some cases, a third voltage to power the output stage.

Understanding comparator specifications

Not only are comparators and op amps designed for different applications, they are also specified differently, posing several problems.

First, the specs don't always have the same definitions as they do for other devices. "Offset voltage," for example means one thing in an op amp and something else in a comparator. Comparator specs often use digital, rather than analog, terminology. Thus one is more likely to know a comparator's "propagation delay" than its "bandwidth" or "slew rate."

Second, comparator characteristics often interact in unexpected ways. Gain can affect offset voltage; load current can affect input impedance; input overdrive can affect response time. Most data sheets include about a dozen graphs to characterize a comparator.

Third, different manufacturers have different ways of measuring some characteristics.

In choosing a comparator, an engineer usually has two major factors to consider: accuracy and speed. He will also have to consider other factors such as logic compatibility, power-supply requirements and price. Let's look first at those comparator characteristics that determine accuracy.

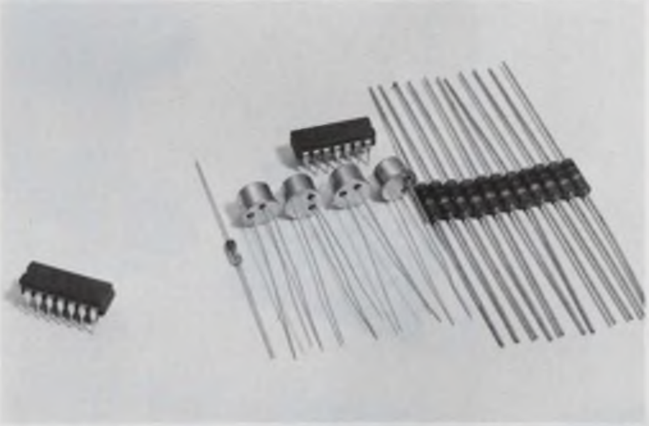
What are the accuracy factors?

It would be convenient if data sheets listed a single figure of merit for accuracy. It would tell us the minimum differential input voltage that a comparator detects reliably. But there is no such specification. The characteristic that comes closest to fulfilling this need is input offset voltage. Most companies list offset voltage on their data sheets, and, usually, the comparators with the lowest offset voltages have the best resolution—though not necessarily the best stability.

Offset voltage doesn't have quite the same meaning for comparators as it does for op amps. For op amps offset voltage is usually the differential input voltage that must be applied to produce zero output. For comparators, it's commonly the differential input voltage that produces some nonzero output voltage—usually one of the two logic levels.

A comparator's accuracy is primarily controlled by two factors—the true offset-voltage error and the gain error (the amount of signal required to cause the comparator to switch). As defined by most manufacturers today, "input-offset error" accounts for both of these error terms—not just offset.

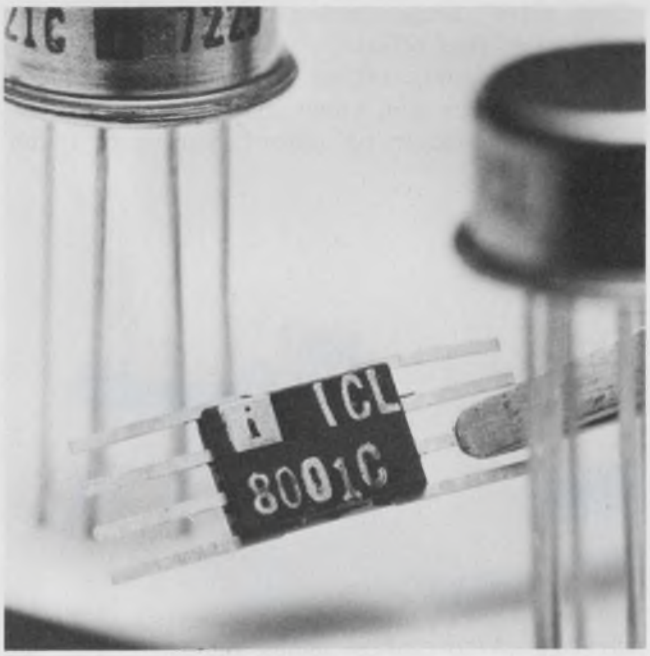
When IC comparators were first introduced about six years ago, offset and gain error were specified separately by manufacturers in much the same way as for op amps. But as manufacturers produced newer comparators with higher gains, gain became a negligible source of error and offset voltage was redefined to include the limitations on resolution caused by finite gain. Note, however, that not all manufacturers measure offset voltage in the same way. If a manufacturer's comparator has low offset error but low gain, he may choose to define the two error terms separately in the hope that the gain error will be overlooked. Thus it pays to read the definitions of offset voltage and to ask manufacturers how they measure it.



Fairchild's μA750 dual-comparator subsystem (left) can replace (right) a conventional dual comparator, 11 resistors, four transistors and one zener diode. The monolithic circuit includes two independent high-current comparators, a voltage reference and circuitry for hysteresis control and overload protection.

A few trial calculations can usually put the various error sources in perspective and determine their effect in a specific application. For example, Robert Dobkin, director of advanced circuit development for National Semiconductor, argues that gain is a relatively unimportant spec, because comparators are normally operated with some overdrive. He assumes an application that requires monitoring a level of 3 V and producing a logic output if the signal exceeds 3.1 V. If one then assumes very large gain and ±5 mV offset, the comparison can occur anywhere between 3.095 and 3.105 V. Yet if the gain were, say, only 2000 (with a 4-V output swing) there would be an additional error of only ±2 mV. The total error would still be less than 0.3%.

An opposing argument is presented by Jerry Zis, product marketing manager for Precision Monolithics. He considers an example where a comparator has an input resolution (gain error)



Intersil's 8001 precision comparator is now available in the company's tiny Pico Pak case, which is half the size of the smallest flat packages. Analog Devices also sells this comparator—as type AD351—but not in the miniature flat package.

of 0.5 mV and an offset voltage of 2 mV. Then the effective error band amounts to 2.5 mV, which Zis says would not be adequate for a precision application, such as a 12-bit a/d converter. Zis concludes that a separate "input-resolution" spec is often a coverup for poor gain in some so-called "precision" comparators.

As with op amps, it is possible externally to null out a comparator's offset voltage. This technique isn't as useful as might appear, however, because comparators with high offset voltages tend also to have high offset-voltage drifts. Nulling the voltage won't null the drift. Also one should be aware of unspecified interactions. For example, with some comparators, input offsets and their drifts depend on the output load.

Another application pitfall that can cause a deterioration in accuracy is exceeding a comparator's common-mode voltage range. The common-mode limits are specified on most data sheets, but they are often overlooked by comparator users. If the input voltages exceed the specified range, a comparator won't work correctly. The offset voltage and input bias current may be much higher than expected.

Perhaps one reason why engineers sometimes exceed the common-mode range is that they confuse it with the absolute input-voltage limits. Surprisingly, however, there are also frequent instances where the absolute maximum ratings are exceeded. In industrial applications, it is not unusual for comparators to be subjected to high-voltage spikes or leakage from a 115-V ac line under fault conditions. Comparator manufacturers could help here by designing circuits with internal overload protection or by specifying suitable protection circuits in their data sheets.

Another application pitfall involves input impedance. At high frequencies, the input impedance won't be the same as at low frequencies. If it turns out to be substantially lower than expected, serious errors will result due to input currents. Most manufacturers specify input resistance rather than input impedance. Those who do specify impedance sometimes fail to mention the frequency at which it is measured.

Does it have the required speed?

One of the most serious areas of confusion is speed. Most data sheets define speed in the form of a "response time" or "propagation delay." The problem is that not all companies measure this in the same way, so it becomes difficult to compare the speeds of different comparators.

There can be large variations in response time when it is measured differently. So this area is fertile ground for possible specsmanship. Because comparators are designed like linear amplifiers—not like trigger circuits—response time depends heavily on the amount of overdrive applied to the input. Also, the response time won't be the same for a step input voltage, as it will for a sine-wave input.

The most common way of measuring response time is to use a 100-mV step with a 5-mV overdrive. What this means is that the comparator is initially held off in its saturated state by application of a 100-mV reference voltage at the input. Then a 105-mV signal of the opposite polarity is applied at the input. The output then switches to its other logic state, and the propagation delay is measured from input to output. Usually the test is made with the comparator's offset error externally nulled. Some manufacturers use 95 mV instead of 100 mV for the reference voltage. The effect of this probably isn't too significant. But if a comparator is saturated with a very high voltage—say, 5 V—it will probably take longer to recover. One comparator has typical response times of 90 ns for a 100-mV step and 135 ns for a 5-V step—both with 5-mV overdrive.

This testing method has the advantage that it's fairly well standardized among comparator manufacturers, so it does allow one to judge the relative speeds of different types of comparators. But the method has the serious disadvantage that it doesn't accurately represent the actual conditions under which comparators will be operated. It's not likely that comparators will always be operated with stepped inputs, nor is it likely that they will be operated with exactly 5 mV of overdrive.

Because response time varies with overdrive, and with other variables such as temperature and load current, most manufacturers now include curves in their data sheets to show the effects of these interactions.

Questions about speed measurement

Another method for testing response time is to apply a sinusoidal differential input—for example, a 10-MHz signal with a peak-to-peak amplitude of 30 mV. This method is especially popular with manufacturers whose comparators have such poor resolution that they can't show their paces under the usual test conditions. These manufacturers can legitimately argue, however, that their test method is more representative of the actual operating conditions for high-speed comparators. The best way to resolve these arguments, and to give the user all the information he needs, would be for manufacturers to list response times for both test methods. One company, Fairchild, is already doing this, so others may soon follow suit.

Often comparators have different response times for positive and negative step inputs. Most manufacturers list only one of the two response times, but some are now listing both. Usually the difference in propagation delay for positive and negative steps is quite small—less than 20% —but in such applications as zero-crossing detectors the resulting asymmetry could cause errors.

Another question regarding response-time measurements is this: Which parts of the input and output pulses does the manufacturer use for his time measurements? Some vendors don't tell you, others use the 50% amplitude points, while others use the 10% and 90% points. Also the output logic levels themselves are often poorly defined. Some companies claim TTL levels, but they don't guarantee the voltage and current limits that one would expect for true TTL compatibility. Furthermore you should see if a comparator needs external pull-up resistors to achieve its specified response time and fanout. Because these resistors dissipate a lot of power, many comparator designers leave them off the chip. But this isn't always clearly spelled out on the data sheet.

To overcome the limitations of existing comparator specs, industry specialists have proposed some new specs. Zis of Precision Monolithics advocates a spec called "input slew rate," pioneered by his company. This is defined as the maximum rate of change in differential and/or common-mode voltage that the input stage can follow. Zis says this characteristic is important because fast comparators are often called upon to handle widely varying voltages—like those at the input of a multiplexed a/d converter.

In a tacit admission that most comparators are unstable at least part of the time, Joel Scheinberg, Fairchild's marketing manager for analog products, says that manufacturers should define frequency stability. This, he says, could be done by specifying an input range over which the comparator's output is unstable.

Tradeoffs between performance characteristics

Fundamental design tradeoffs make it extremely difficult to produce a comparator that is fast while offering simultaneously good input characteristics and versatility—such as the ability to operate from a single supply line over a wide range of supply voltages or with diverse output loads. While some companies have circumvented many of the tradeoffs to produce devices with impressive all-around performance, these comparators still can't match the speed of the front runners.

From the viewpoint of the user, however, a universal comparator may not be desirable. It would probably be more expensive than a comparator that has less performance in some areas. And, more important, it may not work as well as a comparator that's optimized for a specific application. For example, precision comparators are designed to work from high source impedances. But if you needed speed, you would drive the comparator from a low source impedance. Also, fast comparators easily burst into oscillation. So it doesn't pay to use a comparator that's faster than necessary for a given application.

Another reason why comparators tend to fall into two well-defined groups is that different fabrication processes are used for fast comparators and other types. Fast comparators are usually gold doped while other types are not. And recently Schottky-barrier devices have been used in some high-speed comparators.

Gold doping produces faster transistors. But it causes lower breakdown voltages, lower gain and higher input bias current. And it prevents the use of pnp devices, which could simplify the design of comparators that must operate from a single supply line.

Zener diodes are needed for level shifting to avoid the use of saturating stages in high-speed comparators. But because monolithic zeners have 7-V breakdown, this again complicates the design of a high-speed comparator that can operate from a single 5-V supply line. Yet another problem in the design of high-speed comparators is that higher currents are needed to charge the load and various internal capacitances rapidly. But these higher currents boost the internal power dissipation. Dissipation can be reduced and low-voltage operation achieved, while speed is preserved, by a reduction in the amplitude of internal voltage swings in the comparator. But this restriction also limits the input voltage range of the circuit.

Some new comparator designs have circumvented some of the problems by employing Schottky devices for clamping and by reorganizing the circuitry to get away from the "op-amp" approach to comparator design. The Signetics NE529, for example, has essentially three stages—a video amplifier, a high-speed level shifter and a digital output gate. Transistors are Schottky clamped rather than gold doped.

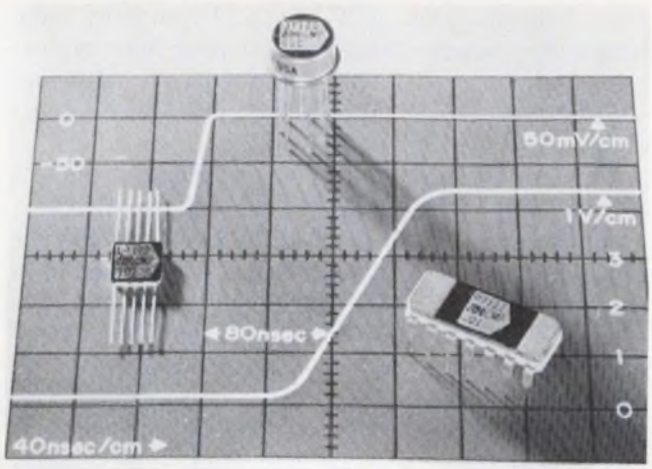
Even the newer design techniques, however, don't avoid all the tradeoffs between speed and other features. There is no panacea. Basically a user must evaluate comparators in terms of speed, accuracy or in combination with other features.

Some important high-speed comparators

About six years ago Fairchild introduced the first monolithic comparator—the μA710. Even by today's standards, the 710 has an impressive combination of specs. Because of its competitive performance and low cost, it remains the workhorse of the industry. Its strong point is speed—it has a typical response time of 40 ns. Its weak point is fanout—it can only drive one TTL gate. Another disadvantage is that it operates from asymmetrical supply lines, +14 V and −7 V. Other specs stack up fairly well against competing devices. Its maximum offset voltage is a low 2 mV, while the offset current is 3 μA. In quantities of 100 up, the 710 costs $2.34, while a commercial version (μA710C) costs only $1.05.

Because of its popularity, the 710 is extensively second-sourced. Other companies offering versions of the 710 include ITT, Motorola, National Semiconductor, Nucleonic Products, Raytheon, Signetics, Silicon General, Solitron, Texas Instruments and Transitron.

Fairchild's dual version of the 710 is the μA711. This has the same 40-ns response time as the 710, but some of its other specs are slightly worse. For example, the maximum offset voltage is 5 mV, while the maximum offset current is 10 μA. The major disadvantage of the 711—in addition to poor fanout—is that it's not a true dual comparator. Though there are two sets of inputs, there is only one output terminal. However, unlike the 710, the 711 can be strobed. Its price is about the same as that of the 710. In 100-up quantities the 711 costs $2.70 for the military version and $1.05 for the commercial.



Precision Monolithics' monoCMP-01 combines precision with speed. As shown in these waveform drawings, the response time with 5-mV overdrive is typically about 80 ns. (The specified maximum is 150 ns.)

Because of the limitations of Fairchild's μA711, other companies, such as Motorola and Texas Instruments, have introduced their own dual versions of the 710. Motorola's MC1514, for example, is a truly dual device with separate output stages for each of the two comparators. Also, it has the same offset specs as the basic 710—not the inferior specs of the 711. In yet another improvement, Motorola has boosted the output sink-current capability so that, unlike the 710, the MC1514 provides true TTL compatibility under worst-case conditions. The price of the 1514 is slightly higher than for the 711. In 100-up quantities, the military version sells for $3.25 while the commercial version (MC1414) goes for $1.17.

National Semiconductor's LM106 retains the 40-ns response time and the input characteristics of the 710, while overcoming most of the disadvantages of the earlier circuit. Unlike the 710, the 106 can operate from symmetrical, ±15 V, power supplies and it can be strobed. It also has a fanout of 10 instead of one. Not only is the 106 compatible with RTL, DTL or TTL logic, it can also drive other loads by switching up to 18 V at currents as high as 100 mA. Thus it is a plug-in replacement for the 710, and it offers greater versatility. In 100-up quantities the LM-106 costs $18, while a commercial version (LM-

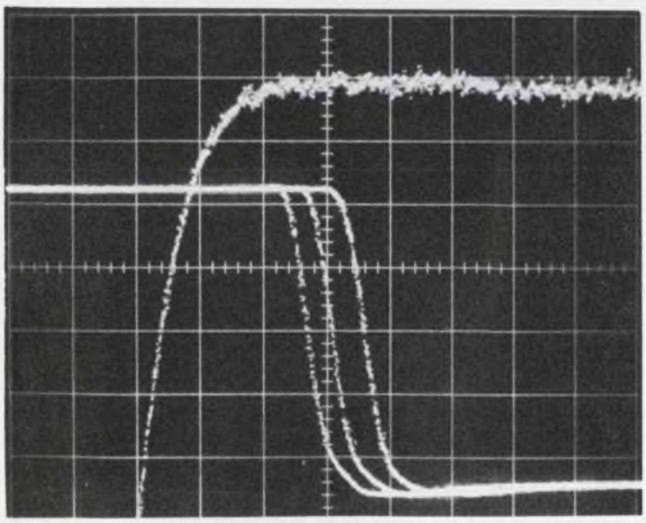
306) costs $6.80.

Other comparators offer faster response than the 40 ns of these devices—but at the expense of other features. For example, Fairchild's μA760 was designed specifically for high-speed operation. Its typical response time is 16 ns, but its maximum voltage offset of 6 mV and its current offset of 7.5 μA are both worse than those of the 710. In 100-up quantities, the μA760 costs $8.83, and the commercial version costs $3.28.

Two very popular high-speed comparators are the Signetics SE527 and SE529. With average response times of 15 and 11 ns, respectively, these comparators were until recently the fastest available. The two ICs are identical, except that the 527 has an emitter-follower input stage to reduce input currents. The 527 and 529 have maximum offset currents of 0.5 and 3 μA, respectively, while the corresponding bias currents are 2 and 12 μA. Both have a maximum offset of 4 mV, and Signetics guarantees the offset to be less than 6 mV over the operating temperature range. Unlike the μA760, the 527 and 529 have strobe capability and can drive ECL logic as well as TTL—though pull-up resistors are needed for ECL. In 100 quantities, the 527 and 529 both cost $4.60, while commercial versions (NE527/529) are available at $2.

The fastest comparator on the market at present is Advanced Micro Devices' Am685. This has a *maximum* propagation delay of 7.5 ns (delays for the other units cited are typical). Unlike other high-speed comparators, the 685 was designed to drive directly 50-Ω ECL lines rather than TTL. Also the 685 has latching rather than strobing capability. Though these features suggest the 685 was tailored for ultra-fast applications, it still has quite good input characteristics. The maximum offset voltage is specified as 2 mV, and the offset current is only 1 μA. Its offset voltage drift of 10 μV/°C, however, is somewhat higher than for most other comparators. In 100-up, the military version costs $20 and the commercial version $8.95.

Soon there may be other, even faster comparators. Motorola, for example, intends to announce its new MC1650 dual comparator during the first quarter of 1973. This IC is already available in sample quantities. Though it hasn't yet been fully characterized, preliminary indications are that it will have a typical response time of around 3.5 ns and an offset voltage of under 5 mV. In sample quantities, the MC1650 costs $30. Production quantities aren't yet available, but the initial 100-up price will be around $20.



Propagation delay depends on input overdrive, as shown in this scope picture for the Advanced Micro Devices Am685. The picture showns transitions to a ZERO output, and the input is a 100-mV step with overdrives of 5, 10 and 20 mV—with the largest overdrive yielding the shortest delay. The horizontal scale is 2 ns/div, and the vertical scales are 5 mV/div for the input and 200 mV/div for the outputs.

Some significant precision comparators

Precision Monolithics calls its monoCMP-01 "the industry's fastest precision comparator." With a typical response time of 90 ns, it falls outside our arbitrary 50-ns cutoff point for *high-speed* comparators, but it is much faster than other *precision* comparators. It has maximum offset voltages and currents of 2.8 mV and 80 nA, and a typical unnulled offset-voltage drift of only 2.2 μV/°C. Its power-supply requirements are extremely flexible. It operates from bipolar supplies (from ±5 to ±18 V) or from a single +5-V supply. The commercial version costs $3.25 in 100-up quantities.

Another Precision Monolithics circuit, the monoCMP-02, trades off speed for precision. It has a typical response time of 160 ns. Though worse than the monoCMP-01, this is still better than other precision comparators, which typically have response times of 200 ns or more. But the input characteristics of the CMP-02 are about the best combination you can get in a monolithic comparator. The maximum offset voltage is a spectacular 0.8 mV, the offset current is only 3 nA (note this is nA not μA), and offset voltage drift is typically only 1 μV/°C. Like the CMP-01, the -02 can operate from a single +5-V supply, and is pin-compatible with other popular comparators, like the LM111. In 100-up, the military version sells for $12 (metal can), and a commercial version goes for $3.25.

The most widely used precision comparator IC is the LM111, originally introduced by National Semiconductor and now extensively second-sourced. The 111 is the workhorse of precision comparators, just as the 710 is the workhorse of high-speed comparators. When it was introduced a couple of years ago, it represented a breakthrough in comparator performance and versatility. Since then, however, newer devices, such as those from Precision Monolithics, have achieved superior performance in many areas. Nevertheless the specs for the 111 tend to be the yardstick against which the performance of other precision comparators is evaluated.

Perhaps the chief reason the 111 gained popularity so rapidly was because of its versatility. It was the first comparator that could be operated from a single 5-V supply—or from ±15 V. This means that it's compatible with analog systems that use op amps or digital systems that use TTL. Other features include a maximum offset voltage of 3 mV, a maximum offset current of 10 nA and a maximum bias current of 100 nA.

What is the offset-voltage drift?

There is some controversy regarding the 111's drift, however. National doesn't specify offset-voltage drift on the data sheet. According to National's applications engineers, the drift is typically ±5 μV/°C. But manufacturers of competing devices cite drift values of anything from 16 to 40 μV/°C for the 111. Jack Gifford, Intersil's director for analog products, says that the LM111 has fundamental design weaknesses that cause excessive drift and also offset uncertainty when the output is loaded. These problems, he says, were eliminated in Intersil's version of the 111. Dobkin of National replies that though there was a design weakness in the first version of the LM111, the problems were eliminated in a redesign a few weeks after the initial introduction. He points out, however, that some companies may have copied the original design, so he can't vouch for the drift performance of second-source versions.

In 100-up quantities, the LM111 costs $12. A commercial version (LM311) costs $3.25. Companies second-sourcing the 111 include Advanced Micro Devices, Fairchild, Harris Semiconductor, Intersil, Microsystems International, Motorola, Raytheon, Silicon General and Texas Instruments.

In addition to the monoCMP-01 and -02, two other precision comparators compete with the 111—though they're not pin-compatible with it. These are Fairchild's μA734 and Intersil's 8001M (also offered by Analog Devices under the type number AD351). They have comparable input specs but lower (and specified) drift. Input-offset drift is typically 2.5 μV/°C for the 734 and 2 μV/°C for the 8001M. In quantities of 100-up, military versions of the μA734 and 8001M cost $8.83 and $11.50, respectively. Corresponding prices for commercial versions are $3.28 and $3.00.

With the newest comparators, there seems to be a trend toward including more circuitry on the chip. There are several dual comparators, and more recently a couple of quad comparators—National's recently announced LM3901 and Motorola's soon-to-be announced MC3302. Also additional circuit features are being added. Fairchild's μA750, for example, includes such on-chip features as a voltage reference, overload protection and hysteresis control.

We can expect continuous gradual improvements in the performance of monolithic voltage comparators. Meanwhile engineers who need better performance should consider the many hybrid microelectronic and discrete-component comparator modules available from companies not surveyed in this report. ■■

Need more information?

This report highlights several important voltage-comparator ICs, but the types and specifications not included may be more significant in some applications. Readers who need more information may wish to consult the manufacturers. ELECTRONIC DESIGN is grateful to the following for their help in furnishing information for this report:

Advanced Micro Devices, Inc., 901 Thompson Pl., Sunnyvale, Calif. 94086. (408) 732-2400. (Leonard Brown, Linear IC Marketing Manager) **Circle 401**

Analog Devices, Inc., Route 1 Industrial Park, Norwood, Mass. 02062. (617) 329-4700. (Stan Harris, Product Marketing Manager) **Circle 402**

Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. 85706. (602) 294-1431. (C. R. Teeple, Product Specialist) **Circle 403**

Exar Integrated Systems Inc., 733 N. Pastoria Ave., Sunnyvale, Calif. 94086. (408) 732-7970. (James Shales, Vice President of Marketing) **Circle 404**

Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. 94040. (415) 962-5011. (Joel Scheinberg, Marketing Manager, Analog Products) **Circle 405**

Harris Semiconductor, P.O. Box 883, Melbourne, Fla. 32901. (305) 727-5400. (Jack S. Kompan, Marketing Communications Manager) **Circle 406**

Intersil Inc., 10900 N. Tantau Ave., Cupertino, Calif. 95014. (408) 257-5450. (Jack Gifford, Director of Analog Products) **Circle 407**

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Microsystems International Ltd., 800 Dorchester Blvd., Montreal 101, Quebec, Canada. (514) 875-2814. **Circle 409**

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Precision Monolithics Inc., 1500 Space Park Dr., Santa Clara, Calif. 95050. (408) 246-9222. (Jerry Zis, Product Marketing Manager) **Circle 413**

Raytheon Co., Semiconductor Div., 350 Ellis St., Mountain View, Calif. 94040. (415) 968-9211. (Al Borken, Linear Product Marketing Manager) **Circle 414**

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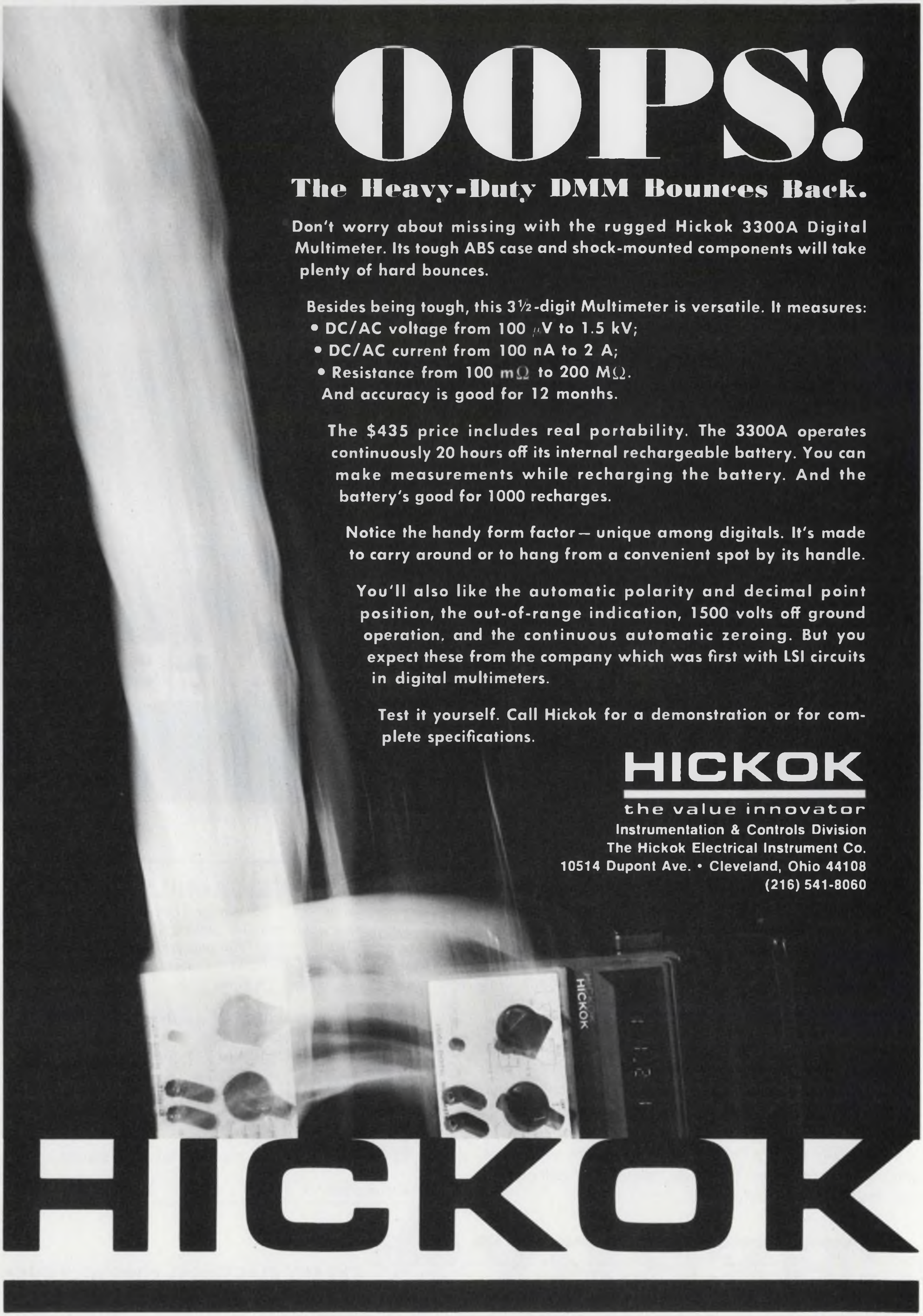

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INFORMATION RETRIEVAL NUMBER 37

Expand programmable-calculators by adding peripherals. You can often top a minicomputer's performance in straight calculating and in automating systems.

Peripherals can overcome many limitations of the manual, stand-alone calculator (Fig. 1). They can reduce dependence on manually keyed inputs. They can overcome the limitation in electronic-display calculators of a single-number output, if many numbers are needed for data evaluation. And they can extend memory size.

Manual input in a stand-alone calculator can cause operator fatigue, with resulting data-entry errors in lengthy calculations. And it consumes lots of time. The operator is forced to watch the display to determine when he must enter more data. Even under program direction, the calculator stops every time data are needed and transfers control to the keyboard. The operator must enter the data and transfer control back to the program by pressing a GO key.

Large amounts of data make the chances of error high. Finding an erroneous or missing entry can be difficult, and correcting it can be burdensome.

Single-number visual output, another limitation, often forces an operator to write down a number, return control to the calculator, write down another number—and continue this slow process.

But a wide variety of peripherals (Figs. 2 and 3) are available to cope with both the input and output limitations and with the small memories that are soon overloaded as auxiliary devices are added.

Devices that feed data to calculators

Card readers and punched-paper-tape readers are among the more popular input peripherals. Either can supply program instructions or numerical data.

Two types of card readers are commonly used —a mark-sense reader and a punched-card reader. For either marked or punched cards, many readers use a 40-column format with the information in an octal code. The 80-column tab card with a Hollerith code (or other codes) is also very popular. A card reader may either transfer data into the memory of the calculator or operate the calculator directly without intervention of the memory. Many calculators have a built-in I/O connector wired to tie a card reader directly to the calculator's bus.

A two-step instruction is usually required to activate the card reader. The first step selects the appropriate I/O circuit, and the second sets the mode of operation. The card reader directs program control in the run mode, or loads data into memory in the learn mode. In either mode the last reader instruction must be a GO command to return control to the calculator. Then the internal program takes over, or if the original card-reader address was keyboard-generated, control is resumed by the keyboard.

Often it is more convenient to record data on punched paper tape. Most modern tape readers handle eight-level ASCII code. As in the case of the card reader, the tape reader can also often be plugged directly into the I/O bus of the calculator. But first the ASCII code must be converted to the calculator code, and the tape reader must supply its own sequential control circuitry and the means for subsequent return of control to the calculator.

Like the card reader, the tape reader requires a two-step command from either the calculator keyboard or a program stored in the calculator's memory. The first step selects the I/O circuit, and the second causes the tape reader to transfer the information on the tape to the calculator for a learn or run mode. The tape inter-record separator code is often translated into a GO command for the calculator. Control is returned either to the calculator keyboard or program, whichever initiated the tape-reader operation. The calculator's ability automatically to transfer control from calculator to tape and back, permits a user to design programs with iterative loop routines for data entry.

Devices that read data from calculators

In some applications that produce a large amount of output, only a small amount of input

Lowell W. Smith, Market Development Specialist, Wang Laboratories, Inc., Tewksbury, Mass. 01876.

is needed. Manual entry of the data is therefore not always the important limiting factor. In interactive applications, manual entry is a necessity. The operator directly and continually modifies the data or assumptions, and changes, stops or restarts the program.

In fact, the need to display much output data is probably the first roadblock a calculator user encounters. The first peripheral to be added is most often a hard-copy output device. These come in three categories: column printers, typewriters and teletypewriters, and line printers.

Since a hard-copy unit is so frequently the first peripheral, many machines come with a column printer already built in, because it is the easiest and cheapest to add. It not only can list input data for verification and print the output results, but often it also prints the step number, instruction code number and symbol. A disadvantage of the column printer is that its formatting ability is severely restricted. It is confined to printing in columns, and the repertoire of available symbols is limited. Except for a few applications, the column printer is mostly a working tool. Data must be transferred manually to prepared forms if a special format is required.

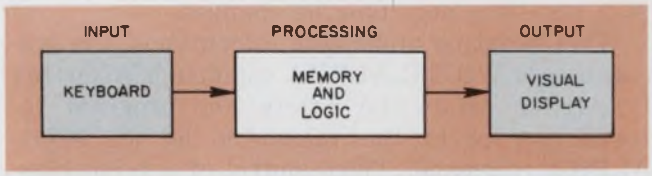
On the other hand, the output typewriter can format in an immediately usable form. The calculator can direct the full complement of typewriter controls and functions, including space, tab, line feed, carriage return, upper and lower case and a programmed quantity of numbers to the left and right of the decimal point.

The basic interfacing for a typewriter consists of the following:

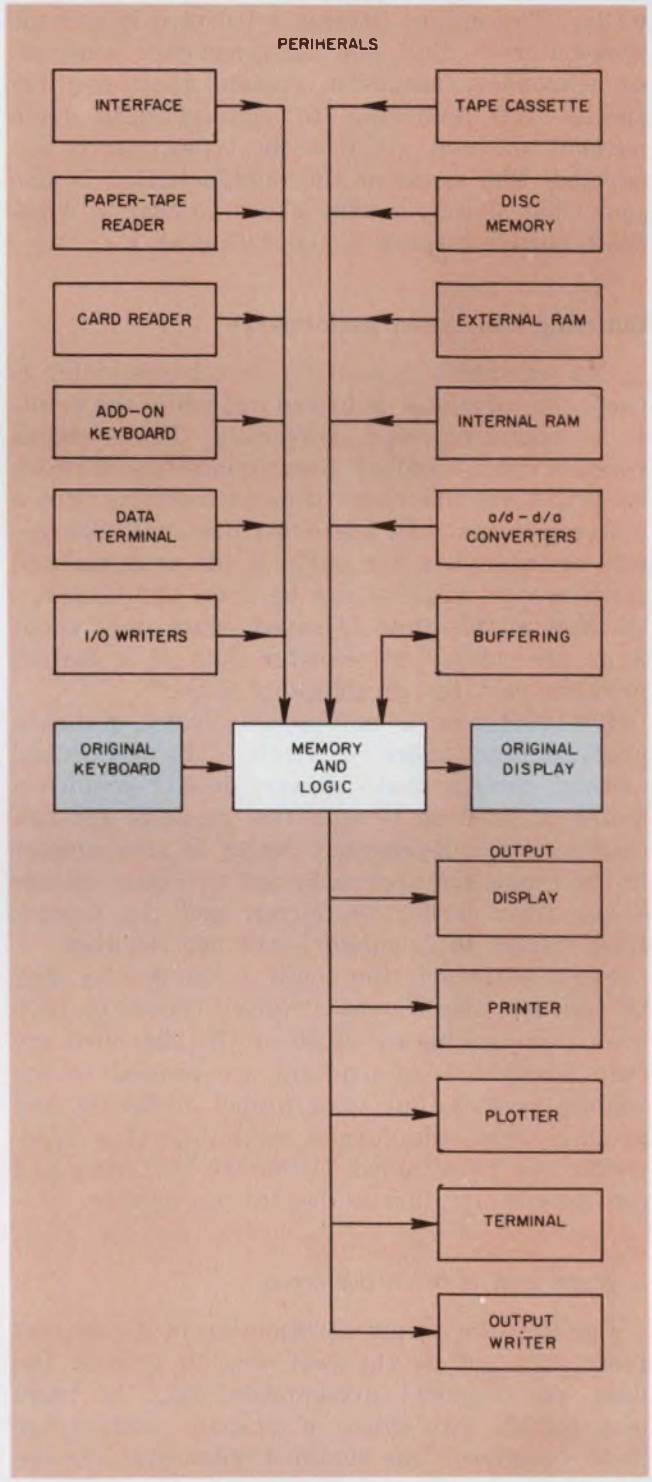
- A micro-programmer that can sequence the typewriter functions.
- A code translator that converts the calculator code into a code (ASCII, Selectric, etc.) that is compatible with the typewriter.
- A coupling circuit for voltage-level matching between the typewriter and the calculator.

In operation, unless a buffer is used in the calculator output, data are temporarily stored in the display registers of the calculator until the printing is complete. A WRITE command in the program activates the typewriter.

When the typewriter is printing numbers, the WRITE command is followed by a format command that designates the number of digits to be placed to the left and right of the decimal. A busy line is also energized to prevent changing the data in the display registers while the typewriter is performing a positioning function, such as carriage return or line index. This signal remains on until all the digits are printed. At the completion of printing, as signaled by a counter in the interface, the busy signal is dropped and control is returned to the calculator for keyboard or further program control. The data in the dis-



1. **The stand-alone calculator** is made up of three major sections. Peripherals can be used to supplement or expand the functions of each section.



2. **An expanded calculator system competes** very effectively with a minicomputer or a data terminal not only in straight computation but also in data processing and logging and dedicated system controls.

play registers may now be changed.

When printing alphabetic information, the system uses a WRITE-ALPHA command. After the typewriter prints the letters, the program returns control to the calculator by an END-ALPHA command. Thus control of a typewriter requires very few additions to a program. And the computation portion of the program, of course, remains unchanged.

Another useful peripheral is the teletypewriter. The major difference between it and the typewriter is that the teletypewriter uses an asynchronous, serial-bit stream that requires special I/O buffering to convert data from parallel to serial, whereas the typewriter is bit-parallel. The speed of the teletypewriter is also somewhat slower, usually about 10 char/s, while the typewriter speed is about 15 char/s.

Buffering can speed performance

But whether a typewriter or teletypewriter is used, the calculator is locked out while the printer is operating—and conversely. The system's speed is output-limited. Great quantities of printed output require much time to complete. But a buffered output can speed performance. Characters are stored in the buffer while printing, and therefore calculations can be done simultaneously. Appreciable time is saved, since only about 8 μs are needed to transfer data to a buffer; printing requires considerably more.

But buffering is not popular, since it makes programming more difficult. The sequential method, though much slower, doesn't require a match of printing time, buffer capacity and calculating time. Equipment design is also simpler in the sequential approach, and two busy signals —one from writer to buffer, and the second, from buffer to calculator—are not required.

For greater printing speed, a line printer may be added to the system. Printing speeds to 1000 lines/min and higher at 80 or 132 char/line are then possible. Line printers are cousins to the column printer, but with proper buffering and programming, the format flexibility of a typewriter can be attained. Often the buffering and control circuitry are built into the printer.

A graph plot is often preferred

Printing the output information in list or text form may not be the best way to present the data. A graphical presentation may be more meaningful. Two types of graphic plotters are most often used: the modified typewriter and the pen plotter.

The modified typewriter, with stepping motors added to position the typing head, is the more versatile—but also more expensive. The X-Y digital locations generated by the calculator are converted to pulses to drive the stepping motors. After the type head reaches its position, a PRINT command activates it to print the desired character. As in the case of typewriter units, a busy signal locks the calculator and keyboard until the positioning and printing operation is completed. Since this system requires a point-to-point incremental signal, the calculator software must include a routine to compute the difference between plotting points from the absolute X-Y location data that the calculator normally provides. The incremental values are then converted to equivalent pulse quantities. Such an incremental plotter can also serve as a conventional output typewriter.

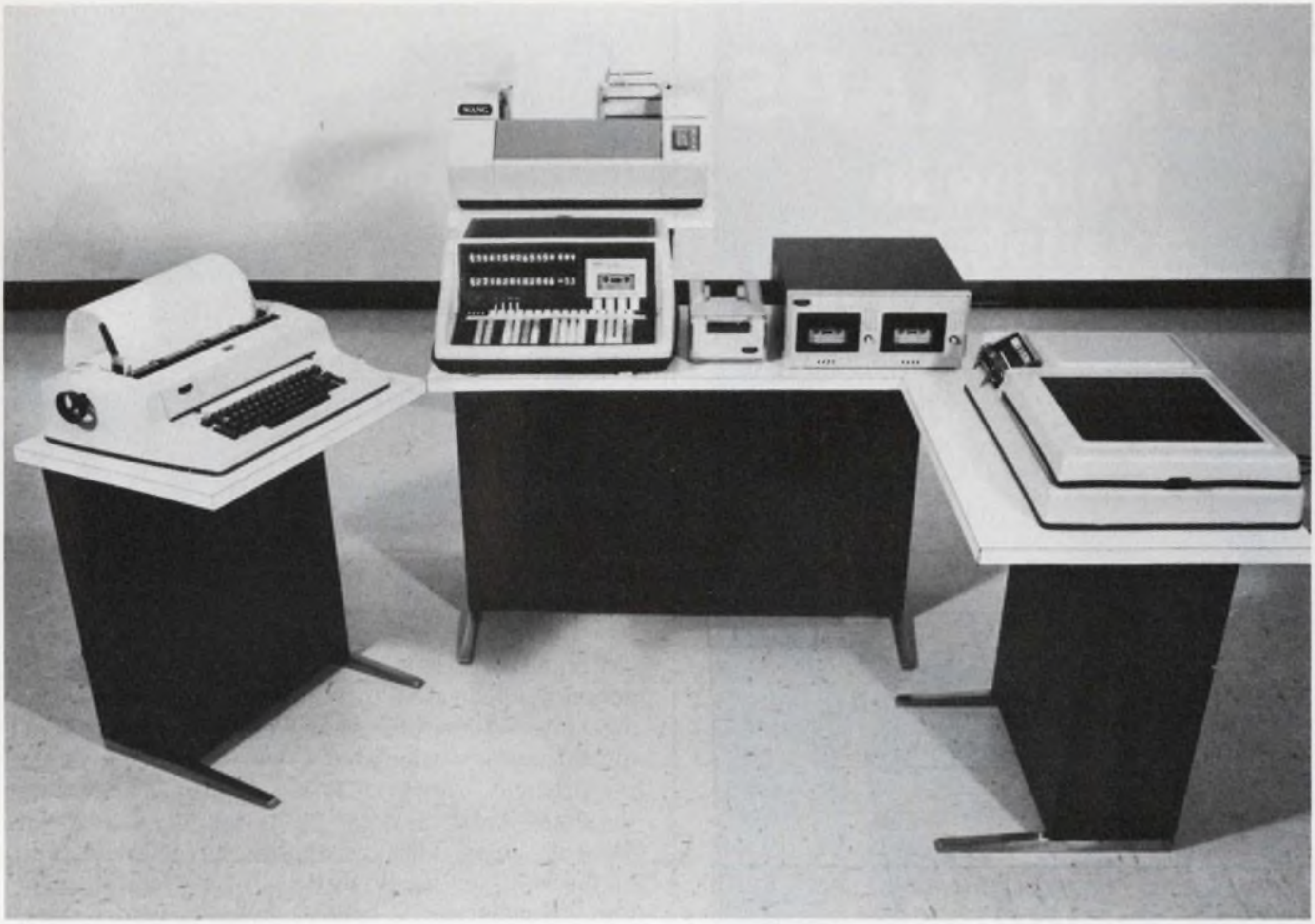
The more popular and more economical device is the analog, single-pen, flat-bed plotter. Here the calculator X-Y digital signals must be converted to analog signals. This d/a conversion circuitry and the necessary scaling adjustments are usually in the plotter. As with other peripherals, a busy signal locks the calculator and keyboard during plotting. The analog plotter can also be programmed to trace out alphanumeric characters, but this is a rather slow process.

For applications such as statistical analysis, where a combined graphic and tabulated output is frequently required, the modified typewriter plotter is the best choice. But where alphanumeric data-output requirements are minimal, the analog plotter can serve well. A still better choice might be to combine an analog plotter and typewriter. Each can then be used to attain the greatest efficiency for a specific application, without need for compromise.

Memory is also expandable

Because calculators use a machine language, they require very specific detailing of each program step instead of the general statements of an assembly language. This means that there are a great many steps in a calculator program, and this is further complicated by the addition of peripherals, since each function of the peripheral must be exactly planned and programmed. The result is that the 500-to-2000-byte calculator memory is soon full. With peripherals, more memory almost always becomes necessary. It can be added internally in many calculators, or it can be added externally in the form of random-access core or semiconductor modules, a tape-cassette unit or a magnetic-disc device.

The addition of an internal memory increases the number of operational storage registers and therefore the number of program steps that can be handled by direct addressing. Added internal memory does not require special programming, because it functions in exactly the same way as



Peripherals such as (left to right) plotting typewriter, line printer (above calculator), mark-sense card reader, dual tape cassette and disc memory—and almost all the peripherals that can be used with a computer—can be used with a calculator. Measuring instruments can supply inputs for data processing and system control.

the original calculator memory. But an external memory, attached to the calculator through the I/O bus, requires the assignment of extra addressing commands and keys. Furthermore external memory can function only as storage. Therefore, for processing, blocks of information must be transferred to the internal calculator memory.

Tapes and discs have long memories

Though slower than core or semiconductor memories, a tape-cassette unit can be added to the calculator for long-term storage of large amounts of data. Long, complex programs can be preserved for future use. The data are organized on the tape in blocks, so that each block is handled in its entirety. When the instructions on a block are completed, the calculator signals an ADVANCE command to the tape to load the next block into the internal memory.

In this way very long programs are broken down and handled in small units. Even so, there are limitations to program length. First, the number of steps in a single block can't exceed the number of steps that the working memory of the calculator can employ at one time. Second, the length of tape on a cassette is limited, though several cassettes can be used successfully. Finally, the operating time for a long program can become excessive, and errors tend to increase with length of programs on many tapes.

Though a single tape cassette serving simply as a source of information is a powerful adjunct to a calculator, the addition of a multitape unit is an even greater asset. It vastly expands flexibility. For instance, a three-tape cassette unit can store the master program on one of the tapes, allow numerical data to be transferred from the second tape into the calculator working memory, as required for arithmetic processing, and record results on the third tape.

The magnetic-disc memory, however, can do this in a single unit with greater data-access speed and greater freedom in data manipulation. Blocks of data can be read or recorded in random order, thus overcoming the sequential constraints imposed by a tape unit. This imposes less of a need for careful planning in program preparation. Many units have replaceable discs. Such units can thus store as much data as tape units can.

Calculators serve as data processing systems in many dedicated applications.

Because a programmable calculator system is generally dedicated to a single, specific task at any given time, the sharing of peripherals by more than one calculator is not usually a system requirement. However it is sometimes desirable to share a large data base that is stored on discs or tapes. Two calculators can share a tape or disc unit by using a special Tee coupling system. If calculator A addresses the memory unit, the circuitry in the Tee sends a busy signal to calculator B, and vice versa. This system of sharing is particularly satisfactory for problems that call for infrequent reference to the memory unit.

Calculators for on-line use

Many users couple a programmable calculator directly to instruments to process and record data while an operation or experiment is in process. Such on-line use is made possible by the calculator's I/O architecture. However, special interface circuits for the instruments are usually necessary. They may often be obtained from the calculator manufacturer, or in some cases the user can design and build his own. Also custom-designed and prepackaged interface systems are available for some classes of instrumentation.

No matter what the source, the interface circuit must perform the following general functions:

- Match the voltage levels to and from the I/O bus of the calculator.
- Translate codes acceptable to both the calculator and the instruments.
- Provide a GO signal to return control to the calculator after data have been transferred. Also, by multiplexing techniques, the interface can greatly increase the number of available input ports for data-scanning applications. ■■

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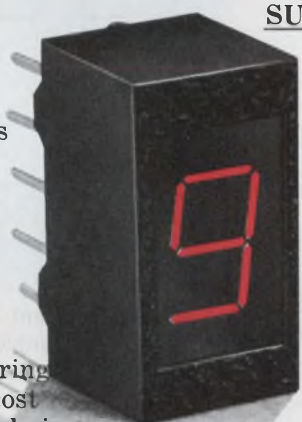

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INFORMATION RETRIEVAL NUMBER 39

Eliminate spikes in dc-to-dc converter

by adding a second transformer. There is no sacrifice in either efficiency or high-speed performance.

High collector-current spikes, always present in conventional dc-to-dc converters that use a single saturable transformer, damage switching transistors, generate electromagnetic interference and keep the conversion efficiency at a low 80%. Reducing the spikes with the usual brute-force method—by addition of a capacitor or a diode across the switching transistors—results in a further decrease in efficiency. But the spikes can be virtually eliminated if a second transformer is added to the dc-to-dc converter.

A look at several two-transformer circuits and examination of the design procedure for a simple two-transformer dc-to-dc converter will show how this can be done.

Nonsaturable transformer eliminates spiking

Collector-current spikes are caused by the saturation of the output transformer (see box). Consequently they can be eliminated if the output transformer is not permitted to saturate.

Referring to Fig. 1a, we see that the output transformer, T_1, does not saturate, so that collector spiking is almost eliminated. The transistors are driven, and the oscillation frequency is determined, by a separate, small, saturable transformer, T_2. The output-transformer design is less critical now, since the transformer never saturates. Also, its efficiency will increase, raising the over-all efficiency of the converter. As is illustrated in Figs. 1b through 1h, both voltage and current spikes are practically eliminated.

Another way to build a converter with a nonsaturable output transformer is to insert a saturating inductor into the switching-transistor base circuit (Fig. 2). Square-loop material is used for the inductor, L_1, and linear magnetic material for the output transformer, T_1.

The design of T_1 and L_1 is such that L_1 saturates before T_1 does. When L_1 saturates, it turns off the conducting transistor, simultaneously turning on the nonconducting transistor.

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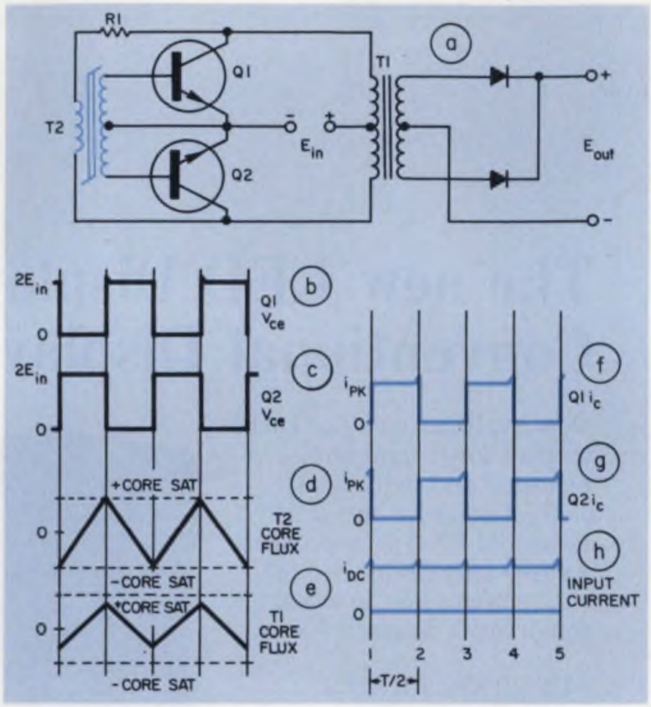
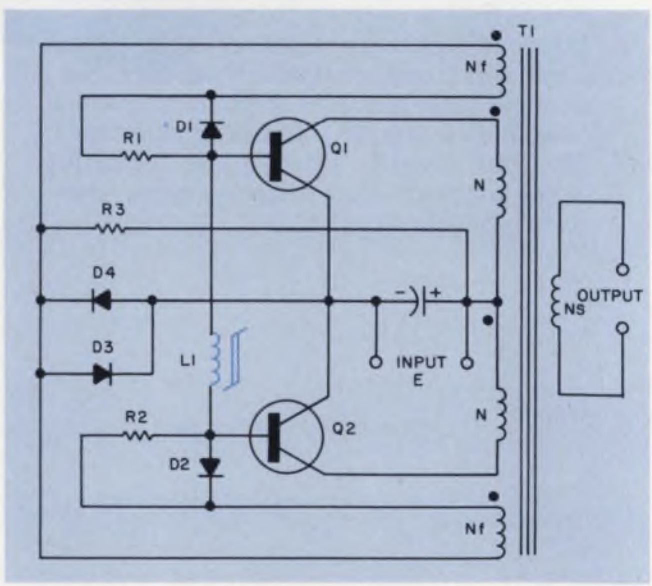


1. **Collector-current spikes are eliminated** when, instead of the output transformer, a second, small transformer, T_2, is driven into saturation.

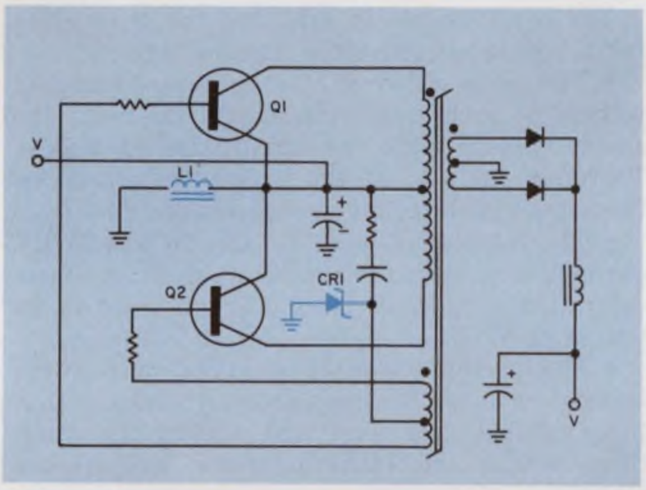


2. **Another way to eliminate spikes** is by inserting a saturable inductor, L_1, into the base circuit.

Diodes D_1 and D_2 insure fast turn-off times for Q_1 and Q_2, and diodes D_3 and D_4 proper operation of L_1. Converter frequency can be set at any desired value by adding or subtracting turns of the L_1 winding.

Another circuit that reduces spiking is called a pseudosaturating converter[1] (Fig. 3). In this circuit, inductor L_1 and Zener diode CR_1 prevent the output transformer from going too deeply into saturation—that is, when the transformer core (a high-permeability material) begins to saturate, the current through L_1 increases rapidly, thus raising the voltage level at the emitters of Q_1 and Q_2. Because of base-emitter capacitances, the bases of Q_1 and Q_2 will follow the emitter until the base voltages are clamped by CR_1. The transistors will then turn off and limit the current into T_1.

Note that L_1 is now in the emitter circuit rather than, as in Fig. 2, the base circuit.



3. **Spikes are reduced** when the output transformer is permitted to saturate only partly by combined action of L_1 and the zener diode CR_1.

Finally a totally new two-transformer converter circuit is shown in Fig. 4. It uses two cores, one within another. The feedback winding is placed on the inner core, while the primary and secondary windings are on both cores. This converter operates as follows:

If it is assumed that Q_1 is on, a positive voltage will be applied from B to A, and the induced voltage at E will—before saturation of the outer core—collapse as the inner core saturates. As voltage E decreases, Q_1 turns off, and the flux in the inner core begins to change in the other direction, turning on Q_2. The latter transistor will remain on until the inner core saturates in this direction.

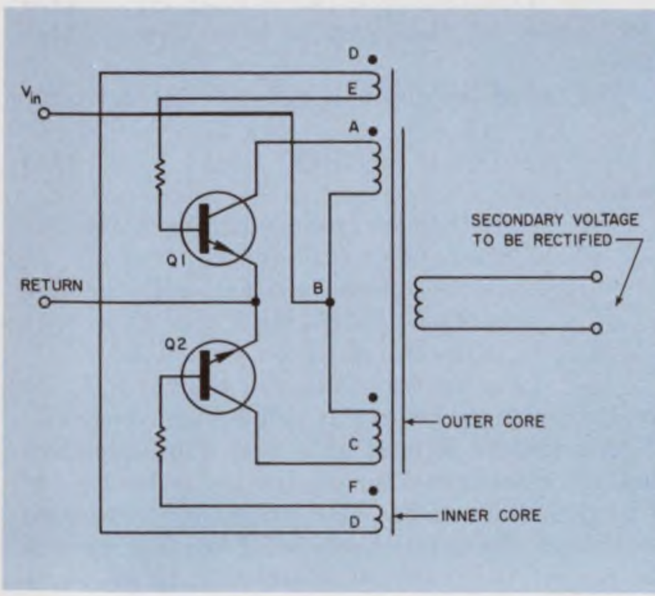
The inner core saturates before the outer because its mean circumference is smaller, while the magnetizing ampere turns are the same. Thus the switching is accomplished without excess magnetizing current and associated losses, thereby raising over-all converter efficiency and greatly reducing electromagnetic interference.

Designing a two-transformer converter

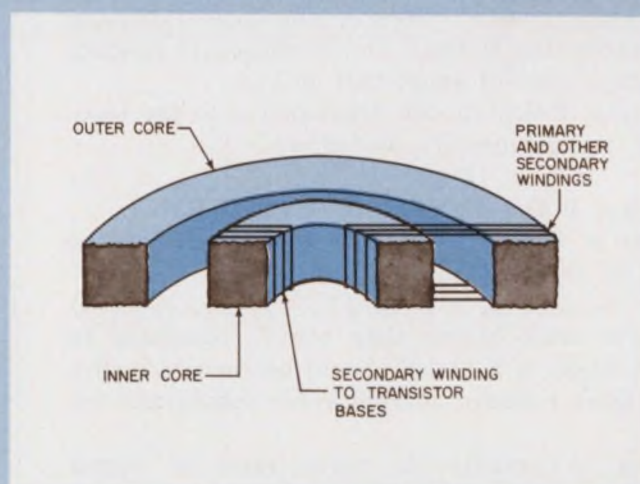
Let's consider now the design procedure for a two-transformer converter (Fig. 5). This procedure can be adapted, if the designer chooses, to build other two-transformer converter circuits[2].

The design of a converter is usually based on the available dc supply voltage, the required output voltage and power, and the ambient temperature that the unit will be subjected to. In addition other requirements might include efficiency, size, weight, operating frequency and stability. The procedure is as follows:

Step 1. Calculate the power delivered to the



4. **A unique two-core transformer reduces spikes** by switching the transistors before the outer core saturates.



The technique improves conversion efficiency and reduces electromagnetic interference.

output transformer, T_1, from

$$P'_{out} = P_{out}/\eta_1, \qquad (1)$$

where P_{out} is the specified converter power output and η_1 is the transformer efficiency (90 to 95%).

Step 2. Estimate transistor collector current for a square wave, I'_C:

$$I'_C = P'_{out}/V_s, \qquad (2)$$

where V_s is the supply voltage.

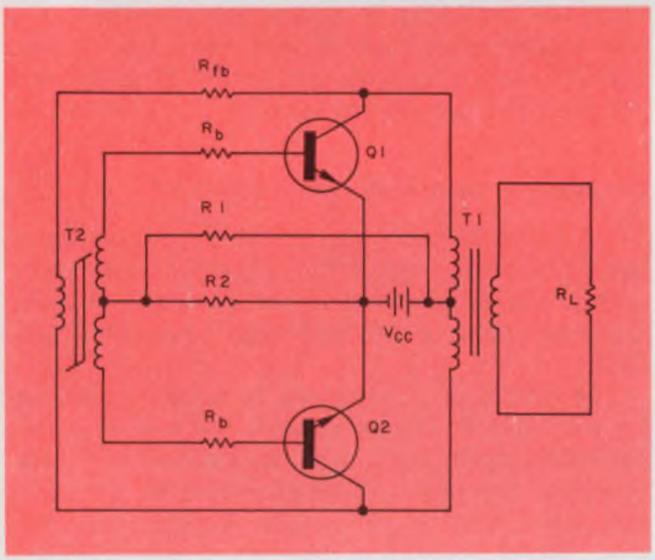
Step 3. Using the manufacturer's value of transistor saturation voltage, $V_{CE(sat)}$—which corresponds to the collector current I'_C, and case temperature, T_c—recompute the collector current as follows:

$$I''_c = P'_{out}/(V_s - V_{CE(sat)}). \qquad (3)$$

Step 4. Compute base-circuit power input as follows:

$$P_{in} = V_{BE}(I''_C/h'_{fe}) + R_B(I''_C/h'_{fe})^2, \qquad (4)$$

where V_{BE} (base-to-emitter voltage) and h'_{fe} are



5. **Design equations are developed** for this basic two-transformer circuit. Note that T_2 uses a rectangular-loop core material, while T_1 has a linear core.

obtained from transistor data sheets for the I''_C and $V_{CE(sat)}$ used in Step 3. The base stabilizing resistance, R_B, is small and is chosen to produce a voltage drop of about half of V_{BE}.

Step 5. Calculate the input power to the base-drive transformer, T_2, as follows:

$$P'_{in} = P_{in}/\eta_2, \qquad (5)$$

where η_2 is the efficiency of T_2 (90 to 95%).

Step 6. Compute the collector current on the basis of the total power:

$$I_C = (P'_{out} + P'_{in})/(V_s - V_{CE(sat)}). \qquad (6)$$

If I_C is much higher than the I'_C computed in Eq. 3, steps 4, 5 and 6 should be repeated, with the higher collector-current value substituted for I''_C.

Step 7. Compute the turns ratio of output transformer, T_1, using the specified load impedance, Z_L, and the reflected impedance, Z'_L:

$$Z'_L = (V_s - V_{CE(sat)})/I_C, \qquad (7)$$

so that the turns ratio for T_1 becomes

$$n^2 = Z_L/Z'_L. \qquad (8)$$

Step 8. In determining the turns ratio of the base-drive transformer, T_2, keep in mind that its primary voltage, V_{pri}, is

$$V_{pri} = V_s - V_{CE(sat)}, \qquad (9)$$

since the value of the feedback resistor, R_{fb}, is usually chosen to drop half of the available voltage. The corresponding primary current is

$$I_{pri} = P'_{in}/V_{pri}. \qquad (10)$$

Step 9. Obtain the turns ratio of T_2 from

$$n = (V_{BE} + I_B R_B)/V_{pri} \qquad (11)$$

where

$$I_B = I_C/h'_{fe}. \qquad (12)$$

This generalized design procedure is deceptively simple. It works—but only if the designer knows how to select the right transistors and the best transformer type for the job, and provided a suitable starting network is included.

Choosing the right transistors

The requirements in selecting the transistors for a high-speed converter include these:

- The peak value of the collector-to-emitter voltage at each transistor should be twice the supply voltage plus the amplitudes of spikes. Therefore the V_{CEO} of the transistors should be twice the supply voltage plus another 20%.
- The transistors must be able to handle the currents to produce the specified power, and their saturation voltages at these currents must be as low as possible for higher over-all efficiency.
- The junction-to-case thermal resistance of the transistors must be low enough to insure that the available heat sink and cooling maintain them within the manufacturer's temperature ratings.

The maximum collector current of the transistors is

$$I_C = (P_{out}/\eta_1)/(V_s - V_{CE(sat)}), \qquad (13)$$

for which all the symbols have already been defined.

The transistor dissipation is calculated from

$$P_D = (T_1/T)\{V_{CE(sat)} I_C + 2I_{CEX}V_s + [(t_{on} + t_f)/T](V_s I_C/3)\}, \qquad (14)$$

where

T is the converter switching period,
$T_1 = (1/2)[T - (t_{on} + t_f)]$,
I_{CEX} is the collector current, with the base reverse-biased (for $V_{CE} = 2V_s$),
t_{on} is the transistor on time at I_C,
t_f is the transistor fall time at I_C,

and all other terms are as defined previously.

Equation 14 is used as a first approximation, and the exact transistor dissipation is determined experimentally later. The transistor saturated switching characteristics should be fast enough to neglect the transient dissipation terms.

The required heat-sink thermal resistance is given by

$$\theta_{ca} = (\Delta T/P_D) - \theta_{jc}, \qquad (15)$$

where ΔT is the permissible junction temperature rise and θ_{ca} is the case-to-air thermal resistance, including mounting, any insulation and heat sink.

Selecting output and base-drive transformers

For a high-speed converter, a ferrite core is best for both the output and the base-drive transformers. The base-drive transformer, T_2, should have a rectangular-loop ferrite core (because it must saturate), while the output transformer, T_1, should use a linear ferrite core. In general, at higher frequencies iron cores cannot compete with ferrite either in performance or cost. Even at lower frequencies, ferrite cores are less costly, because iron must be in the form of very thin laminations. In addition ferrites have fairly constant losses up to about 40 kHz, increasing as $f^{0.1}$, where f is the operating frequency. At frequencies higher than 40 kHz, the losses go up as $f^{0.6}$. Both the rates are much higher for iron cores.

The core of a transformer is selected on the basis of power-handling requirements, frequency and temperature of operation. Temperature is an important consideration, since Curie temperature for many ferrites is low. (Magnetization is zero above the Curie temperature.) Core manufacturer's data sheets usually contain most design information and should be consulted closely.

The basic equation for designing the output transformer is

$$N_p = (V_p \times 10^8)/(4fAB), \qquad (16)$$

where

N_p is the number of turns on the primary,
V_p is the primary voltage in volts,
f is the operating frequency in Hz,

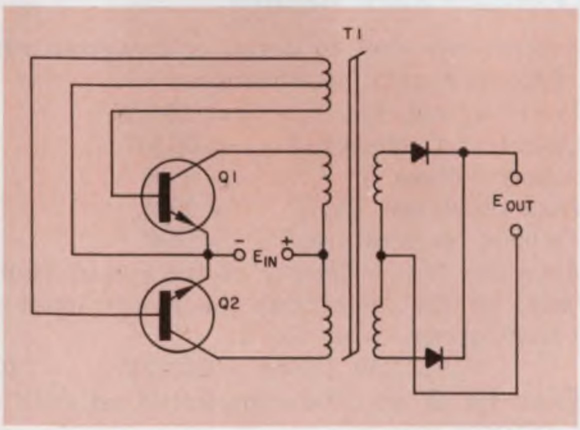
The basic saturable-transformer, dc-to-dc converter:

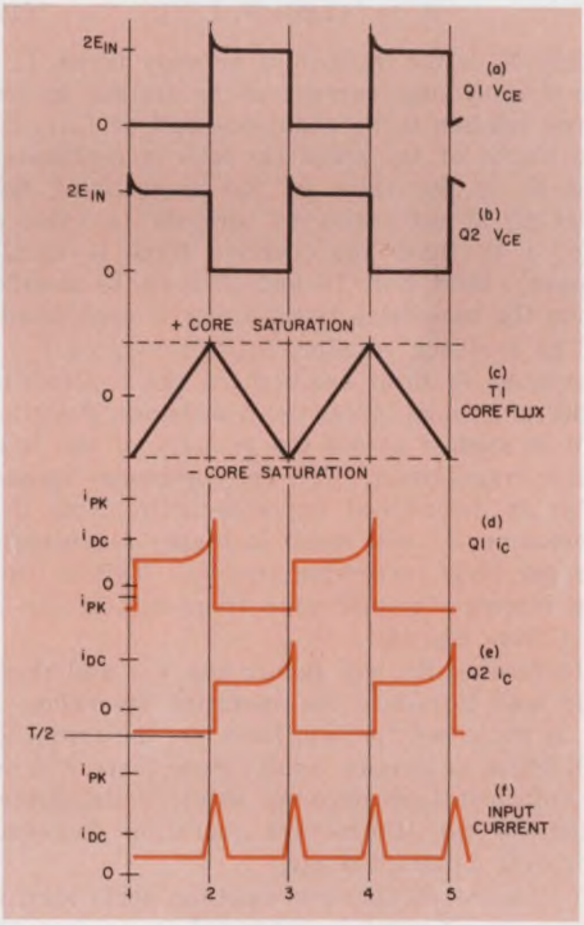
The operation of a self-oscillating converter (see schematic) is as follows: A dc input is chopped by the oscillator into complementary square waves, which are transformed and then rectified to produce the desired dc output. The efficiency of such a unit generally runs at around 80%.

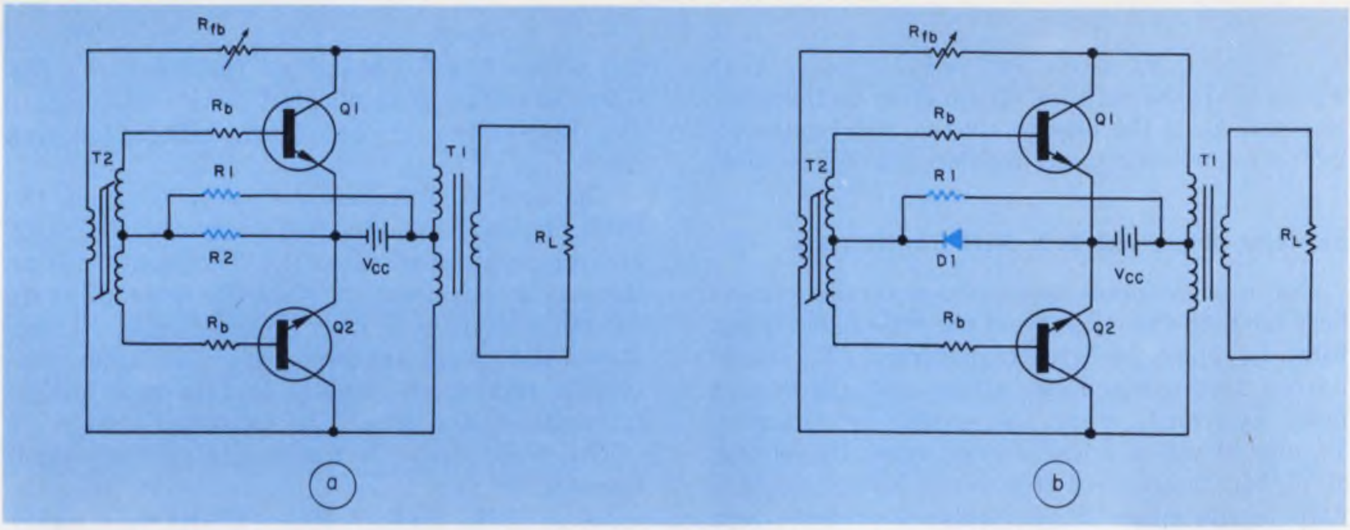
The alternate saturation and cutoff of push-pull transistors Q_1 and Q_2 produces the collector voltages shown in the top waveforms (a and b). The feedback windings of the saturable transformer provide positive feedback to drive the transistors. The voltage drop across the saturated (or ON) transistor is small—typically 0.2 V—so that the voltage across the corresponding half of the primary is nearly equal to the supply voltage.

The primary's voltage remains constant for a half a cycle (c), during which time magnetizing flux builds up steadily. When the core saturates, it tries to maintain its same rate of flux change, causing the magnetizing current to rise suddenly to its peak value. Then the flux-change rate decays to zero, and the voltage across the winding collapses, removing the base drive and turning off the transistor.

The collector-current peaks (d and e), caused by the saturation of the transformer, occur shortly before the transistor turns off. Although short in duration, these spikes produce instantaneous power peaks that are many times the steady-state dissipation. Thus they can cause transistor breakdowns and interference.







6. **Reliable converter starting is insured** either by a resistive divider network (a) or a resistor-diode network.

A is the transformer core area in cm^2 and
B is the flux density in gauss.

The design of the saturable base-drive transformer is a bit more involved than that of the output transformer, because when the transformer saturates, a sharp drop in the applied primary voltage must be produced. Thus the magnetizing current must increase considerably from a small value to one that is comparable to the primary current given by Eq. 10. Because of the saturation requirement, the following equation must be used in addition to Eq. 16 to determine the number of primary turns:

$$H_s = [(1.26)\ N_p I_m]/l, \qquad (17)$$

where N_p is the number of primary turns, I_m is the magnetizing current at saturation in amperes (chosen to be about one-half of I_{pri}), l is the length of the magnetic path in centimeters and H_s is the value of the magnetizing field strength at saturation in oersteds (a value of five to 10 times the coercive force is usually chosen). Both Eqs. 16 and 17 must be satisfied when the base-drive transformer is designated.

The feedback resistor, R_{fb}, for a given I_{pri} is computed to drop one-half of the collector-to-collector voltage across the transistors. The other half is applied across the primary of the base-drive transformer, T_2. The optimum resistor value is determined experimentally. Note that decreasing R_{fb} will result in higher magnetizing current, thus increasing the V_{pri}. This in turn will increase the operating frequency, as can be seen from Eq. 16.

Increasing R_{fb} will reduce the V_{pri} and therefore tend to reduce the operating frequency. If R_{fb} is increased further, however, the frequency will begin to increase again, since there will not be sufficient base drive to saturate transistors. Thus R_{fb} can control the operating frequency only over a limited range.

To insure reliable self-starting, some kind of bias network must be provided to produce the current. There are many possible circuits. Let's discuss two—one with a resistive divider network and the other with a diode-resistor circuit.

Referring to Fig. 6a, we see a resistive starting circuit, R_1 and R_2. The resistor values can be found from

$$R_1 = V_s/I_s$$
$$= V_s/\{2I_B + [(V_{BE} + I_B R_B)/R_2]\}. \qquad (18)$$

Since the denominator in Eq. 18 is equal to the starting current, I_s, R_2 can be determined readily if a starting-current value is assumed. R_1 can then be computed also. Final determination of the starting current is best done experimentally.

Figure 6b depicts a diode-resistor starting circuit. The value of R_1 is found from

$$R_1 = V_s/(2I_B + I_D), \qquad (19)$$

where I_D is the diode current.

As the converter begins to oscillate, the base current flows through the base-emitter junction and through the starting-network diode. To compensate for the diode voltage drop, more voltage should be provided by the T_2 secondary winding. Low-voltage silicon diodes, capable of carrying base current continuously, should be used.

Let's design a 250-W converter

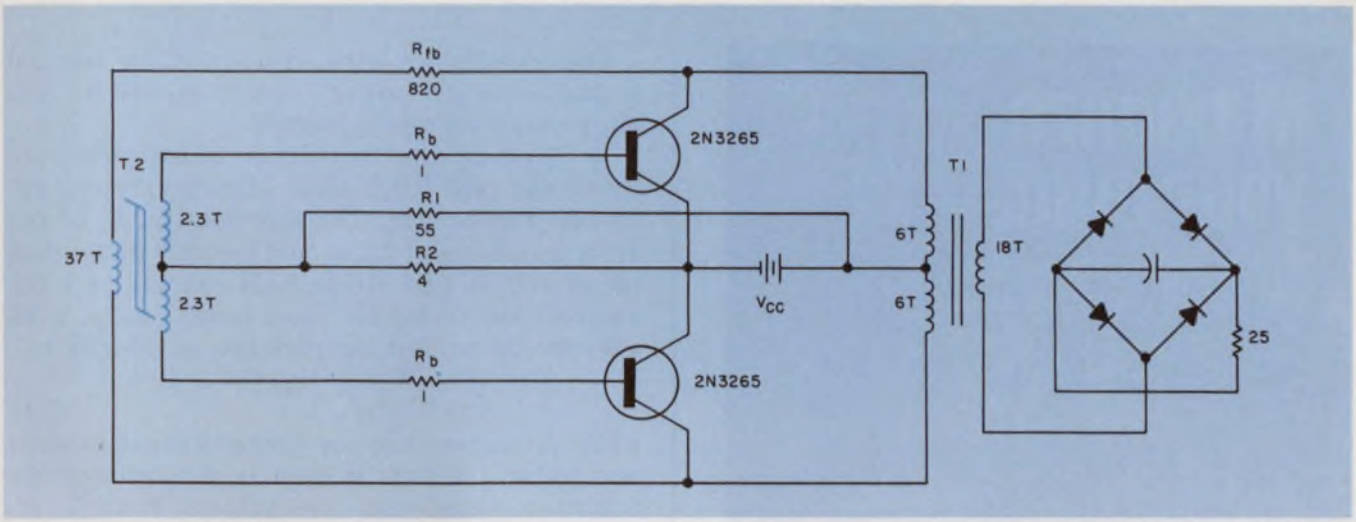
Suppose we want to design a converter with the following major specifications:

Power output, P_{out}	= 250 W.
Operating frequency, f	= 50 kHz.
Supply voltage, V_s	= +28 V.
Load resistance, R_L	= 25 Ω.
Ambient temperature, T_A	= 25 C.

Assuming 95% efficiency of the output transformer, we first determine the power input to the transformer, using Eq. 1:

$$P'_{out} = 250/(0.95) = 262.5\ W. \qquad (20)$$

From Eq. 2, we obtain the initial estimate of the collector current:



7. **The complete schematic of a 250-W converter** shows component values calculated in the example.

$$I'_C = (262.5)/28 = 9.4 \text{ A}. \quad (21)$$

The transistor collector-to-emitter breakdown voltage, V_{CEO}, should be at least twice the supply voltage plus 20%, to allow for spikes. Thus the minimum V_{CEO} should be 67 V. Looking at the specifications for a 2N3265 power transistor, we find that it has a V_{CEO} of 90 V and a $V_{CE(sat)}$ of 0.75 V (at $I_C = 15$ A). The 2N3265 also has very short switching times—both the fall time, t_f, and the on time, t_{on}, are 500 ns, which is short compared with the 20-μs period of the converter.

Thus the second estimate of the collector current becomes (from Eq. 3):

$$I''_C = (262.5)(28 - 0.75) = 9.62 \text{ A}. \quad (22)$$

Data sheets give h_{FE} of 40 at 10 A. Thus the forced value of $h'_{fe} = 20$ is chosen to make sure that the transistors will saturate. The $V_{BE(sat)}$ at the collector current of 10 A is given as 1.3 V.

To determine the value of R_B, we must have an idea of the required base current, which can be obtained from

$$I_B = I''_C/h'_{fe} = (9.62)/20 = 0.481 \text{ A}. \quad (23)$$

Thus the R_B of 1 Ω will produce a drop of about half a volt, which is sufficient. The base-circuit power input (Eq. 4) is

$$P_{in} = (1.3)\ (9.62/20) + (9.92/20)^2$$
$$= 0.86 \text{ W}. \quad (24)$$

Again, if we assume 95% efficiency for the base-drive transformer, T_2, the power input to T_2 becomes (from Eq. 5):

$$P'_{in} = (0.86)/(0.95) = 0.902 \text{ W}. \quad (25)$$

From Eq. 6, the collector current is

$$I_C = (262.5 + 0.902)/(27.25) = 9.65 \text{ A},$$

which is sufficiently close to the previously calculated estimates of I_C.

From Eq. 7, the impedance reflected into the primary of the output transformer is

$$R'_L = (27.25)/(9.65) = 2.84\ \Omega, \quad (26)$$

so that the T_1 turns ratio is

$$n^2 = 25/(2.84) = 8.85$$
$$n = 2.98. \quad (27)$$

Continuing the output-transformer calculations, we get, on the basis of 95% efficiency, the following magnetically dissipated power in T_1:

$$P_M = P_{out}\ (100\% - 95\%) = 12.5 \text{ W}. \quad (28)$$

For an operating frequency of 50 kHz, Allen-Bradley WO-3 ferrite-core material, or its equivalent, is suitable. Its maximum usable temperature is 125 C. The flux density, B, for linear operation should be 1000 gauss, and the core-loss factor, ρ, for these conditions is 3.2 μW/cm^3-Hz.

Thus the frequency-dependent core loss becomes

$$\rho' = (3.2\ \mu\text{W/cm}^3\text{-Hz})\ (50 \times 10^3)$$
$$= 160 \text{ mW/cm}^3. \quad (29)$$

Since the specified temperature rise for the converter is 100 C, the maximum temperature core loss (if we assume a loss factor of 3.2 mW/cm^2 − °C) is

$$\rho'' = (3.2 \text{ mW/cm}^3 - {}^\circ\text{C})\ 100$$
$$= 320 \text{ mW/cm}^3. \quad (30)$$

The minimum core volume is determined on the basis of the temperature core loss, since this loss is larger than that due to frequency. Thus

$$\text{Volume} = P_M/\rho'' = (12.5 \text{ W})/(320 \text{ mW/cm}^3)$$
$$= 39 \text{ cm}^3. \quad (31)$$

A pair of "C" cores, type U2625C133A (Allen-Bradley), give a transformer core with the following dimensions: area—2.04 cm^2; length—16.4 cm; volume—40 cm^3.

The number of primary turns for T_1 can now be determined from Eq. 16 as follows:

$$N_p = (27.25 \times 10^8)/(4)(50 \times 10^3)(2.04)(1000)$$
$$= 6.55 \text{ turns}. \quad (32)$$

If we approximate the number of primary turns to be six and the turns ratio (Eq. 27) to be three, the number of secondary turns becomes $6 \times 3 = 18$.

From the data sheet for the core, we see that for linear operation the value of the magnetizing field strength, H, equal to 0.189 Oe should not be exceeded. Thus the magnetizing current becomes (from Eq. 17):

$$I_m = [(16.4)(0.189)]/[(1.26)(6.55)]$$
$$= 0.376 \text{ A}. \quad (33)$$

The transformer wire sizes should be selected to avoid excessive power dissipation, and the primary should be wound bifilarly.

In selecting the base-drive transformer, we choose the type RO 3 (Allen-Bradley) rectangular-loop ferrite core. The flux density, B, of the drive transformer, T_2, should be 3000 gauss, and the saturation field strength, H_s, should be 1 Oe. The core-less factor for these conditions, ρ, is 63 $\mu W/cm^3$-Hz, so that the core loss at 50 kHz is

$$\rho' = (63\ \mu W/cm^3\text{-Hz})\,(50 \times 10^3) = 3.15\ W/cm^3, \qquad (34)$$

which is higher than the temperature-dependent loss factor and thus is used in determining the minimum transformer-core volume. With T_2 efficiency of 95%, the magnetically dissipated power becomes

$$P_M = P_{in}(100\% - 95\%) = (0.86)\,(0.05) = 0.043\ W, \qquad (35)$$

where the value for P_{in} was derived from Eq. 24. Thus the minimum volume is

$$\text{Volume} = P_M/\rho' = (0.043)/3.15 = 0.0136\ cm^3. \qquad (36)$$

Thus the core type TO620H101a (Allen-Bradley) is chosen with these dimensions: area—0.119 cm^2; length—1.53 cm; volume—0.182 cm^3.

The number of primary turns is (from Eq. 16):

$$N_p = (27.25 \times 10^8)/(4)\,(50 \times 10^3)\,(0.119)\,(3000) = 37.5\ \text{turns}. \qquad (37)$$

From Eq. 11, the turns ratio is found to be

$$n = (27.25)/(1.3 + 0.481) = 16, \qquad (38)$$

so that the number of secondary turns is 2.3.

The transformer parameters should now be checked (from Eq. 17) against their ability to produce the required magnetic field strength of 1 Oe. Prior to this, the value of magnetizing current, I_m, should be calculated from Eq. 10:

$$I_m = I_{pri} = (0.902)/(27.25) = 0.0332\ A, \qquad (39)$$

so that

$$H_s = [(1.26)\,(37)\,(0.033)]/(1.53) = 1.01\ \text{Oe}. \qquad (40)$$

The remaining circuit components that need to be calculated are the feedback resistor, R_{fb}, and the values for the starting network. The feedback resistor is calculated to produce the desired magnetizing current, or

$$R_{fb} = V_{pri}/I_{pri} = (27.25)/(0.0332) = 820\ \Omega.$$

From Eq. 18, R_1 is found to be 55 Ω, and R_2 becomes 4 Ω.

The final circuit diagram of the 250-W converter is in Fig. 7. ■■

References

1. Radys, R. G., and Agnew, C. V., "Pseudo-Saturating Power Converter," NASA Tech Brief B72-10042.
2. Hnatek, Eugene R., "Design of Solid State Power Supplies," Van Nostrand Reinhold Co., New York, 1971.

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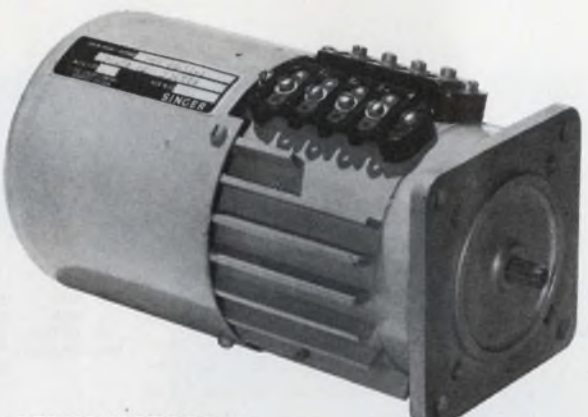

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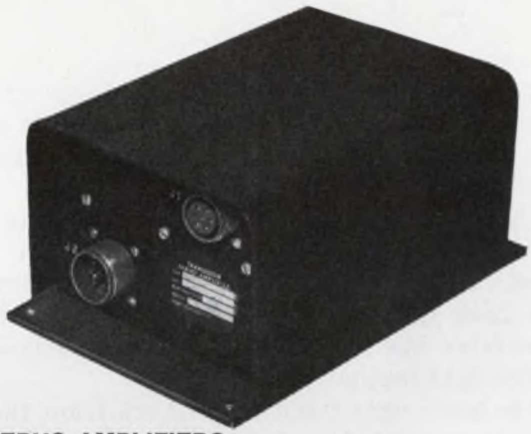

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INFORMATION RETRIEVAL NUMBER 41

Reduce numeric LED-display errors

with an easily expandable octal decoder circuit that locks onto one—and only one—input signal.

Octal decoder/driver circuits for seven-segment LED readouts can be built simply and easily with decode logic only. But these circuits are prone to errors or unwanted displays, and often they require a doubling of the number of components when the number of inputs are increased. These problems are eliminated with a Count Lock Loop—a circuit that displays a decimal number identifiable with one—and only one—of its eight mutual inputs.

In the basic eight-input Count Lock Loop, three gates are connected to form a free-running 10-kHz clock (Fig. 1). At a fourth gate, the clock pulses are gated with the Y output from a data selector/multiplexer. As long as Y remains at logic ONE, clock pulses drive the binary counter.

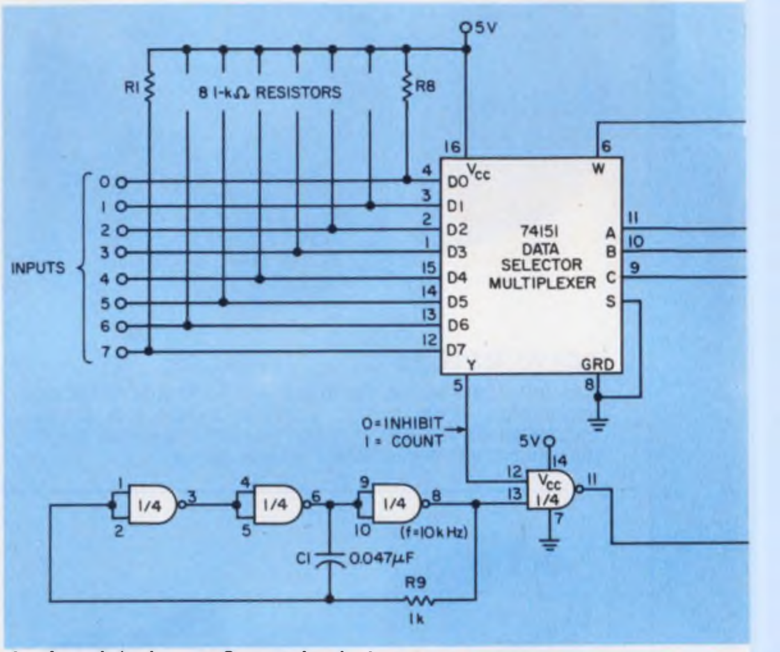
The counter's outputs are connected in parallel to the multiplexer and to the decoder/driver. The counter's eight binary states are decoded so that each of the eight circuit inputs is sampled once during every complete counter cycle—that's once every 800 μs, or eight clock cycles.

As long as all eight circuit inputs are either floating (open-circuited) or at logic ONE, the multiplexer's W output remains at logic ZERO and the Y output (its complement) at logic ONE. Output W's logic ZERO, applied at the BI/RBO terminal of the decoder/driver, forces all seven of its outputs to logic ONE, and the display is blanked.

Response if one input is at ZERO

If one circuit input switches to logic ZERO, the W and Y outputs change state as soon as that circuit input is sampled. This occurs when the binary counter reaches the appropriate state.

The Y output going to logic ZERO keeps clock pulses from reaching the counter, thus preventing it from changing state. The W output going to logic ONE removes the blanking condition from the decoder/driver, allowing it to decode the state of the counter outputs and to drive appropriate segments of the display. The display then presents a decimal number identifying that circuit input, which is at logic ZERO.



1. **An eight-input Count Lock Loop** for any seven-segment LED readout that does not have a built-in decoder. It's more involved than the simplest configuration with

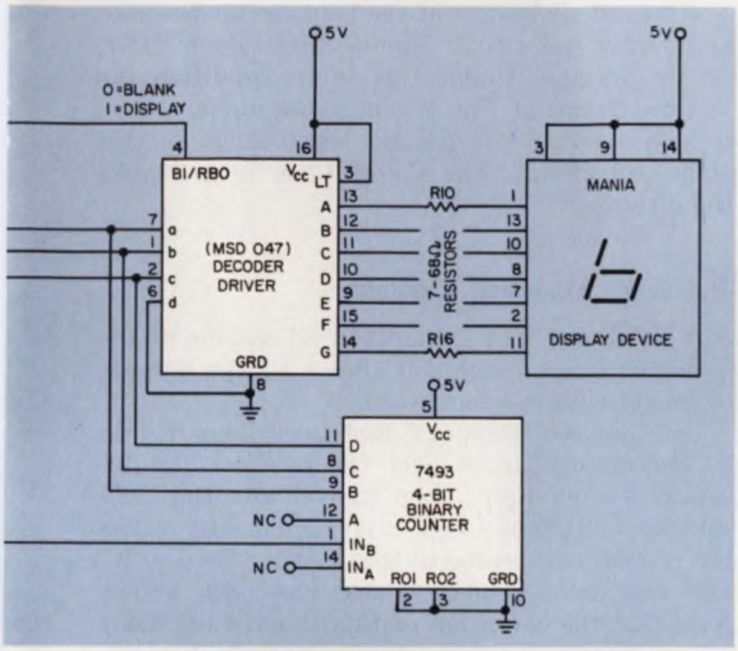
As soon as the circuit input goes back to logic ONE, the W and Y outputs change state, causing the display to be blanked and allowing clock pulses to resume driving the binary counter. The sampling of each circuit input once during every counter cycle is resumed.

What happens in the simpler circuit

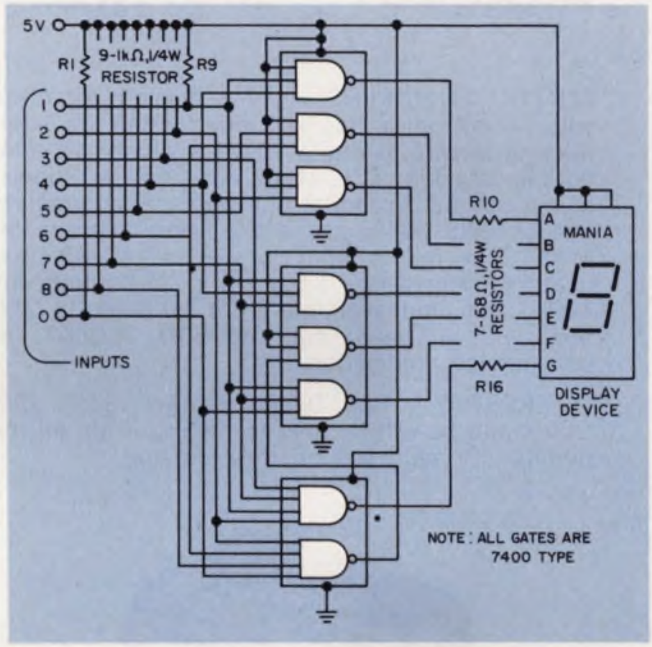
A circuit that uses decode logic only (Fig. 2) can cause an erroneous display. While its general function is similar, its operation is not equivalent to that of the Count Lock Loop. Consider this circuit's response if certain combinations of inputs simultaneously are at logic ZERO.

If circuit inputs 4 and 7 are simultaneously at logic ZERO and all other inputs are at logic ONE, this circuit causes numeral 1 to be displayed (even though circuit input 1 is actually at logic ONE). Another example is the ambiguous

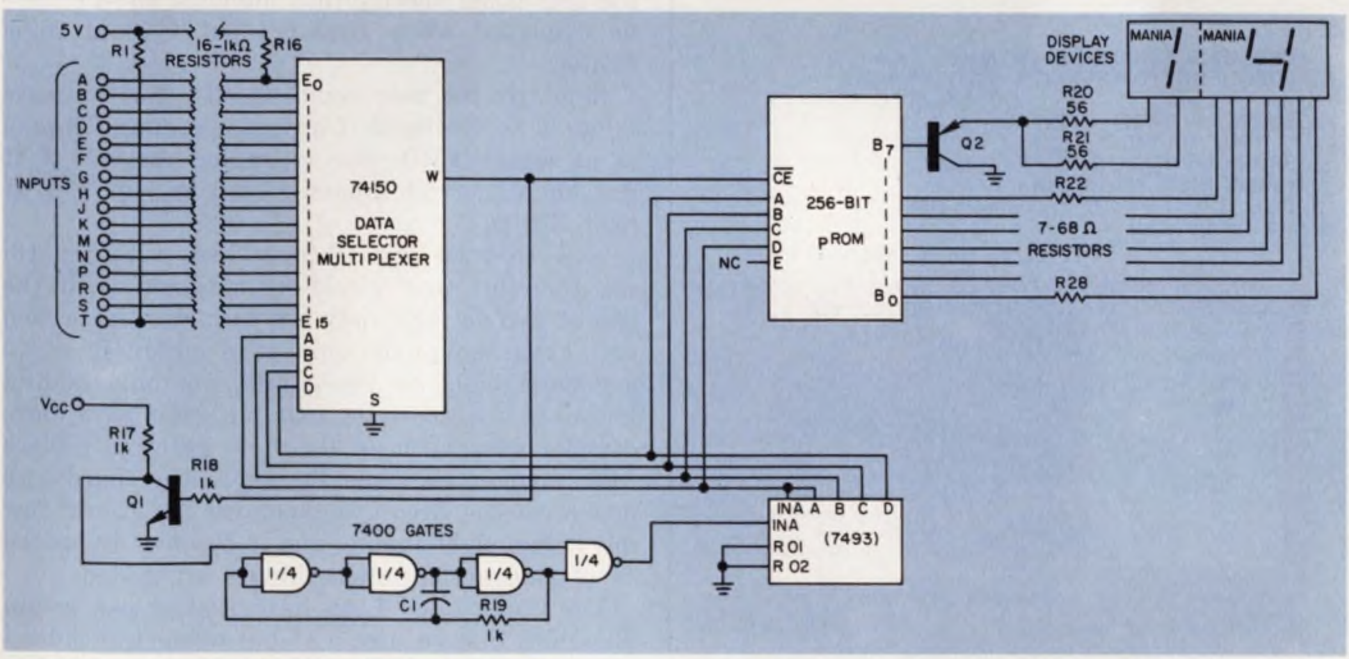
Earl Cole, Monsanto Commercial Products Co., 10131 Bubb Rd., Cupertino, Calif. 95014.



decode logic only, but the octal configuration insures that only one input determines the numeral displayed. And it can be easily expanded for more inputs.



2. **With decode logic only,** you can build this circuit. But the disadvantages include erroneous displays, nonsignificant numerals and limited expandability.



3. **A 16-input Count Lock Loop** requires only a larger data selector/multiplexer, a pROM instead of a decoder/driver IC and one more display. The operation of this larger loop is essentially that of the octal circuit.

character that this circuit displays if inputs 2 and 7 are simultaneously at logic ZERO.

Now consider the response of the Count Lock Loop of Fig. 1. As soon as it detects a circuit input at logic ZERO, the loop causes the input's identifying number to be displayed. Any other circuit input or inputs simultaneously at logic ZERO are not allowed to change the display because the binary counter's state is "frozen." Other inputs continue to be ignored until the displayed circuit input goes back to logic ONE or floats. The Count Lock Loop circuit insures an error-free display.

A second advantage of the loop circuit becomes apparent if all circuit inputs are at logic ONE or are floating. Under this input condition the simpler circuit of Fig. 2 causes the numeral 9 to be displayed, but it has no significance in this eight-lead circuit. The Count Lock Loop blanks the display.

The loop's expansion capability

A third, and very important, advantage of the Count Lock Loop is that it allows a large number of inputs with less hardware.

Consider the 16-input Count Lock Loop in Fig. 3. The main changes over the previous (eight-input) Count Lock Loop are these: the data selector/multiplexer is of a larger bit size, a 256-bit pROM has replaced the decoder/driver IC, and one more display device has been added. Note that the operation of this Count Lock Loop is an extension of that already described.

Also, in the Count Lock Loop with the pROM the user is allowed to specify the code for numerals that designate circuit inputs. For example, the user could specify that numeral 16—or 15—be displayed when circuit input t is at logic ZERO.

Similarly the user could specify that a single numeral be displayed if any of a group of inputs is at logic ZERO—for example, numeral 3 if any one of circuit inputs g or h or j or k is at logic ZERO.

Now contrast this 16-input loop with the 16-input circuit that would be obtained with the use of decode logic only. In the latter approach each expansion of the number of circuit inputs—say from eight to 10—entails not only adding gates but also replacing existing gates with more complex ones, such as five-input gates to replace four-input gates. Thus the amount of hardware doubles if the circuit is expanded for even a few more than eight inputs, and it becomes impractical if substantially more inputs are added.

The Count Lock Loop has greatest use in applications that require a visual numerical indication of OPEN or GROUNDED in a large number of inputs. ■■

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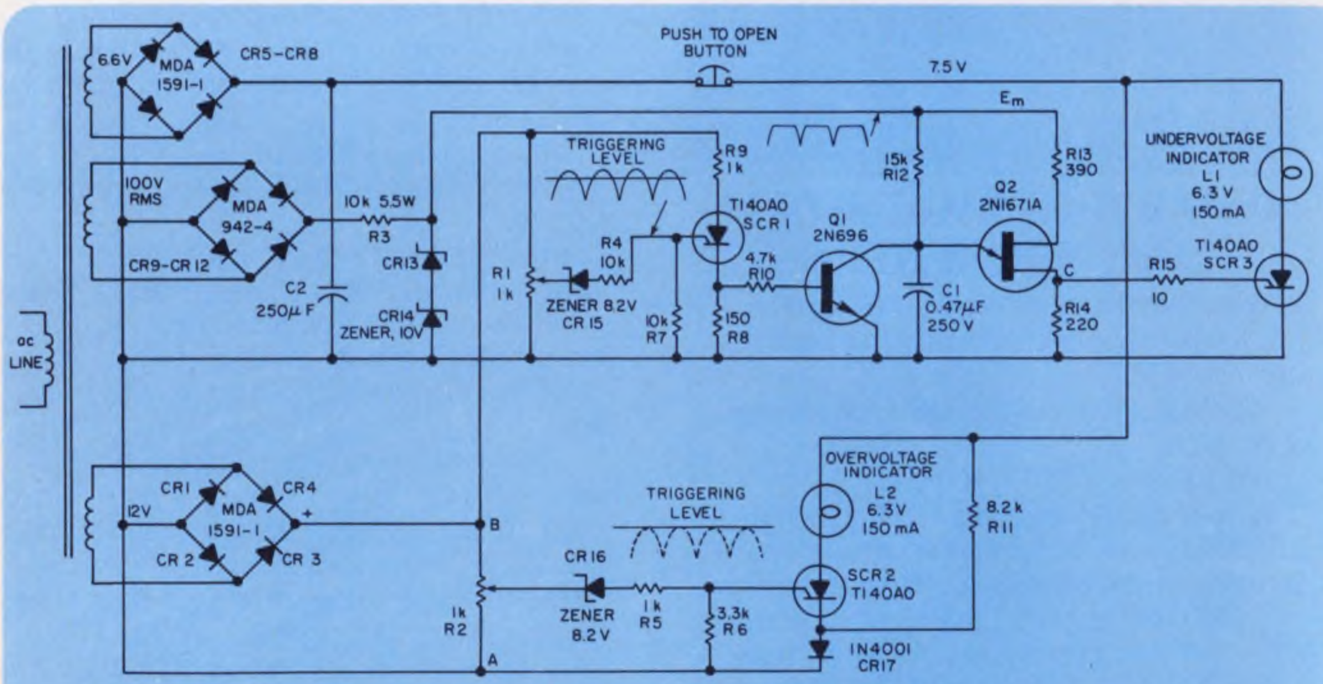
A line-voltage monitor reacts to voltage fluctuations of one-cycle duration. If, in any cycle of line voltage, the negative or positive peak becomes high or low by more than 10% of its normal peak value, an indicator lamp lights.

The diode bridge (CR_1 through CR_4 in Fig. 1), rectifies the line voltage, producing a full-wave rectified output at points A and B. Potentiometer R_1 should be adjusted, so that when the peak value of line voltage is kept within 10% (maximum tolerance) of its normal value, SCR_1 is triggered via zener diode CR_{15}. When SCR_1 turns on, it turns on transistor Q_1, discharging capacitor C_1. With capacitor C_1 discharged, transistor Q_2, SCR_3 and the undervoltage indicator lamp all remain off.

When SCR_1 is turned off, transistor Q_1 also turns off and capacitor C_1 charges. But before capacitor C_1 charges to the triggering level of unijunction transistor Q_2, the peak of the new cycle of line voltage causes it to discharge. As long as the peak value of each cycle of line voltage is not lower than 90% of its normal value, the voltage across C_1 will not exceed the triggering level of unijunction transistor Q_2.

If the peak value of the line voltage fluctuates to less than 90% of its regular value, SCR_1 and transistor Q_1 will not turn on. This allows capacitor C_1 to charge up to the triggering level of unijunction transistor Q_2. When Q_2 turns on, the voltage at point C will rise to the triggering level of SCR_3, thus turning on the undervoltage indicating lamp.

Potentiometer R_2 is similarly adjusted, so that when the peak value of the line voltage is kept at its regular value or 10% higher, SCR_2 remains



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A092/1

off. When the peak value exceeds its regular value by more than 10%, SCR_2 conducts and the overvoltage lamp lights.

SCR_1 is biased to trigger when the value of the full-wave rectified line voltage exceeds E_1, where E_1 is 90% of the regular peak value. The voltage (Fig. 2) across capacitor C_1 is given by the expression

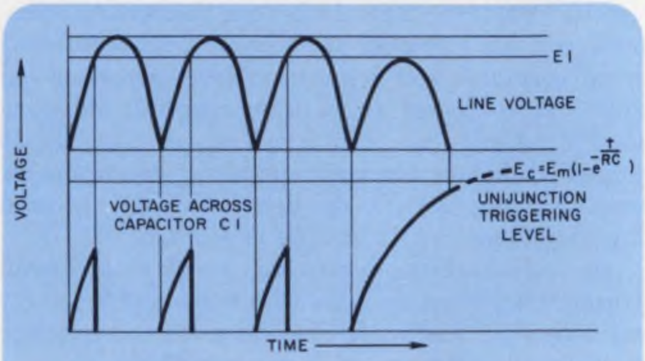
$$E_c = E_m\,(1 - e^{-t/RC_1})$$

where E_c is the voltage across capacitor C_1
E_m is the maximum voltage across unijunction transistor Q_2
C_1 is capacitance of C_1
R is the 15-kΩ resistance of R_{11}.

If SCR_1 is turned off, voltage E_c rises to the triggering level of unijunction transistor Q_2. Different values for C_1 vary the number of undervoltage cycles that will trigger Q_2 and turn on the lamp.

A. Spetsakis and A. Milas, Electronic Div., N.R.C. Democritos, Aghia Paraskevi, Attikis, Athens, Greece.

CIRCLE NO. 311



2. **A 10% drop in line voltage charges** capacitor C_1 to a voltage above the UJT triggering level.

Op-amp current source achieves wide voltage compliance

An elaboration of the simple op-amp current source overcomes the conventional limits of maximum op-amp output current and maximum output voltage swing. The circuit shown provides a constant current, variable from 0 to 10 mA, with a voltage compliance of 28 V. Current and voltage capability are limited only by the op amp, driver transistor Q_1, output transistor Q_2 and the power supply.

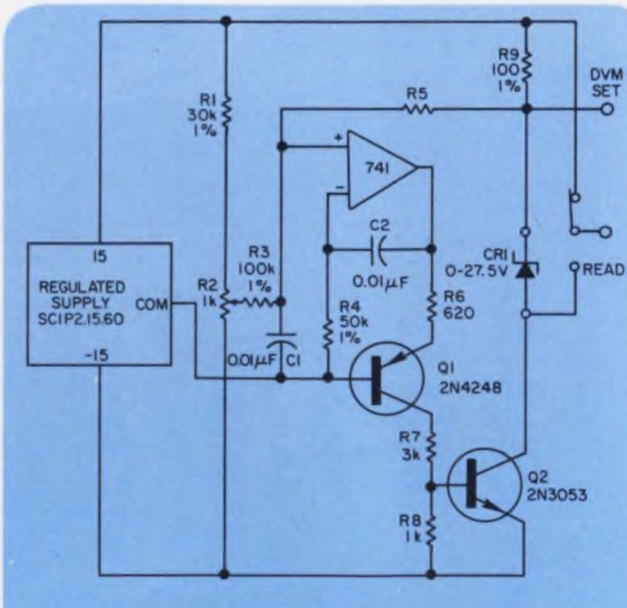
The 741 op amp provides most of the gain required for good repeatability. Common-base driver Q_1 and output transistor Q_2 prevent the op amp from operating with its output at saturation.

To adjust the output current, measure the voltage drop across current-sense resistor R_9 with a short across diode CR_1, which may be any zener having a 0 to 27.5 V range. Variations in the resistance of R_2 adjust the output current from 0 to 10 mA. Output current may be set to three decimal places if R_2 is a 10-turn potentiometer with good resolution. The shunting effect of R_5 introduces an error of 0.1% when a voltmeter with an input impedance of 1 MΩ or more is used.

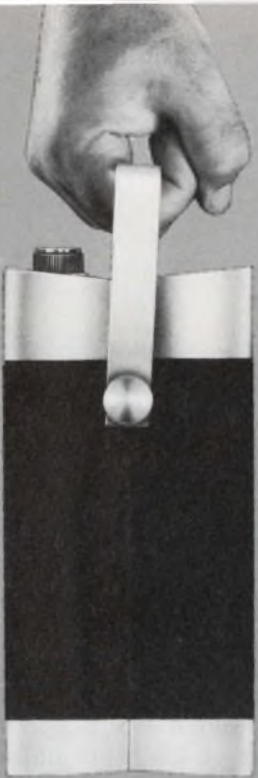
This circuit is power-supply-sensitive because the voltage source generates the reference. Although a Semiconductor Circuits, Inc., Model P2.15.60 supply—which has 0.001% line and 0.01% load regulation at the required output current level—was used, any supply with similar regulation should work.

Donald Belanger, President, Semiconductor Circuits, Inc., 306 River St., Haverhill, Mass. 01830.

CIRCLE NO. 312



The output current and voltage swing of this op-amp power supply are increased by common-base driver Q_1, emitter-follower output transistor Q_2 and the op amp.



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INFORMATION RETRIEVAL NUMBER 45

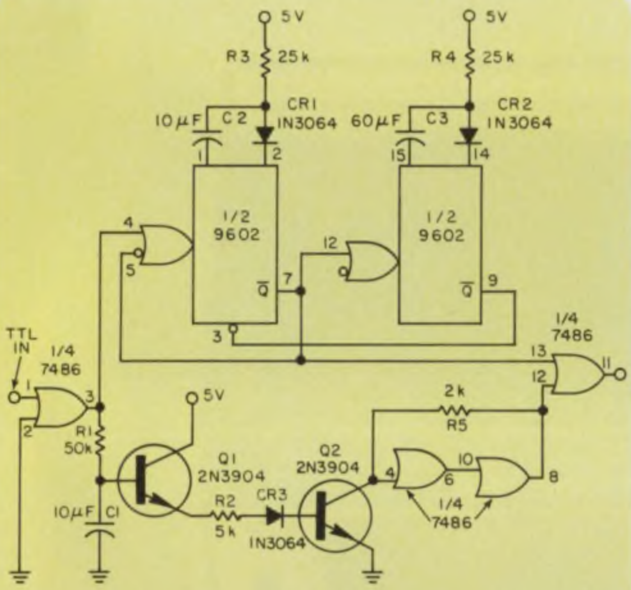
Pulse stretcher indicates presence and polarity of TTL pulses to 20 MHz

A simple pulse stretcher determines the presence and polarity of TTL-pulsed waveforms—with repetition frequencies up to 20 MHz and with pulse widths of greater than 10 ns. Unlike similar logic probes[1], the circuit of Fig. 1 tracks the input pulse duty cycle.

The output signal duplicates the TTL input level. A positive pulse with less than a 50% duty cycle (Fig. 2a) produces the output in Fig. 2b. Conversely, the negative pulse in Fig. 2c produces the output in Fig. 2d. The output polarities may be detected by either a buzzer or an indicator light.

The 9602 retriggerable monostable multivibrator is connected as a nonretriggerable constant-duration pulse generator. A positive input at pin 4 drives output pin 7 LOW for 80 ms (determined by the R_3C_2 time constant). When pin 7 returns to HIGH, it triggers pin 12, driving pin 9 LOW and disabling the input for 320 ms more.

The resulting output at pin 7 is thus a positive pulse with a period of 0.4 s and a width of 80 ms (Figs. 2b, 2d). The average of the input pulse is determined by resistor R_1 and capacitor C_1. Transistor Q_1 acts as a buffer, and Q_2 sets the pulse output polarity at pin 11 of the EXCLUSIVE-OR gate.



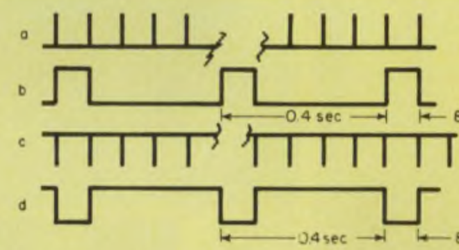
1. **Monostable multivibrator 9602 tracks** the duty cycle of a TTL input, generating a pulse train with the same polarity as the input.

Reference

1. Sinutko, Michael, "Logic Probe Responds to TTL Pulses of Less Than 10 ns in Width," *Electronic Design* 9, April 27, 1972, p. 76.

Jeff Duerr, Hewlett-Packard Co., 1900 Garden of the Gods Rd., Colorado Springs, Colo. 80907.

CIRCLE No. 313



2. **Positive (a) and negative (b) input pulses produce** corresponding output pulse trains (b and d).

IFD Winner of June 22, 1972
Alphonso H. Marsh, Sr. Engineer, Raytheon Co., Sudbury, Mass. 01766. His idea "Gating scheme maximizes dc-dc converter efficiency" has been voted the Most Valuable of Issue award.
Vote for the Best Idea in this issue.

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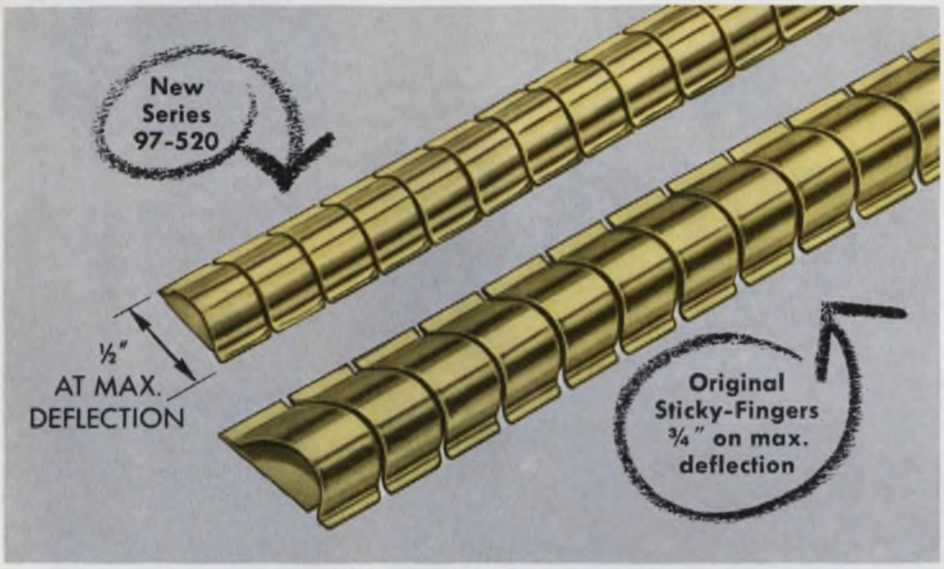
Greater RFI/EMI shielding in new, narrow-width contact strips from Instrument Specialties



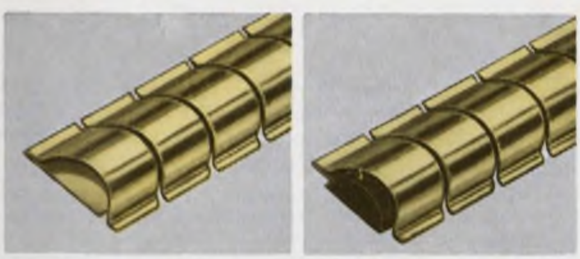
Latest addition to Sticky Fingers® line!

Instrument Specialties now offers Sticky-Fingers self-adhesive, beryllium copper contact strips in three variations to solve your most critical RFI/EMI problems.

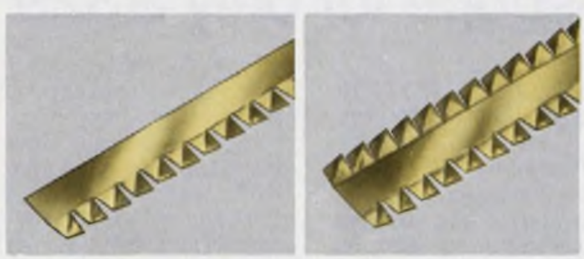
Comparable to the shielding effectiveness of the original Sticky-Fingers, our newest series 97-520* offers shielding effectiveness of 92 dB at 10 GHz plane wave or greater than 92 dB at 1 MHz magnetic, and has a dynamic range of 0.10". Yet, it measures a scant ⅜" wide, and ½" at maximum deflection.

Supplied in standard 16" lengths, series 97-520 is ideal for metal cabinets and electronic enclosures where variations exist in the space to be shielded, and where high shielding effectiveness must be maintained in narrow spaces, even with frequent opening and closing of the cabinet.

Select the exact series that fits your application best. Write today for a complete catalog, list of finishes available, and our latest Independent Shielding Evaluation Report. Address: Dept. ED-68



Series 97-500*—the original ¾" wide Sticky-Fingers. Specify when you require greatest possible shielding and where space permits. Also, supplied as 97-510 with Magnifil® for optimum magnetic shielding.



For those all-purpose applications where economy and space are both factors, specify the ⅜" wide single-twist series 97-555, or ½" wide double-twist series 97-560 Sticky-Fingers.

Specialists in beryllium copper springs since 1938

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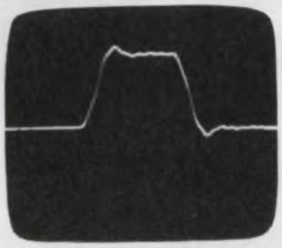
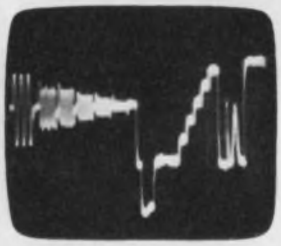
*Patented

INFORMATION RETRIEVAL NUMBER 46

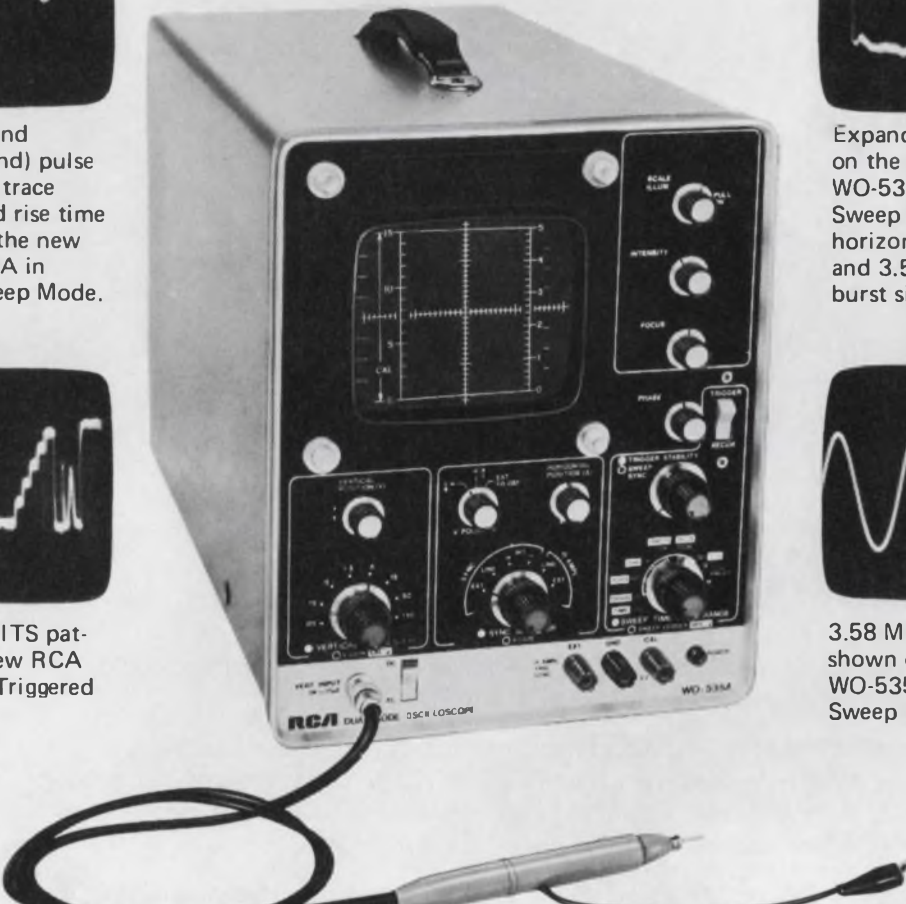
TRIGGERED SWEEP



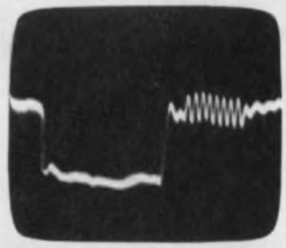
250-nanosecond (¼-microsecond) pulse demonstrates trace expansion and rise time capability of the new RCA WO-535A in Triggered Sweep Mode.



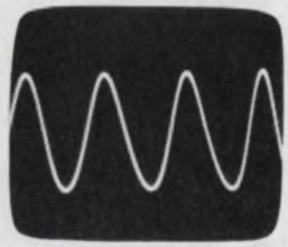
Typical TV VITS pattern on the new RCA WO-535A in Triggered Sweep Mode.



RECURRENT SWEEP



Expanded video signal on the new RCA WO-535A in Recurrent Sweep Mode shows the horizontal sync pulse and 3.58 MHz color-burst signal.



3.58 MHz sine-wave as shown on new RCA WO-535A in Recurrent Sweep Mode.

Now...a 5-inch triggered/recurrent sweep oscilloscope for only $329*

It's the all solid-state RCA WO-535A featuring one-step calibration for simplified voltage measurements and usable frequency response to 10 MHz.

In the Triggered Sweep Mode, you can lock in waveforms and patterns that cannot be viewed easily using recurrent sweep. Triggered sweep with wide, variable trace expansion permits you to view small segments of complex waveforms, such as vertical-interval test signals (VITS). In the Recurrent Sweep Mode, you get all the advantages of a conventional continuous-sweep oscilloscope.

There are many other features of the WO-535A you'll like – and your RCA Distributor will be glad to supply complete information about this general-purpose oscilloscope that provides high performance in such applications as radio and TV servicing, industrial maintenance, troubleshooting, and general waveform analysis.

Also ask your RCA Distributor for the full story on the RCA WO-505A, priced at $299*, and the RCA WO-33A, priced at $180*. Or write RCA Test Equipment Headquarters, Harrison, N.J. 07029.

*Optional Distributor Resale Price, complete with direct/low capacitance shielded probe and cable.

RCA|Electronic Components|Harrison, N.J. 07029.

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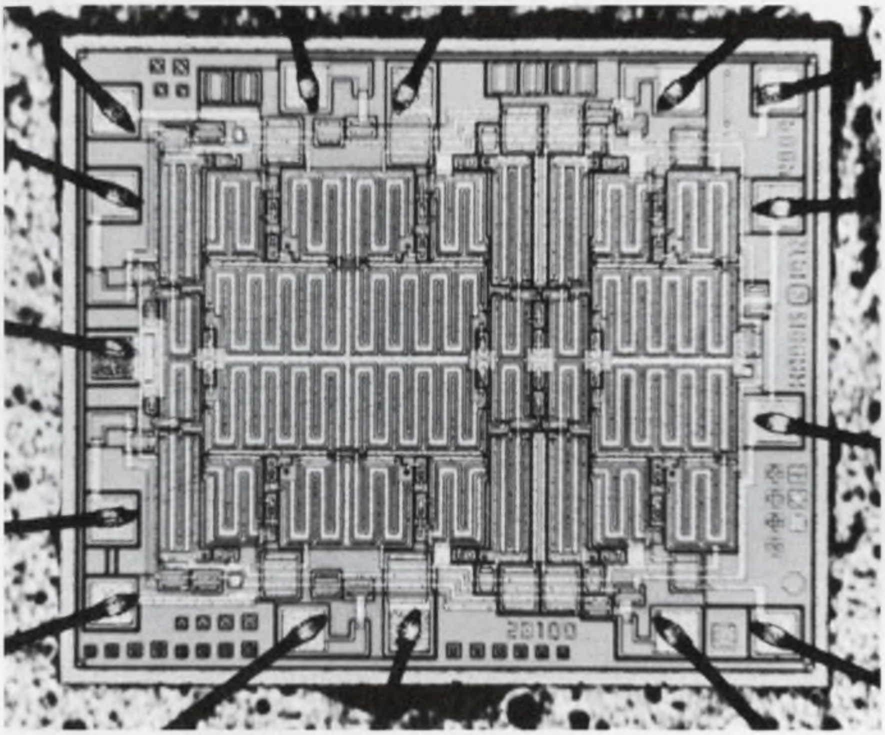
INFORMATION RETRIEVAL NUMBER 47

CMOS line uses dielectric isolation for fastest CMOS ICs on silicon



Harris Semiconductor, P.O. Box 883, Melbourne, Fla. 32901. (305) 727-5407. P&A: See below.

Standard complementary MOS (CMOS) lines, available from a number of manufacturers, have generally tended to be alternate-source devices for the industry's leading series, RCA's COS/MOS CD 4000 family. The latest entry—Harris Semiconductor's HD 4000 line—breaks the pattern with an initial offering of eight basic digital circuits that are reported to give a 2:1 improvement in speed and an order of magnitude reduction in standby power dissipation.

This improvement in performance results from the use of dielectric isolation techniques in the fabrication process. Harris thus avoids the relatively new and expensive silicon-on-sapphire (SOS) technology, now offered only by Inselek in its CMOS/SOS series. Both techniques lead to similar improvements in performance. However, the use of SOS represents a fundamental alteration in the CMOS process: SOS, rather than the more common silicon, is used as the starting substrate.

For CMOS on silicon, National's 54C/74C series presents the major alternate direction of standard CMOS ICs. This line features TTL-pin compatibility and is primarily intended as a direct replacement for equivalent TTL functions. However the specs—especially on speed and power drain—are generally the same as those for similar RCA circuits.

The new Harris circuits have pin-out configurations that are compatible with the RCA and alternate series. Thus these circuits can replace or interface with the standard equivalent RCA series with identical input/output levels.

Compared with RCA CMOS circuits and alternate lines, Harris lists the highest CMOS speeds of any standard line. A NAND gate in the Harris CMOS series features propagation delays of 20 and 10 ns for a load capacitance of 15 pF and supplies of 5 and 10 V, respectively. The corresponding delays of equivalent RCA circuits are 35 and 25 ns. For a 50 pF load and the same two supply voltages, the Harris gate maintains a better than 2:1 improvement in speed.

Flip-flop toggle rates, with 5 and 10-V supplies, are 6 and 15 MHz in the Harris series. Equivalent RCA circuits list 4 and 10 MHz, respectively.

All CMOS lines feature standby power dissipation in the nanowatt region. But the same Harris NAND gate has a 0.5-nW drain, as opposed to 5 nW for RCA circuits. And supply voltages can range from 3 to 18 V, as opposed to the more common 3 to 15 V.

Harris' HD-4000 series, also called DI/CMOS, includes the following seven COS/MOS-equivalent circuits—prices indicate 100-999 quantities and commercial versions (−40 to 85 C): 4000, dual 3-NOR gate ($1); 4001, quad 2-NOR gate ($1); 4009, hex inverter ($2.20); 4010, 16-pin hex buffer ($2.20); 4011, quad 2-NAND gate ($1); 4012, dual 4-NAND gate ($1), and 4013, dual D flip-flop ($2.10).

Unit prices listed are generally competitive with those of other CMOS manufacturers. All devices are available only in ceramic DIPs and all, except for the 4009 and 4010 circuits (16-pin packages), come in 14-pin packages.

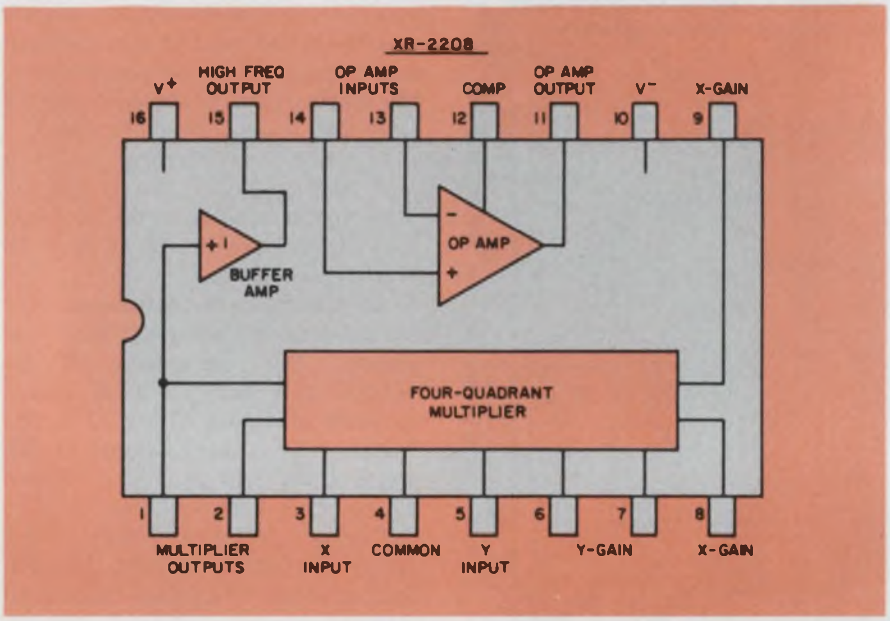
The eighth Harris device, the HD-4809 triple true/complement buffer, is an original Harris circuit. The commercial version sells for $2.25 (100-999).

Other manufacturers offering standard CMOS lines are Hughes Microelectronics, Motorola Semiconductor, Solid State Scientific and Solitron Devices.

For more information on:

Harris HD-4000	CIRCLE NO. 254
Inselek CMOS/SOS	CIRCLE NO. 255
National 54C/74C	CIRCLE NO. 256
RCA CD4000	CIRCLE NO. 257

Versatile multiplier chip extends bandwidth while reducing design complexity



Exar Integrated Systems, Inc., 733 N. Pastoria Ave., Sunnyvale, Calif. 94086. (408) 732-7970. P&A: See below.

Before the introduction of Exar's XR-2208 Operational Multiplier, separate ICs were required for the two major application areas of four-quadrant multipliers: analog computation and signal processing. In general, an op amp or a buffer amp is essential for these applications in addition to the right multiplier. Now one XR-2208 does the job, at the same time providing increased bandwidth with fewer external passive components.

The XR-2208 contains a four-quadrant multiplier (or modulator), an op amp and a high-frequency buffer amp all on the same chip (see diagram). Both amplifiers are uncommitted. They can be used independently or interconnected to the multiplier section depending upon application.

Presently available multipliers include Motorola's fully monolithic MC1595/1495 and MC1594/1494 multipliers, with typical small-signal bandwidths of 3 and 1 MHz, respectively. Available from Motorola and alternate sources, these devices don't have an op amp on the chip. And for multiplication, more than 20 external passive components plus the op amp are needed. The Exar circuit requires only about 15 passive components for the same job.

Other multipliers are Analog Devices' AD530 and Intersil's 8013. These units are monolithic with thin-film resistors, and an op amp is included on the chip. However, the use of film resistors leads to higher prices, and the op amp is connected to the multiplier section, thus limiting the number of applications.

The XR-2208, operating from split supplies ranging from ±4.5 V to ±15 V, has a linearity (defined as the output voltage deviation from a straight-line transfer function) of 0.3% typical and 0.5% maximum. About the same values can be obtained with other multipliers.

But the 3-dB bandwidth of the Exar circuit is 6 MHz, typical, for the X-input, compared with 800 kHz for Motorola's 1594 and 1 MHz for Intersil's 8013. The three-degree phase-shift bandwidth is typically 1.2 MHz vs 240 kHz for the 1594.

The op-amp section of the XR-2208—a 741-type—lists input offsets under 6 mV, bias current of 100 nA, gain of 75 dB and ±12-V output swing for ±15-V supplies.

For analog computation, such as multiplication, the op amp is connected to the multiplier section. This provides a level shifting and single-ended output at pin 11. The op amp can also function as a preamp to the multiplier section for low-level input signals or as a post-detection amp for synchronous demodulator applications.

In a typical configuration for multiplication, potentiometers connected to pins 7, 8 and 5 are used to trim offsets and adjust the scale factor. With a scale factor of 0.1, a 10-V pk-pk output swing can be provided for X and Y voltages of 10 V.

In signal processing the unity-gain buffer amp extends the 3-dB bandwidth of the multiplier to 10 MHz. It also provides a low-impedance (50 Ω) output for high-frequency amplifier and modulator applications.

The XR-2208 is available in a 16-pin DIP ceramic with a temperature range of 0 to 75 C. The price for 100 quantities is $6.90. A military version, the XR-2208M, goes for $9.25 (100 up). And a relaxed electrical-spec version, the XR-2308, covering the industrial temperature range, is available for $4 (100 up). Delivery is from stock.

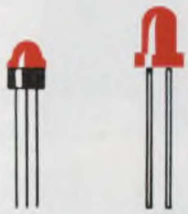
For more information on the following multiplier circuits, circle the appropriate information retrieval number.

For Analog Devices AD530 **CIRCLE NO. 250**

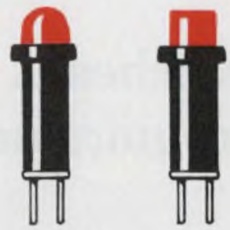
For Exar XR-2208 **CIRCLE NO. 251**

For Intersil 8013 **CIRCLE NO. 252**

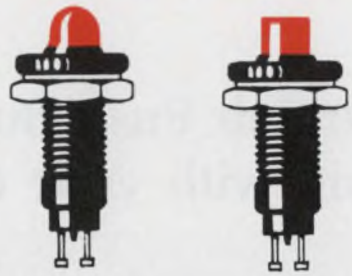
For Motorola 1595/1495, 1594/1494 **CIRCLE NO. 253**



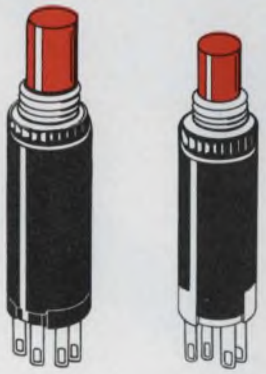
DIODE-LITEs



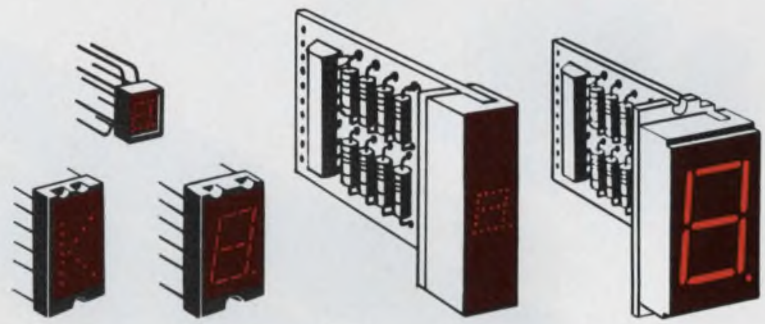
Cartridges



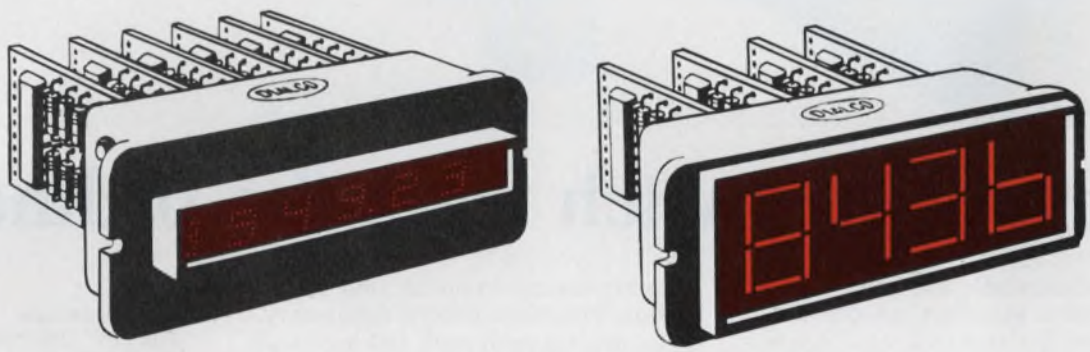
Indicator lights



Lighted push button switches



Readout modules and packages



Readout assemblies

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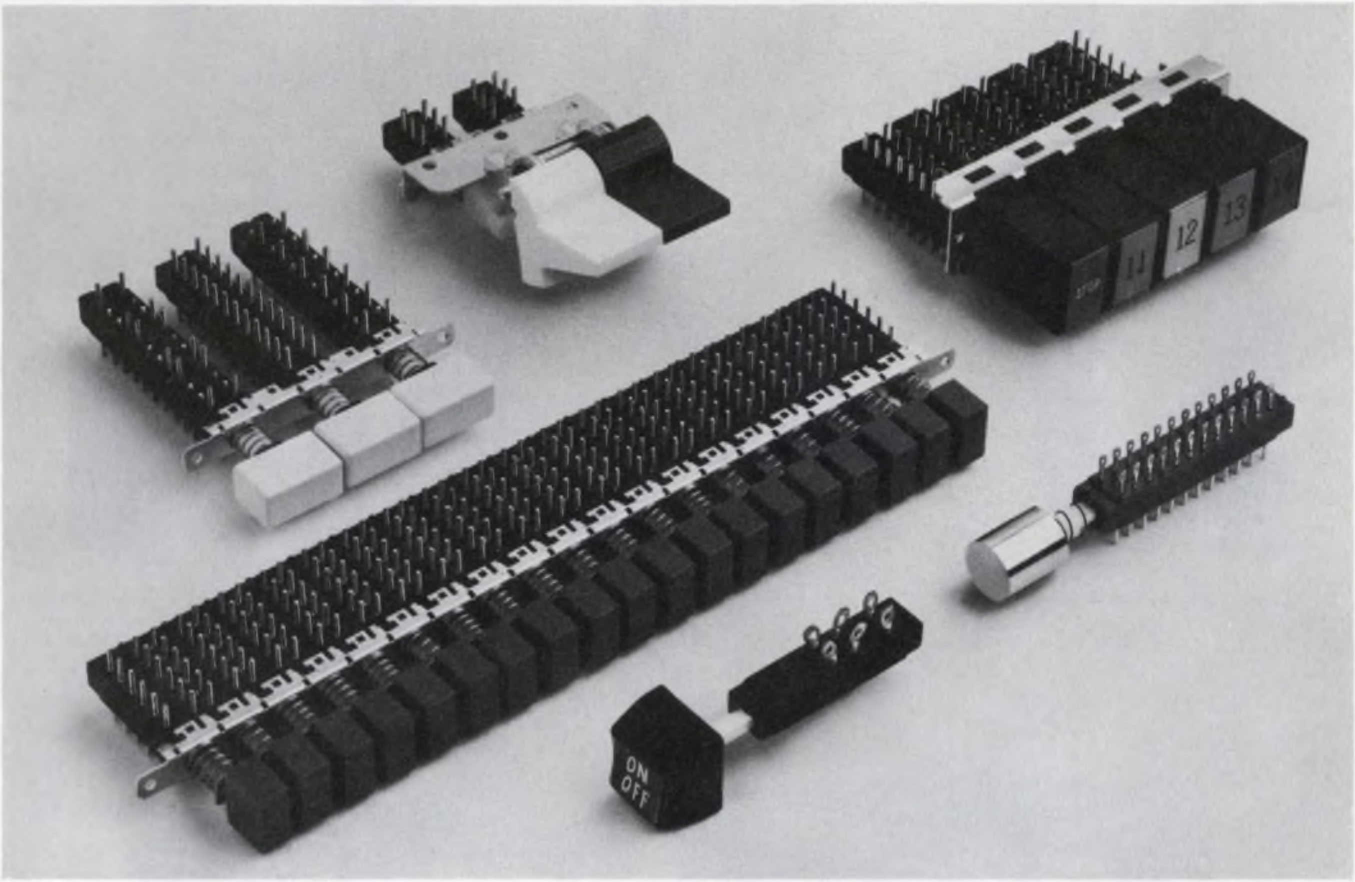
INFORMATION RETRIEVAL NUMBER 48

Centralab Push Button Switches... in line with your design requirements

Write Centralab for Bulletin No. ELC-3



Reasons to switch from the ordinary

Versatile Centralab push button switches* give you more reasons to change from the ones you're using now. Our push button switch conforms to a variety of specifications for consumer products, instrumentation, and industrial applications.

Reasons? Consider these: Centralab is the only manufacturer to offer diallyl phthalate—for highest possible insulation resistance—as well as phenolic or glass alkyd. Our phenolic modules provide greater than 65 db isolation in the voice frequency range. Our modules are available with sealed terminals to avoid flux penetration and we can provide gold contacts and terminals for dry circuit applications.

To conserve space and provide compact stacking in circuit board applications, Centralab modules are adaptable to selective pin cutting or solder lug terminations. We offer three different lockout devices to match your application. Functions include momentary, interlocking, push-push and push-pull. Up to 29 individual switch modules can be ganged on a common bracket. Other options include keyboard and row-to-row interlock. There are five center-to-center spacings with the widest variety of button colors, sizes and shapes.

Or ask for lighted push button switches that offer all the same features plus interchangeable lenses and filters in a variety of colors to provide maximum utility and appeal.

Our versatile module size line switch rated 3 amps at 120 V AC can be utilized in any position within the switch assembly.

If you need more reasons to switch to Centralab, ask for our bulletin and technical data. Write Switch Sales Manager, Centralab.

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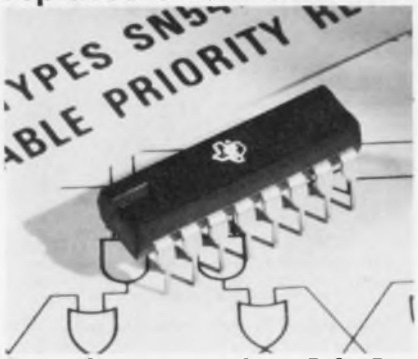
INFORMATION RETRIEVAL NUMBER 49

4-bit priority register replaces 6-1/2 SSI ICs



Texas Instruments Inc., P.O. Box 5012, M/S 308, Dallas, Tex. 75222. (214) 238-3741. SN74278N: $2.70.

A four-bit priority register, capable of performing the priority-interrupt function in high-speed data transmission systems, replaces the equivalent of 6-1/2 SSI packages involving parts of a quad two NOR, a hex inverter, four dual four-expandable NORs and one quad R-S latch. Designated the SN54/74278, this IC consists of four input data latches and a five-line priority decoder in a single package.

CIRCLE NO. 258

Silicon npn power transistors offered

Silicon Transistor Corp., KSC Way (Katrina Rd.), Chelmsford, Mass. 01824. (617) 256-3321.

Two additions to the company's line of high power transistors are the 2N5038 and the 2N5039. These are fabricated using a double epitaxial process and hard solder construction and are available in a TO-3 package. They are suitable for switching control amplifiers, switching regulators, converters and inverters.

CIRCLE NO. 259

Transistors good for mobile applications

RCA Solid State Div., Route 202, Somerville, N.J. 08876. (201) 722-3200. 40967: $6.60; 40968: $8.40 (100 up).

Two rf transistors, for uhf class C amplifier service in low-voltage mobile applications, are designated types 40967 and 40968. The devices are rated for 2-W and 6-W power output at 470 MHz with a 12.5-V supply. They are the former developmental types TA8562 and TA8563, respectively, and are supplied in an RCA HF-44 package.

CIRCLE NO. 260

Sense amps simplify 1103 memory designs

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051. (408) 246-7501.

Two hex sense amps for 1103 memories simplify the operation of memory systems at high speeds. Termed the 3208A and 3408A (with latch), both devices are manufactured with Intel's Schottky bipolar process. As a result, maximum I/O delays are 20 and 25 ns over the temperature range for the 3208A and 3408A, respectively.

CIRCLE NO. 261

Op amps deliver up to 1 A at 12 V

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. (408) 732-5000. LH0021CK: $12.50; LH0041-CG: $8.50 (100 up); stock.

The LH0021/LH0021C and LH-0041/LH0041C general purpose op amps offer large output currents not usually associated with conventional IC op amps. The LH0021 provides output currents in excess of 1 A at voltage levels of ±12 V; the LH0041 delivers currents of 200 mA at voltage levels closely approaching the available power supplies. In addition, both the inputs and outputs are protected against overload. The devices are compensated with a single external capacitor.

CIRCLE NO. 262

FET input hybrid op amp cuts drift to 1 μV/°C

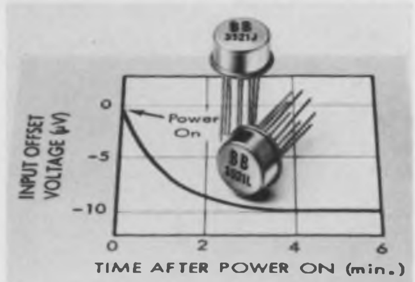


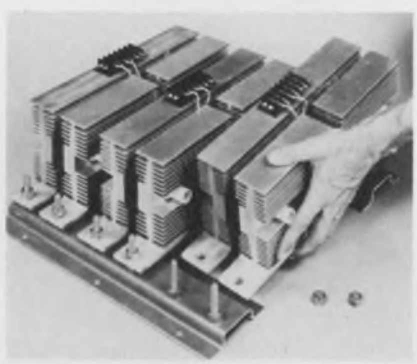
FIGURE 1. Typical Warmup Drift.

Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. 85706. (602) 294-1431. 3521L: $36 (100 up); stock (small qty.).

A FET-input op amp, in a hermetically-sealed TO-99 package, has 1-μV/°C voltage drift, 250-μV offset voltage and 10-pA input bias current. Designated the 3521L IC, it provides FET input performance with drift equal to that of bipolar ICs. Its low drift is obtained by use of a hybrid thin-film approach using a FET monolithic-pair input stage.

CIRCLE NO. 263

Thyristors and diodes for ac motor starters

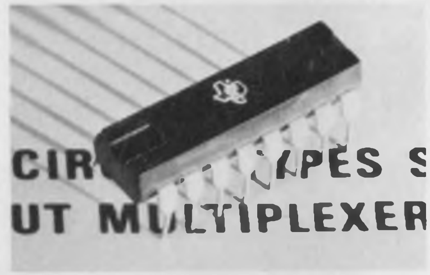


Power Semiconductors, Inc., 90 Munson St., Devon, Conn. 06460. (203) 874-6747.

A line of thyristors and diodes for use in solid state ac motor starters are rated for control of motors up to 1000 hp and line voltages of 240, 480 and 575 V. The devices feature high inrush capability. They are available either as components or in the "fast access" heat sink assembly.

CIRCLE NO. 264

Multiplexer w/storage replaces 2 MSI ICs



Texas Instruments Inc., P.O. Box 5012, M/S 308, Dallas, Tex. 75222. (214) 238-3741. SN74298N: $2.16 (100-999); stock.

A TTL/MSI quad two-input multiplexer with storage replaces the equivalent of two MSI circuits. Termed the SN54/74298, this IC consists basically of the SN74157 multiplexer with a quad D-type flip-flop added to store information selected by the quad multiplexer. The circuit selects one of two 4-bit data sources and stores data synchronously with the system clock. Its multiplexing capability permits connection to operate as a shift register that can shift N-places in a single clock pulse.

CIRCLE NO. 265

Improved counters replace existing types

Advanced Micro Devices Inc., 901 Thompson Pl., Sunnyvale, Calif. 94086. (408) 732-2400.

An improved four-device, high-speed counter series is designed to replace TI's 54/74160 and 54/74161 and Fairchild's 9310 and 9316. These four-bit up counters have built-in carry logic and provide synchronous counting and parallel entry. The Am54/74160 and Am54/74161 replace like-numbered TI devices but have typical count rates of 45 MHz compared to the 32 MHz listed for the TI circuits. The Am9310A and Am-9316A also offer 45-MHz speeds and have (as do the Am54/74160 and Am54/74161) a parallel enable load requirement of one unit load as compared to two for the Fairchild units that they replace. The Am54/74160 and Am9310A are modulo ten counters; the Am54/74161 and Am9316A, hexadecimal counters.

CIRCLE NO. 266

Need efficient cooling in a tighter-than-tight spot?

Rotron® has the answer.

The *BISCUIT®* – Rotron's high performance centrifugal blower that is only 1 3/16" thick. It works in really tight spots where no other can. It's the only 50-60 Hz air moving device that will fit inside a 1 3/4" rack panel instrument.

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14992

INFORMATION RETRIEVAL NUMBER 51

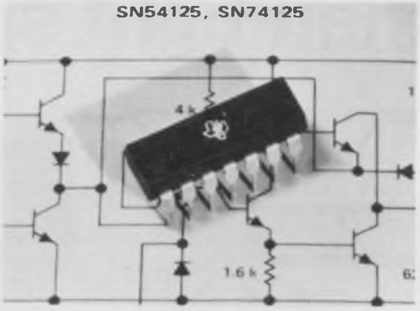
Hybrid decoder drivers simplify LED circuits

SCS Microsystems, Inc., 1150 N.W. 70th St., Fort Lauderdale, Fla. 33309. (305) 974-5400. 1001RL: $6; 1004RL: $11 (1-24).

The SCS 1000RL series, specifically designed for use with seven-segment LED readouts, offers a variety of TTL logic functions in standard DIP configurations. All outputs have series thick-film current limiting resistors eliminating the need for external limiters. Four models are available. Three of these are in 16-pin DIPs—the 1001RL with a decoder/driver plus output limiting resistors, the 1002-RL with a quad latch (memory), decoder/driver and limiters; and the 1003RL with a decade counter, decoder/driver and limiters. The 1004RL is in a 20-pin DIP and includes counter, latch, decoder/driver and output limiting resistors.

CIRCLE NO. 267

Bus buffer offers 2 ns delay

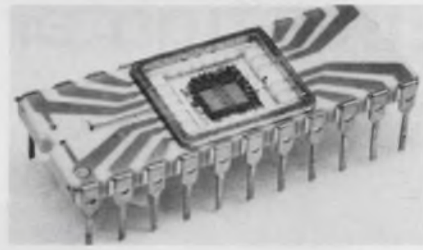


Texas Instruments Inc., P.O. Box 5012, M/S 308, Dallas, Tex. 75222. (214) 238-3741. SN74125N, SN-74126N: $1.15; stock.

Two TTL quad bus buffer gates feature reduced propagation delays and improved output disable times. Termed the SN54/74125 and the SN54/74126 (capable of replacing the DM8093 and DM8094, respectively), the average propagation delay time is only 2 ns. The switching speed between disable and enable is improved by 4 ns, reducing the possibility of two or more outputs overlapping when they are in the low-impedance (ON) state.

CIRCLE NO. 268

ASCII character gen has 350 ns access



Microsystems International Ltd., Box 3529 Station C, Ottawa, Canada K1Y 4J1. (613) 828-9191. $18.20 (100-999).

The MF7107 high-speed 4032 bit high-resolution row scan character generator, fabricated using p-channel silicon gate technology, provides 64 characters of 63 bits arranged in a 9 × 7 format. The device offers fast access and cycle times of 350 ns and operates from a +5 V, −9 V power supply. The MF7107 is directly TTL compatible, has a seven-bit parallel output, single TTL level clock, OR-tie capability and two chip select input leads. It's available in a 22-lead ceramic DIP package.

CIRCLE NO. 269

53-position keyboard costs just $49

Controls Research Corp., 2100 S. Fairview, Santa Ana, Calif. 92704. (714) 557-7161. $49 (5000); stock to 8 wks.

The Model 7100 is a 53-position keyboard ready for installation and operation. A dynamically-scanned MSI electronic encoding system simplifies the electronics and enables all circuitry to be housed on a single PC board complete with key-switch modules. The standard keyboard conforms to the proposed standards of the X4A9/199B committee of ANSI. Features include full ASCII coding (shifted, unshifted, control and control/shift), standard two-key rollover interlock, low-profile single PC board design, less than 300 mA power consumption and standard typewriter array.

CIRCLE NO. 270

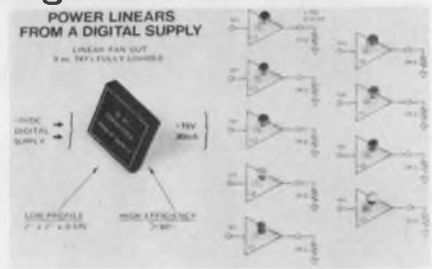
No contact amps sensor has ac input, dc output

American Aerospace Controls, Inc., 129 Verdi St., Farmingdale, N.Y. 11735. (516) 694-5100. $35 (1-9); Stock to 4 wks.

The Series 1003A-M1 industrial grade sensors are designed for 60-Hz, ac-current monitoring. The new line requires no external operating power and permits sensing with complete electrical isolation. Sensing is accomplished by inserting the current-carrying conductor through a hole in the center of the device. The alternating magnetic field surrounding the conductor creates an ac signal which is rectified and filtered to produce a 0 to 5 V dc output signal. The sensors are offered in six different models ranging from 0 to 2 A to 0 to 100 A. The units measure 1 × 2 × 2 inches, with a 3/8-inch diameter pass-through hole.

CIRCLE NO. 271

Dc/dc converters offer high isolation



Stevens-Arnold Inc., 7 Elkins St., S. Boston, Mass. 02127. (617) 268-1170. $39 to $69 ea.; stock to 6 wks.

Stevens-Arnold is offering dc/dc converters having a high degree of isolation. Input voltages are 5, 12, 28 V, with dual output voltages of ±8, ±12, ±15 V and current ratings from ±30 to ±150 mA. Medical types have isolation of 10 pF and 8 kV dc. Seated height is 0.375 to 0.5-inches. The units are shielded on six sides and between primary and secondary of the coupling transformer for negligible rfi/emi. Both input and output are filtered, reducing spikes to 10 mA. On the output, high common mode isolation reduces ripple and noise to less than 40 mV pk-pk when measured wideband from 5 Hz to 10 MHz.

CIRCLE NO. 272

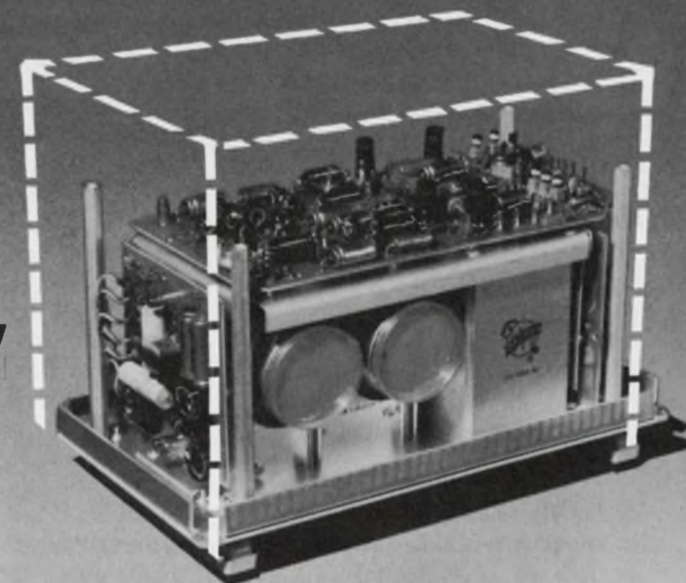
Speed controller eliminates cogging

Contronics, Inc., 2629 Johnstown Rd., Columbus, Ohio 43219. (614) 471-6466. $89.

This Contronics motor speed controller allows precise regulation over an extremely wide speed range without cogging at low speeds. Its full-wave operation has built-in feedback sensing. Usable with either shunt wound or permanent magnet type motors, the unit gives close control, to a 3% variance, depending on motor characteristics. Unit incorporates line-voltage transient protection and can be protected with standard slow-blow fuses. Ac or dc motors, 3/4 to 1 HP, can be controlled, even under full-load start conditions. The controller weighs 20 oz., measures 7 × 4-1/4 × 3 inches and is available for 115 or 230 V, 50 or 60 Hz input (105 or 210 V dc armature and field).

CIRCLE NO. 273

Imagination and Stackpole ferrites can cut a power supply down to size



Tektronix, Inc. uses Ceramag® ferrite materials to achieve efficiency and significant savings.

Conventional power supplies are bulky, heavy and inefficient. Tektronix, Inc. changed all that. With ferrites and a fresh idea.

By rectifying line voltage, converting it to 25kHz and rectifying it again, Tektronix, Inc. engineers produced a power supply that was 50% lighter, over 25% smaller and consumed ⅓ less power. And the overall operating efficiency of 70% is a big improvement over the 50% typical of conventional power supplies.

Ferrites can offer the unique advantages, design freedoms and electronic characteristics that produce exciting new ideas. Stackpole Ceramag ferrites were used throughout the power supply design. Because Stackpole has a wide variety of materials and configurations, designers can unleash their imaginations.

Ceramag 24B

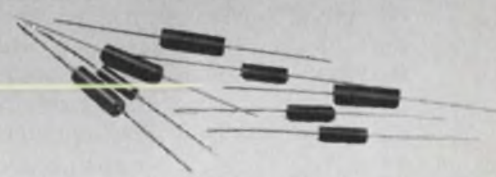
Tektronix, Inc. selected 24B for their "U" and "E" cores. This proven material has seen years of service in flybacks for television. Ideal for power applications, it can be operated at higher frequencies than laminated steel. It is cool running, due to low losses under power conditions and controlled power permeability. Tooling is available for a wide range of "U", "E" and "I" configurations.

Ceramag 24

Toroids of Ceramag 24 were used by Tektronix, Inc. for transformer cores. Again, this is a proven material, widely used by the computer industry for pulse transformer cores. It has a tightly controlled initial permeability, and tooling for a variety of sizes is also available.

Ceramag 7D and 27A

Multiple material selection for coil forms allowed Tektronix, Inc. maximum flexibility and design freedom. Proper inductance values could be achieved in the allotted amount of room. In addition, the high resistance of 7D



material prevents accidental shorting on printed circuit boards.

Great new designs happen when you *start* with the idea of ferrites. Particularly Stackpole Ceramag ferrite components. Why? Because Stackpole offers the variety of materials, numerous tooled configurations and the technical back-up you need. Twenty-four years of television and computer experience makes Stackpole one of the largest and most experienced domestic suppliers of quality ferrites.

Consider ferrites on your next prototype or redesign. But give us a call when you start. Perhaps we (and some Ceramag® ferrites) can help you cut a problem down to size. Stackpole Carbon Company, Electronic Components Division, St. Marys, Pa. 15857. Phone: 814-781-8521. TWX: 510-693-4511.

STACKPOLE
ELECTRONIC COMPONENTS DIVISION

INFORMATION RETRIEVAL NUMBER 56

16-bit d/a converters are glitchless

Phoenix Data, Inc., 3384 W. Osborn, Phoenix, Ariz. 85017 (602) 278-8528. $845 to $1595; 30 days.

Phoenix Data has introduced a new line of 15 and 16-bit glitchless d/a converters for military and commercial-industrial applications. The DAC-G series feature accuracy within 0.005% and linearity within 0.002% of full range; switching amplitude of 600 μV; and a switching transient duration of 200 ns, maximum. The DAC-G is completely self-contained and consists of an internal precision reference-voltage generator, the analog switches to connect the reference voltage into the precision resistor network, the precision network with temperature-matched feedback components, the output amplifier with short-circuit proofing, and a parallel holding register.

CIRCLE NO. 274

Precision voltage source has 0.005% stability

Intech, 1220 Coleman Ave., Santa Clara, Calif. 95050. (408) 244-0500. $85 (1-9); stock.

A precision voltage reference for accurate a/d converters and dc comparators, the A-803, features an input-voltage range of +15 to +25 V dc and an initial output-voltage of 10 V dc ±0.01%. It has 0.005% stability over a range of 0 to 60 C. Load currents to 2 mA are handled without performance degradation.

CIRCLE NO. 275

Scope probe features dc to 900-MHz bw

Tektronix, Inc., P.O. Box 500, Beaverton, Ore. 97005. (503) 644-0161. $375; stock.

The P 2601 is a dc-to-900 MHz, nonattenuating FET scope probe. Full-scope sensitivity is obtained with no sacrifice in the probe rise time of 0.4 ns. Input capacitance is 3 pF and input impedance is 100 KΩ. The probe can be used for both 50 Ω sampling and 1 MΩ conventional scopes. A dc offset permits dynamic measurements of ±600 mV on dc voltages up to ±5.5 V. Plug-on 10X and 100X attenuators extend maximum voltage ranges, provide higher input resistance, and reduce input capacitance. The probe is designed for the TEK 7904 and 7704A scopes. An optional accessory power supply (Model 1101) permits the probe to be used with other scopes.

CIRCLE NO. 276

Photodetector/amp offers 10:1 S/N ratio

Meret Inc., 1815 - 24th St., Santa Monica, Calif. 90404. (213) 828-7496. $145 (unit qty.); stock to 2 wks.

Available in both TO-5 (MDA-325) and flat pack (FDA325) versions, the units' photodetector/transimpedance amplifiers require a single voltage supply between +9 and +15 V. The units function as complete receivers for modulated light in the range of 300 to 1100 nm. Response at 905 nm is greater than 15 mV/μW over a 10-MHz bandwidth. Pulse response rise time is less than 40 ns.

CIRCLE NO. 277

Active filters cover the 0.001 Hz to 1 MHz range

Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. 85706. (602) 294-1431. $21 to $33 (100 up); 2 wks.

Burr-Brown's ATF76-Series active filters have low-pass (Butterworth, Bessel or Chebyschev), bandpass or band-reject characteristics. Low-pass models are available with two, four, six or eight poles. Bandpass models are single-tuned (one pole-pair) or stagger tuned (two pole-pairs) with Qs from one to 50. On standard versions cutoff or center frequencies range from 1 Hz to 20 kHz. Customized versions can be supplied for a wider range, 0.001 Hz to 1 MHz. Special packaging is also available. All types operate on ±15 V.

CIRCLE NO. 278

Thick-film hybrid unit rectifies synchronously

Tadiran, Israel Electronics Industries Ltd., 3 Hashalom Rd., P.O. Box 648, Tel Aviv, Israel.

Hybrid assembly, TH-D2-1, is used to demodulate servo-system suppressed-carrier signals. Gain stability is better than 100 ppm/°C and the output offset voltage is less than 30 mV for −55 to +125 C. The unit can also be used as a phase detector and precision full-wave synchronous rectifier. Gain and carrier-harmonic filtering can be externally trimmed. The assembly, designed to meet MIL-STD-883, is fabricated by a thick-film technique and sealed in a TO-8 package.

CIRCLE NO. 279

All you ever wanted to know about your capacitors... immediately, digitally, automatically, accurately.

The Model 275 Digital Capacitance Meter is a fast, simple, compact box that gives you automatic capacitance (both series and parallel) and dissipation measurements with the accuracy of a manually balanced instrument (approximately 0.1% plus one digit).

Designed primarily for production testing—outgoing and incoming—the 275 is simple to operate and features a brightly lit readout of 3½ digits with decimal point. Because of its wide range of capacitance measurements and the high resolution of its D measurements, however, it is also suited for use in developmental laboratories. Its small, half-rack size is another plus for bench work.

Normal mode of operation provides for repetitive measurements tracking at the rate of 4 per second, either C series or C parallel. When D is to be measured, the operator simply pushes the D button and the measurement is instantly displayed. The instrument's reliability is unusually high; circuitry is wholly solid state and mounted on a single, readily accessible, master PC board.

To extend the applications of the Model 275, several options are available. With the companion comparator sorting can be done, by C values *and* D values if desired. If bias measurements are required, an external bias supply can be connected to switch-controlled rear terminals. Holding and sorting fixtures are also available.

If you are making or buying capacitors, the Model 275 Capacitance Bridge will tell you what you need to know before you ship or wire them in. For just about $1200—plus $600 if you want the sorting option. Write or call for the entire story—there's nothing else quite like it.

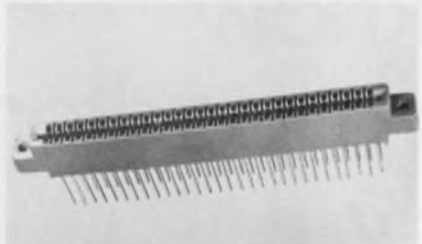
e|s|i ®

ELECTRO SCIENTIFIC INDUSTRIES

13900 N.W. Science Park Drive • Portland, Oregon 97229 • Telephone: 503/646-4141 • Telex: 36-0273

INFORMATION RETRIEVAL NUMBER 58

PC connectors span 5 to 50 contacts

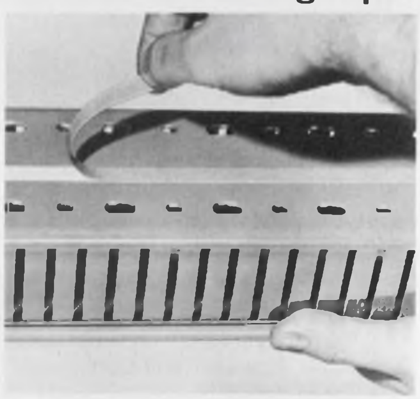


Fabri-Tek, Inc., National Connector Div., 5901 S. County Rd. 18, Minneapolis, Minn. 55436. (612) 935-0133. $0.02/contact; stock to 60 days.

An innovative series of direct card connectors for PC applications, the Series 9, is available in either 100 or 125-mil centers, and with any number of contacts from five to 50 dual contact positions. The Series 9 features 25-mil square wrapped-wire tails, bifurcated contacts and five mounting hole options.

CIRCLE NO. 300

PVC wiring duct has adhesive mounting tape



Electrovert Inc., 86 Hartford Ave., Mount Vernon, N.Y. 10553. (914) 664-6090.

A PVC wiring duct features pre-punched mounting slots and a temporary adhesive mounting tape as part of the standard design. The duct is positioned in place by means of the adhesive backing and the holes are then drilled in the mounting panel to coincide with selected mounting slots in the duct. This will assure perfect alignment and eliminate the need to drill through the duct. The line includes all standard sizes ranging from 1 × 1-in. to 4 ×4-in.

CIRCLE NO. 301

Heat dissipator doubles extrusion efficiency

W. F. Chew Enterprises, 441 E. 4th St., Long Beach, Calif. 90812. (213) 432-2704. Stock.

MODsink, a lightweight heat dissipator for semiconductors, is 100% more efficient and yet requires only two-thirds the space of an extrusion type heat sink doing the same job. Balanced air flow distribution in a new compact modular package with increased surface area is responsible for the improved performance. Thermal resistance is 0.13 C/W to 0.23 C/W depending on air flow. Dissipation of 200 to 2000 W (4 to 40 transistors) may be accomplished with a single fan.

CIRCLE NO. 302

Resistive pastes aimed for thick film hybrids

Transene Co., Inc., Route One, Rowley, Mass. 01969. (617) 948-2501. $36/oz. (small quantities); stock.

Ohm-resist, a resistive cermet composition for thick film hybrid microelectronic circuits, is formulated as screenable resistor pastes with carefully controlled rheology. The product is applied by screening on ceramic substrates and fired to generate discrete resistors and resistor networks. Ohm-resist is available in a wide selection of sheet resistance values ranging from 10 ohms to 100 kilohms.

CIRCLE NO. 303

Low profile DIP sockets come in 14 or 16 pins

Vero Electronics, Inc., 171 Bridge Rd., Hauppauge, N.Y. 11787. (516) 234-0400.

Solderless-wrap 14 and 16-pin low profile DIP sockets feature low contact resistance and high reliability of the flow solder versions. This was achieved by using the same contact form in phosphor bronze, with a 25 × 25 × 583-mil termination. Contact finish is 1 UAU over 0.8 UAG. The body material is glass-filled nylon and its design features mounting points for hexagon bolts or nuts.

CIRCLE NO. 304

The bright new ideas are also inexpensive.

This is one of the least expensive precision lighted pushbuttons in existence. We call it our Series 4.

Precision—because our reliable SM snap-action basic does the switching. Inexpensive—because our standard price includes assembled product with lamp. In short . . . low installed cost.

You just snap the Series 4 into the front of your panel. Quick-connect terminals make wiring a snap, as well. Relamping? Just pull out the display screen and the lamp is automatically extracted from its socket.

There's a choice of low energy (1 amp, 125 vac max.) and power load (5 amps, 250 vac max.) switching—both UL listed. Bezel and barrier housings plus matching indicators are also available.

So, depending on the business you're in, you can use this new pushbutton on things like business machines, computer peripheral, instrumentation and commercial equipment.

Make it your business to call your MICRO SWITCH Branch Office or Authorized Distributor (Yellow Pages, "Switches, Electric"). Or write for Product Sheet Series 4.

In either case, we guarantee to make your life a little brighter.

MICRO SWITCH makes your ideas work.

MICRO SWITCH

FREEPORT, ILLINOIS 61032

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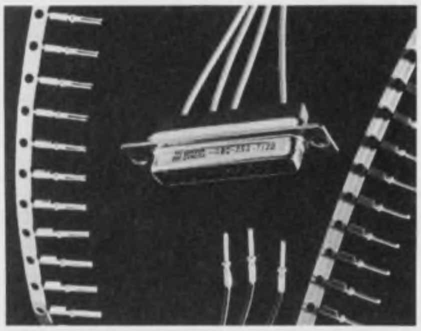
MICRO SWITCH products are available worldwide through Honeywell International.

INFORMATION RETRIEVAL NUMBER 60

Connectors permit 1500 terminations/hour



ITT Cannon Electric, 666 E. Dyer Rd., Santa Ana, Calif. 92702. (714) 557-4700.

Subminiature rectangular connectors with stamped contacts permit 1500 terminations per hour. Burgun-D Mark IV connectors accommodate wire gauges from 20 to 30 AWG. Contacts are on a carrier strip designed for an 18-inch-diameter reel to be used on semiautomatic crimp machines that are available for sale or lease.

CIRCLE NO. 305

Two-piece PC connectors solve mating problems

Control Data Corp., Connector Operation, 31829 La Tienda Rd., Westlake, Calif. 91361. (213) 889-3535.

Two-piece PC connectors having 25-mil square post terminations with 100-mil spacing are designed for nonedgeboard PC applications, mother-daughter board designs, and intermateability between PC cards. Fourteen standard sizes are offered—10, 13, 16, 20, 23, 26, 30, 33, 36, 40, 43, 46, 50 and 53 dual row positions. Contact rows in plug and receptacle are on a 100 × 150-mil grid, and all contacts are located within a 20-mil diameter of true position to accommodate solderless-wrap equipment.

CIRCLE NO. 306

Edge connector reduces installation time

Reed Devices Inc., 21W183 Hill Ave., Glen Ellyn, Ill. 60137. (312) 858-2050. $9.90 (10 up)/22 pins; stock.

A PC board edge-connector mounting system conveniently mounts single cards and provides terminal screws for field wiring. Offering savings in time and expense in panel mounting systems where only a few cards are required, the Snaptrack system is claimed to reduce installation labor 30%. Three models are offered to handle notched and straight cards in single-sided 22-pin and double-sided 44-pin output configurations.

CIRCLE NO. 307

Wash-away adhesive holds delicate parts

Aremco Products, Inc., P.O. Box 145, Briarcliff Manor, N.Y. 10510. (914) 762-0685. $25/5 sticks; stock.

Crystalbond 509, an acetone soluble thermoplastic polymer used as a temporary bond, acts as a "wash-away" adhesive for holding delicate parts such as crystals, and ceramic substrates for slicing, grinding, dicing, or polishing operations. The adhesive has excellent adherence properties and will bond to porous or non-porous metals, glass or ceramic surfaces, and yet will not clog the cutting blades of grinding media. The Crystalbond melts at 160 F.

CIRCLE NO. 308

Contact cleaner absorbs moisture

WD-40 Co., 5390 Napa St., San Diego, Calif. 92110. (714) 297-4938.

WD-40 has the ability to drive out moisture from the pores of metals and can be used as a contact cleaner that also eliminates corrosion. It quickly dries out wet electric motors and deposits a thin molecular film that inhibits reentry of damaging moisture, preventing rust, corrosion and further malfunction. As it is a non-conductor, the product may freely be used on motors, generators, alternators, wiring and connectors.

CIRCLE NO. 309

Still paying for oscillator stability you don't need?

Plug in our K1065A instead. Medium stability and price. 1 to 5 MHz range: 3×10^{-8} stability for -20° to +55°C; less than 5×10^{-9} aging per day. Prototype quantities available for immediate delivery in 1.0 MHz and 5.0 MHz. Details available from Motorola Component Products Dept., 4545 W. Augusta Blvd., Chicago, Ill. 60651. MOTOROLA

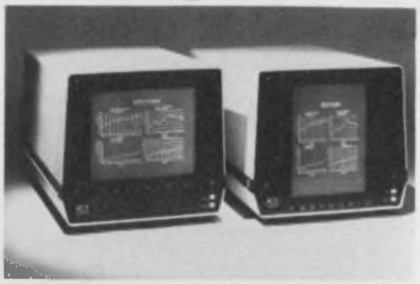
3-1/2-digit DMM uses LSI for reliability

John Fluke Manufacturing Co., Inc., P.O. Box 7428, Seattle, Wash. 98133. (800) 426-0361. $299; stock.

Featuring a basic accuracy of 0.1%, the new Fluke 8000A DMM measures, in 26 ranges, ac and dc voltages from 100 μV to 1200 V, ac and dc currents from 100 nA to 2 A and resistance from 100 milliohms to 20 MΩ. All instruments are guaranteed to meet specs for one year. According to the manufacturer, the instrument is the first to use both analog and digital LSIs. The two chips used, equivalent to over 3000 circuit elements, help reduce the parts count to about one-third that of typical 3-1/2-digit voltmeters. Because of the low parts count and LSI design the company says that it expects high reliability. The instrument is designed to withstand a fall from bench height without damage.

CIRCLE NO. 320

Ultra-bright display uses storage CRT



Tektronix, Inc., P.O. Box 500, Beaverton, Ore. 97005. (503) 644-0161. $2200.

The "Ultra-Bright" 613 is an 11-inch, flat, direct-view storage display that is said to put out four times the brightness of other large storage CRT displays. It offers group viewing in an office where the ambient lighting is as high as 100 foot-candles. Besides being super sharp, the trace on the "Ultra-Bright" 613 has no flicker or drift characteristics. The unit doesn't use external memory devices to refresh the display. Instead, it uses a storage CRT that stores the information on the screen.

CIRCLE NO. 321

DPMs offered for high-accuracy systems

Newport Laboratories, Inc., 630 E. Young St., Santa Ana, Calif. 92705. (714) 540-4914. 2000A: $385 to $465; 2000B: $280.

Newport Laboratories announces their new Series 2000A and 2000B DPMs. Series 2000A has higher accuracy and resolution—±0.01% of reading ±0.005% of full scale and ±39,999 counts full scale, respectively. Its reading rate is up to 20 readings/sec. The 2000A also features auto-polarity, ratio and indefinite storage of a reading, upon external command. The 2000B gives less accuracy and resolution—±0.02% reading error and ±19.999 counts—but it's smaller in size and faster at 30 readings/sec. Both series feature buffered, isolated and gated BCD outputs.

CIRCLE NO. 322

"Our customers don't worry about delivery" 1-800-325-2595

your Toll-Free Number — to place your IC order, ask a question, or verify a rumor!

CATALOG NUMBER	ANY QUANTITY PER ITEM 1-99 MIX	100-999 MIX	1000-UP MIX	MULTIPLES OF 10 PER ITEM 100-990 MIX	1000-9990 MIX	10,000-UP MIX
7400	.26	.25	.23	.22	.21	.20
7401	.26	.25	.23	.22	.21	.20
7402	.26	.25	.23	.22	.21	.20
7403	.26	.25	.23	.22	.21	.20
7404	.28	.27	.25	.24	.22	.21
7405	.28	.27	.25	.24	.22	.21
7406	.52	.50	.47	.44	.42	.39
7407	.52	.50	.47	.44	.42	.39
7408	.32	.30	.29	.27	.26	.24
7409	.32	.30	.29	.27	.26	.24
7410	.26	.25	.23	.22	.21	.20
7411	.28	.27	.25	.24	.22	.21
7413	.58	.55	.52	.49	.46	.44
7416	.52	.50	.47	.44	.42	.39
7417	.52	.50	.47	.44	.42	.39
7420	.26	.25	.23	.22	.21	.20
7421	.26	.25	.23	.22	.21	.20
7423	.80	.76	.72	.68	.64	.60
7425	.50	.48	.45	.43	.40	.38
7426	.34	.32	.31	.29	.27	.26
7430	.26	.25	.23	.22	.21	.20
7437	.56	.53	.50	.48	.45	.42
7438	.56	.53	.50	.48	.45	.42
7440	.26	.25	.23	.22	.21	.20
7441	1.73	1.64	.155	1.46	1.37	1.27
7442	1.27	1.21	1.14	1.07	1.01	.94
7443	1.27	1.21	1.14	1.07	1.01	.94
7444	1.27	1.21	1.14	1.07	1.01	.94
7445	1.71	1.62	1.53	1.44	1.35	1.26
7446	1.24	1.17	1.11	1.04	.98	.91
7447	1.16	1.10	1.04	.98	.92	.85
7448	1.44	1.37	1.29	1.22	1.14	1.06
7450	.26	.25	.23	.22	.21	.20
7451	.26	.25	.23	.22	.21	.20
7453	.26	.25	.23	.22	.21	.20
7454	.26	.25	.23	.22	.21	.20
7460	.26	.25	.23	.22	.21	.20
7470	.42	.40	.38	.36	.34	.32
7472	.38	.36	.34	.32	.30	.29
7473	.50	.48	.45	.43	.40	.38
7474	.50	.48	.45	.43	.40	.38
7475	.80	.76	.72	.68	.64	.60
7476	.56	.53	.50	.48	.45	.42
7480	.76	.72	.68	.65	.61	.57
7482	.99	.94	.88	.83	.78	.73
7483	1.63	1.55	1.46	1.38	1.29	1.20
7485	1.43	1.35	1.28	1.20	1.13	1.05
7486	.58	.55	.52	.49	.46	.44
7490	.80	.76	.72	.68	.64	.60
7491	1.43	1.35	1.28	1.20	1.13	1.05
7492	.80	.76	.72	.68	.64	.60
7493	.80	.76	.72	.68	.64	.60
7494	1.18	1.12	1.05	.99	.93	.87
7495	1.18	1.12	1.05	.99	.93	.87
7496	1.18	1.12	1.05	.99	.93	.87
74100	1.52	1.44	1.36	1.28	1.20	1.12

CATALOG NUMBER	ANY QUANTITY PER ITEM 1-99 MIX	100-999 MIX	1000-UP MIX	MULTIPLES OF 10 PER ITEM 100-990 MIX	1000-9990 MIX	10,000-UP MIX
74107	.52	.49	.47	.44	.42	.39
74121	.56	.53	.50	.48	.45	.42
74122	.70	.67	.63	.60	.56	.53
74123	1.21	1.06	1.00	.94	.89	.83
74141	1.63	1.55	1.46	1.38	1.29	1.20
74145	1.41	1.33	1.26	1.18	1.11	1.04
74150	1.63	1.55	1.46	1.38	1.29	1.20
74151	1.20	1.13	1.07	1.01	.95	.88
74153	1.63	1.55	1.46	1.38	1.29	1.20
74154	2.43	2.30	2.16	2.03	1.89	1.76
74155	1.46	1.39	1.31	1.23	1.16	1.08
74156	1.46	1.39	1.31	1.23	1.16	1.08
74157	1.56	1.48	1.39	1.31	1.23	1.15
74158	1.56	1.48	1.39	1.31	1.23	1.15
74160	1.89	1.79	1.68	1.58	1.47	1.37
74164	1.89	1.79	1.68	1.58	1.47	1.37
74166	1.98	1.87	1.76	1.65	1.54	1.43
74176	1.62	1.53	1.45	1.36	1.28	1.19
74177	1.62	1.53	1.45	1.36	1.28	1.19
74180	1.20	1.13	1.07	1.01	.95	.88
74181	5.20	4.90	4.59	4.28	3.98	3.67
74182	1.20	1.13	1.07	1.01	.95	.88
74192	1.98	1.87	1.76	1.65	1.54	1.43
74193	1.98	1.87	1.76	1.65	1.54	1.43
74196	1.98	1.87	1.76	1.65	1.54	1.43
74197	1.98	1.87	1.76	1.65	1.54	1.43
74198	2.81	2.65	2.50	2.34	2.18	2.03
74199	2.81	2.65	2.50	2.34	2.18	2.03
NE501	2.99	2.82	2.66	2.49	2.32	2.16
NE526	3.59	3.38	3.17	2.95	2.74	2.53
NE531	3.81	3.58	3.36	3.14	2.91	2.69
NE533	3.81	3.58	3.36	3.14	2.91	2.69
NE536	7.31	6.88	6.45	6.02	5.59	5.16
NE537	7.53	7.09	6.65	6.20	5.76	5.32
NE540	2.16	2.04	1.92	1.80	1.68	1.56
NE555	.98	.93	.88	.83	.78	.73
NE560	3.57	3.36	3.15	2.94	2.73	2.52
NE561	3.57	3.36	3.15	2.94	2.73	2.52
NE562	3.57	3.36	3.15	2.94	2.73	2.52
NE565	3.57	3.36	3.15	2.94	2.73	2.52
NE566	3.57	3.36	3.15	2.94	2.73	2.52
NE567	3.57	3.36	3.15	2.94	2.73	2.52
N5111	.90	.86	.81	.77	.72	.68
N5556	1.87	1.77	1.66	1.56	1.46	1.35
N5558	.80	.76	.72	.68	.64	.60
N5595	3.40	3.20	3.00	2.80	2.60	2.40
N5596	1.87	1.77	1.66	1.56	1.46	1.35
709	.42	.40	.38	.36	.34	.32
710	.42	.40	.38	.36	.34	.32
711	.44	.42	.40	.37	.35	.33
723	1.00	.95	.90	.85	.80	.75
733	1.90	1.80	1.70	1.60	1.50	1.40
741	.44	.42	.40	.37	.35	.33
747	1.05	.99	.94	.88	.83	.77
748	.48	.46	.43	.41	.38	.36

We also stock a complete line of SCHOTTKY TTL devices, and 7-segment LED Displays.

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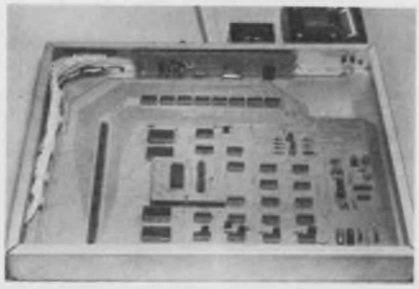
DATA PROCESSING

Circuit converts TTY printer to data logger



Gryczuk Electronics Co., Inc., 208 Hillcrest Ave., Millheim, Pa. 16854. (814) 349-5555. Under $2000 including teletypewriter.

The PPSDC 1000/I, when coupled to a Teletype ASR 33, converts the printer to a data-logging terminal for data sources like DVMs and counters. Custom-designed formats, which can be changed in-the-field, are accommodated by the plug-in design. The unit will accept most binary codes with positive or negative logic. Options include parity generation and a buffered 64-bit input.

CIRCLE NO. 323

Digital filter simulates all classical filters

Rockland Systems Corp., 230 W. Nyack Rd., W. Nyack, N.Y. 10994. (914) 623-6666. $8500; 12 wks.

Digital-filter configurations to eight poles and eight zeros are implemented by the Model 4136 in cascade, recursive form with variable sampling rates to 80 kHz. Many classical filter types can be programmed with the unit's twelve, 16-bit filter coefficients. Types include Butterworth, Chebyshev, Bessel and Cauer (elliptic). The digital-signal input and output can have up to a 16-bit resolution; while internal computation is carried out with 24-bit accuracy. Internal 12-bit a/d and d/a converters are available as options.

CIRCLE NO. 324

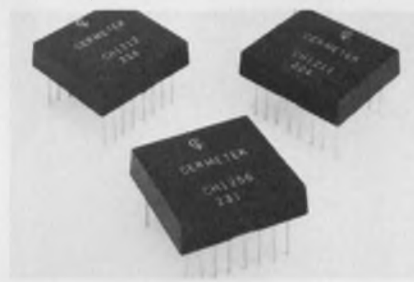
Flexible-disc memory stores 1.4 million bits

Century Data Systems, Inc., 1270 N. Kraemer Blvd., Anaheim, Calif. 92806. (714) 632-7041. $500 (OEM qnty); Under $4 per cartridge.

The CDS-110 flexible-disc drive accepts a removable 7.5-in. four-mil mylar-jacketed disc that stores over 1.4 Mb of data on 64 tracks. Data is transferred at 33.3 kb/s and track-to-track access time is 40 ms. Units are available with read only, read/write or read-after-write capability. The disc cartridge is removable from the unit and can be mailed or stored for future use.

CIRCLE NO. 325

FSK modem modules occupy only 2.35 in.^{2}



Cermetek, Inc., 660 National Ave., Mountain View, Calif. 94040. (415) 969-9433. $33.55 (100 up) for set of three modules.

Thick-film hybrid modules for frequency-shift-keying modems use switched active resonator circuitry for modulation and demodulation. The technique eliminates many of the problems associated with phase-lock loop circuits and requires a minimum of external components. Packaged in a double-spaced, 16-pin DIP, the unit's dimensions are 0.85 × 0.92 × 0.25 in. A typical 300 b/s modem uses a CH1211 demodulator, a CH1212 modulator and a CH1256 bandpass filter, and occupies only 2.35-in. of board space.

CIRCLE NO. 326

DATA PROCESSING

Encoder allows remote use of WATS line

Electronic Concepts Laboratories, 70 Hilliard St., Manchester, Conn. 06040. (203) 522-2171. Encoder: $250; Base station: $500.

Tel-Extenda-Line makes any telephone an extension of WATS, tie or trunk lines, and provides off-premise access to internal or private secondary telephone systems. The system consists of a portable pocket-size encoder, and a decoder base station that is connected to WATS or internal telephone lines and to a dedicated local line. Use of encoder audio signals and the dedicated local number ensures that only an authorized, properly equipped individual can gain access. The encoder is powered by one 9-volt transistor battery.

CIRCLE NO. 327

Laboratory peripheral unit interfaces PDP-11

Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754. (617) 897-5111. Under $3000.

Designed to interface to the PDP-11 family of computers via the Unibus, the LPS11-S performs a variety of functions including a/d conversion (12-bit, sample and hold), multiplexing (eight-channels), measuring, display controlling and real-time clocking. This new laboratory peripheral system is suitable for applications including biomedical research, analytical instrumentation, data collection and reduction and industrial testing.

CIRCLE NO. 328

Minicomputer uses a 4-k, 16-bit LSI memory

Texas Instruments Inc., Digital Systems Div., P.O. Box 1444, Houston, Tex. 77001. (713) 494-2186. $3475 (1-100); 45 days.

TI's new Model 980A minicomputer includes for its $3475 price a 4-k word, 16-bit, semiconductor memory with a 750-ns cycle time. The mini features items such as a hardware multiply/divide system, an I/O bus with four ports (expandable to 13) and a direct memory access channel (expandable to eight ports). Also, extensive software is included. A $100 battery pack option provides standby power for two weeks.

CIRCLE NO. 329

PCM system changes data format on command

Spacetac, Inc., Burlington Rd., Bedford, Mass. 01730. $10,000 to $20,000; 45 days.

Format control and frame synchronization in the Series 2100 PCM encoders are done with electrically-programmable read-only memories (EPROMS) which allow storage of up to eight formats. Selection of any format is commandable or programmable. Other features are: Handles any bit rate to 256 kb/s at 6 to 11 b/word; up to 2048 b/frame; up to 128 subframes; 6 to 10-bit analog-to-digital resolution; any of 10 output codes; and various parity options. Up to 128 analog and 320 digital inputs can be handled without restrictions on the combinations.

CIRCLE NO. 330

Laser light used to record on 8-mm film

Laser Microfilming, Inc., 800 Shames Dr., Westbury, N.Y. 11590. (516) 334-4402.

Using laser light to photographically expose 8-mm film, the PDR-5A analog recorder/reproducer provides 36 independent channels on a 2000-ft reel. The data is recorded as varying shades of gray with a density of 2500 cycles/in. The bandwidth is flat from 0 to 150 kHz.

CIRCLE NO. 331

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Availability in **88 STANDARD SIZES** and **23 STANDARD FINISHES** make **2024 COMBINATIONS** for your distinctive cabinetry.

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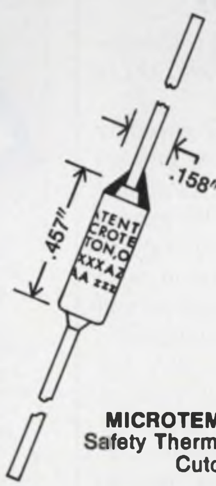
INFORMATION RETRIEVAL NUMBER 69

mi·cro·temp (mī′krō temp′)

A patented, positive safety thermal cutoff.
It will interrupt a circuit when the operating temperature exceeds the rated temperature of the cutoff. Normally employed as a back-up safety protector to cut off power to electronic circuits or components that develop abnormal temperature build-up, this device is fast, reliable and accurate to ± 3°F. MICROTEMPS are UL/CSA listed and insure product safety. Costing as little as 7.5¢ each, MICROTEMPS are available in a wide range of configurations, ratings and terminations to suit your individual applications. MICROTEMPS are hermetically sealed; unaffected by vibration, shock, aging or positioning. For specific details regarding your requirements, call or write:



MICROTEMP
Safety Thermal Cutoff

MICRO DEVICES CORP.
1881 Southtown Blvd. Dayton, Ohio 45439
Ph. (513) 294-0581 Telex: 28-8087

INFORMATION RETRIEVAL NUMBER 70

HALEX, INC.

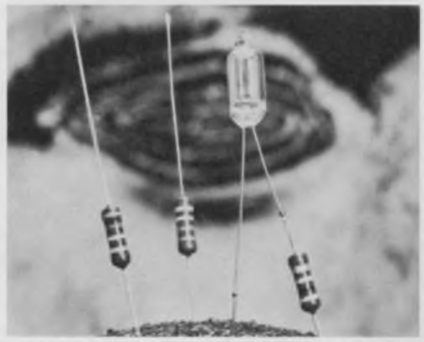
Second-sourcing:
0007 Clock Driver
0009 Dual Clock Driver
0033 High Speed Buffer
0034 Level Shifter

For prices and data sheets on these or other high-quality thin-film microcircuits, please call or write:

Halex, Inc.
P.O. Box 2940
Torrance, California 90509
(213) 772-4461, (213) 542-3555
Telex 65-3442

INFORMATION RETRIEVAL NUMBER 71

Film resistors feature weldable leads



Piher International Corp., 1239 Rand Rd., Des Plaines, Ill. 60016. (312) 297-1560.

Piher copperply weldable-lead carbon-film resistors are ideal for neon glow lamp applications. Featuring a specially-formulated, conformally-coated encapsulant, the 1/3 W, 5 and 10% resistors are resistant to environmental conditions. A temperature coefficient of 180 ppm/°C max., a moisture resistance change of ±1.5% max., and a shelf-like change of 0.15% provides stability better than carbon-composition resistors. They are available in lead-tape and reel packaging.

CIRCLE NO. 332

Low inertia dc motor accelerates rapidly

Magnedyne, Inc., 5580 El Camino Real, Carlsbad, Calif. 92008. (714) 729-7191.

A low-inertia dc motor specially designed for fast computer peripheral equipment has been introduced by Magnedyne, Inc. Designated the Model 702, the new moving coil motor features an aluminum wire armature supported by resins and other lightweight, nonmagnetic materials. These features give the Model 702 high torsional resonant frequency together with high inherent damping and theoretical acceleration on the order of 600,000 radians/sec^2. And armature circuit inductance is only 60 μH maximum at 1000 Hz. Torque constant of the high-performance motor is 11.5 oz-in/amp, armature inertia is only 0.0009 oz-in-sec^2, and armature circuit resistance is 0.65 ohms.

CIRCLE NO. 333

Hall-effect head reads magnetic stripe on cards

Pioneer Electronic Corp., Components & Data Products Div., 525 W. Remington Dr., Sunnyvale, Calif. 94087. (408) 245-3511.

The CRH-3101, a read-only Hall-effect head, meets ABA and IATA proposed requirements. Its primary applications are for 0.25 in. stripes on magnetically-encoded credit cards, sales tags and other hard-surface media. The head generates an ouput that is independent of speed and proportional to the magnetic flux. The output signal at a recording density of 210 FRPI is typically 4 mV peak to peak with a balanced load of greater than 10 kΩ at a control current of 8 mA dc.

CIRCLE NO. 334

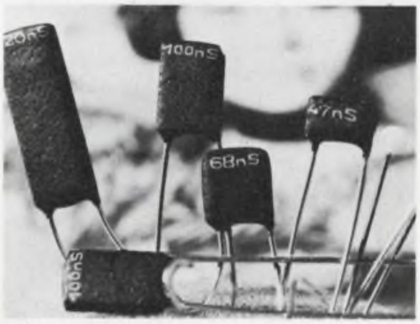
Semiconductor heating element regulates itself

Murata Corp. of America, 2 Westchester Plaza, Elmsford, N.Y. 10523. (914) 592-9180.

New semiconductor devices act as heating elements and provide their own inherent temperature control. They are called Posistors and have a positive temperature coefficient that tends to dissipate a constant power level (for loads under 100 W) over a range of voltages. For higher wattages, Posistors may be used to control other conventional high-power heating elements. The Posistor line includes versions for temperatures from 40 to 200 C and wattages from 2.4 to 100 W. Other units are available to control high-power heating elements in the 100 W to 2 kW range.

CIRCLE NO. 335

Titanate ceramic has 50 k dielectric constant



Siemens Corp., Components Div., PB Dept., 186 Wood Ave., Iselin, N.J. 08830. (201) 494-1000. $0.10 to $0.25 (100 up).

Capacitors with a new titanate-ceramic dielectric have a dielectric constant of 50,000. This permits a significant reduction in size. Radial leaded, flat capacitors with values to 220 nF at 40 V dc are available. Operating temperature is −25 C to 85 C with a tolerance of +50% to −20%.

CIRCLE NO. 336

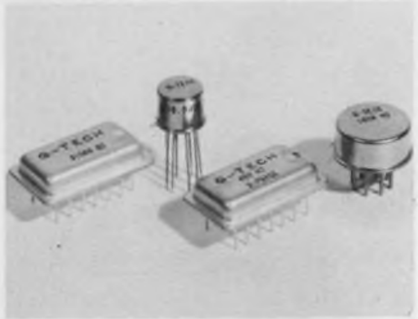
Slide switch selects decimal-point location

OEM Mectronix, Inc., 115 E. Bethpage Rd., Plainview, N.Y. 11803. (516) 293-1530. Stock.

Five-position slide switch, ASI P/N 1577, is primarily used to control the number of digits displayed after the decimal point in electronic calculators. It has four NO contacts and one NC contact. In calculators, the switch turns the power on and then selects two, four or six digits after the decimal point. The switch is aimed at low voltage and current applications. It is capable of carrying and switching 0.5 A at 110 V ac.

CIRCLE NO. 337

Crystal oscillator has 300,000 hours MTBF

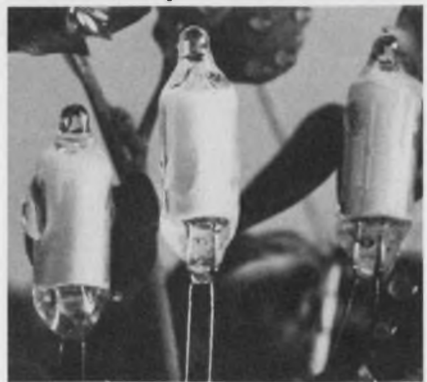


Q-Tech Corp., 11529 W. Pico Blvd., Los Angeles, Calif. 90063. (213) 473-1105. $13 (1000 up) for 0 to 50 C, TO-5 models; stock to 6 wks.

Hybrid thin-film crystal controlled oscillators in TO-5, TO-8 or DIP have an MTBF of 300,000 hr when tested at 85 C. Frequency range is 6-25 MHz for units in TO-5 packages and 400 Hz-25 MHz for TO-8 and DIP types. They are TTL compatible and available in single, complimentary, and 3-phase (DIP only) versions. Operating temperature is from 0 to +50 C or −55 to +105 C, with the frequency stabilities of AT-cut quartz crystals.

CIRCLE NO. 338

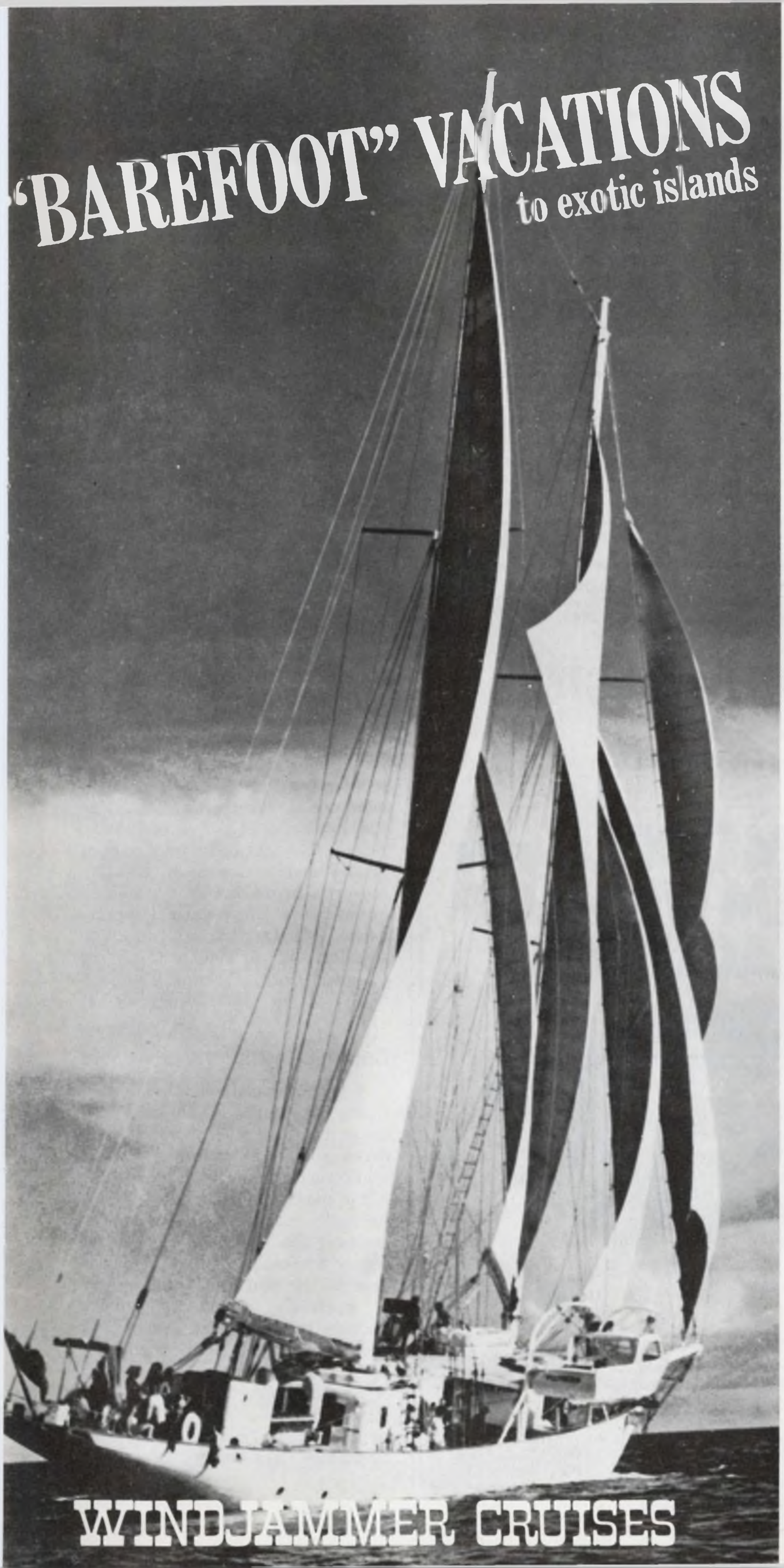
First practical green neon lamp is announced



General Electric Co., Nela Park, Cleveland, Ohio 44122. (216) 266-2258; stock.

An industry first—a practical, long-life, green neon glow lamp—adds two colors—green and blue (with filter)—to the red, yellow and orange of present glow lamps. Key to the green light output is a special phosphor coating applied to the inside surface of the bulb and a new gas. Designated G2B, the new lamp is directly interchangeable electrically and physically with GE's C2A glow lamp. Average useful life is 10,000 hours.

CIRCLE NO. 339


"BAREFOOT" VACATIONS
to exotic islands
WINDJAMMER CRUISES

evaluation samples

Assembly pins

A broad variety of assembly pins are made from either steel, stainless steel, copper or from any other variety of wire and materials. The pins can be pointed sharp at one end, dull ended or bullet nosed so that they may be inserted very easily during assembly operations. The pins can also be double chamferred and pointed on both ends when required. John M. Dean Inc.

CIRCLE NO. 340

Encapsulation epoxy

Plaskon Epiall MX-3000 is an improved epoxy compound for the encapsulation of electronic devices that is designed to have excellent electrical property retention during prolonged, continuous exposure to high temperature and excessive moisture. Devices encapsulated in Plaskon Epiall MX-3000 resin have repeatedly withstood a minimum of 10 six-hour cycles in a pressure cooker with no corrosion problems or evidence of electrical breakdown. Minimum compressive strength is 30,000 psi. Allied Chemical Corp., Plastics Div.

CIRCLE NO. 341

Ceramic insulators

A practical method of manufacturing ceramic insulators with metal members molded in place reduces costs of making electrical connections from one side of ceramic parts to the other compared to parts made by the four-step mold-metalize-fire and braze procedure presently required. Molded-in-metal components give electronic engineers considerably more latitude in component design and positioning of metal members. Also, they permit a hole pattern of much greater density than currently available and with exceptionally close member-to-member tolerances. Ceram Corp.

CIRCLE NO. 342

Octagonal socket

A new socket is octagonal in shape to allow close packing on a 400-mil pitch. The socket body is molded in glass-loaded nylon and the contacts are gold plated phosphor bronze. The over-all height of 0.3 in. allows devices with leads up to 0.25-in. long to be fully inserted. The solder tails are suitable for boards up to 125-mils thick and are arranged on 283-mils P.C.D. These sockets are inexpensively priced at $0.20 each for small quantities and as little as $0.12 each for 250-499. Jermyn.

CIRCLE NO. 343

Glass bubbles

A lightweight glass bubble is available for use in syntactic foams where minimum density must be controlled very precisely. Called the B18A type 3M brand glass bubble, it is the lightest of the high strength B—a series of bubbles that have found uses from the depths of the sea to outer space. Particle size averages 80 microns and density of a typical sample is 0.16 grams per cc. Combined with epoxy resin binders, the B18A glass bubbles can make compounds, such as adhesives, sealers and core-fillers, with a density as low as 34 lb./cu. ft. and a hydrostatic collapse strength as high as 10,000 psi. 3M Co.

CIRCLE NO. 344

Polyethylene foam

A plastic work surface and drawer liner material for laboratories, trade-marked Clean Sheets, is a cross-linked polyethylene foam. The closed-cell construction of this material provides a smooth, nonabsorbent, nonwetting surface that is easily cleaned. The new material is resilient but not spongy. It protects glassware against breakage, cushions delicate equipment and eliminates clatter. The matte-white finish provides a bright, clean surface without glare. The cross-linked polyethylene material is unaffected by acids, bases, alcohols or titrants. The closed-cell construction holds chemicals on the surface, makes spills easy to clean. Nagle Co., Labware Div.

CIRCLE NO. 345

application notes

Computer-aided wiring

A twenty-eight page booklet describes steps used in preparing input data for computer-aided wiring of DIP sockets and panels. Three optional computer-entry points are described in detail—logic diagram, pin list, and to-to punched cards. Electronic Engineering Company of California, Electronic Products Div., Santa Ana, Calif.

CIRCLE NO. 346

Stainless steel tubing

A 150-page three-ring binder covers stainless steel pipe and tube specifications. Included are stainless steel pipe and tubing sizes, weights, and theoretical burst pressures for products ranging from 1/8 inch O.D. to 48 inches O.D. Also shown are applications, and chemical and physical properties for 300 series stainless, Hastelloys, Inconels, Incoloy, Waspaloy, and Monel. Colt Industries, Trent Tube Div., E. Troy, Wis.

CIRCLE NO. 347

Temperature control

A newly revised 56-page guide "How To Get Better Temperature Control" discusses the selection of a temperature controller, general operating techniques, installation and adjustment procedures, and troubleshooting tips. Fenwal, Inc., Ashland, Mass.

CIRCLE NO. 348

Crystal polishing

An 80-page technical manual details procedures for orientation, shaping, lapping and polishing of single crystal, polycrystal, mineral and metal specimens to optical tolerances of $\lambda/20$ flatness and 1 second of arc parallelism. Specimens may be shaped in wafers, discs, tubes, cubes, rods, etc. Hacker Instruments, Inc., Fairchild, N.J.

CIRCLE NO. 349

Rf power supplies

A four-page engineering bulletin entitled "Applications & Advantages of the RF High-Voltage Technique" reviews the theory of operation of a new type of HV power supply, and explains its unique advantages. The advantages include safety factors, such as low stored energy and inherent safeguarding against overloads and short circuits; low initial and maintenance costs; lower weight and smaller size; increased reliability and efficiency; and much greater ease of control, regulation, programming, and interface accommodation. Spellman High-Voltage Electronics Corp., Bronx, N.Y.

CIRCLE NO. 350

OCR concepts

Optical character recognition and video display terminal concepts with flow charts are offered in a 12-page booket. Economic word-processing for input systems is the subject matter of this comprehensive report. Aimed at prospective users, considering OCR—with or without VDT, the report details various applications. Datatype Corp., Miami, Fla.

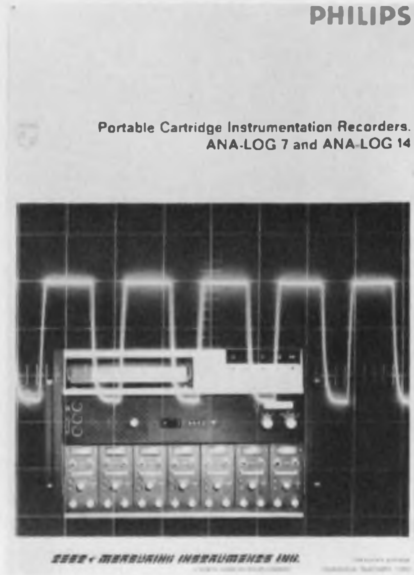
CIRCLE NO. 351

Cold-heading stainless

Comparison data to help select the best stainless steels for cold-heading applications at lowest possible cost are presented in a new folder. The four-page brochure is basically a chart comparing 13 AISI stainless steel types and highlighting the four recommended by the company as most adaptable to cold-headed techniques. A simple specification change to one of these four—302 (heading quality), 305, 410, or 430—can provide a better stainless with more corrosion resistance and better welding properties. To aid in correct specification of a stainless steel for a particular product use, the chart lists for each type its chemical composition, physical and mechanical properties, heat treatment, heat resistance, welding and cold-heading properties, corrosion resistance and machinability. Elco Industries, Inc., Rockford, Ill.

CIRCLE NO. 352

new literature



Instrumentation recorders

The Philips ANA-LOG 7 and ANA-LOG 14 portable cartridge instrumentation recorders are described in a 36-page full-color brochure. The instruments are designed for use in fundamental and applied research. The brochure contains detailed technical descriptions of the features and functions of the recorders and their accessories and provides background information on various applications and related instrumentation requirements. Color photographs of the instruments and of the applications discussed support the text throughout the brochure. Test & Measuring Instruments Inc., Hicksville, N.Y.

CIRCLE NO. 353

Synchro conversion guide

A Selection & Evaluation Guide describes synchro and resolver data conversion. The booklet describes some of the most advanced state-of-the-art conversion devices applicable to industrial, commercial, avionics and military ground support systems. Accompanying the guide are application notes comparing tracking, multiplexed, synchro-to-linear and synchro-to-nonvariant sin/cosine converters. Data Device Corp., Hicksville, N.Y.

CIRCLE NO. 354

LED selector guide

"LED Product Selector Guide," a 52-page catalog, details the company's broad line of light-emitting diodes, indicators, switches and related readout devices. The guide, designated SG-721, is basically divided into eight product categories—light sources; ultra-miniature indicators; 0.625″ readouts; 0.125″ and 0.205″ readouts; 0.270″ readouts; 0.300″ readouts; decoder/drivers and switches. All the units described work with or contain light-emitting diodes. For each product category, the company gives complete specifications, curves, applications, and mounting details, where appropriate. Dialight Corp., Brooklyn, N.Y.

CIRCLE NO. 355

IC reliability program

A new program for increased quality and reliability of ICs is described in a four-page pamphlet, "Rel II High Reliability Integrated Circuits from TI Supply." The brochure explains that the Rel II program is primarily intended for plastic ICs which fill the need for products more reliable than standard products, yet not as costly as military grade ceramic products. A flow diagram in the bulletin shows the various testing steps prescribed by the Rel II program. Texas Instruments Inc., Dallas, Tex.

CIRCLE NO. 356

Lexan resin

A polycarbonate design brochure highlights Lexan resin's versatility, toughness and over-all engineering properties. The 48-page brochure provides designers with a one-stop technical reference for polycarbonate applications. The brochure covers design parameters and techniques, application analysis, assembly techniques, problem analysis, typical properties and a glossary of terms. General Electric Plastics, Pittsfield, Mass.

CIRCLE NO. 357

Communications topics

"Semiconductors For Communication Systems," a 64-page technical brochure, covers the solid state device types suggested for both radio and wire communication systems. Special emphasis is given to data communications and new industry trends such as hybrid construction, phase locked loops, monolithic voltage regulators, etc. Each section of the brochure presents a discussion of new developments and processes, as well as preferred device tables listing solid state products suggested for each particular application area. The tables are designed to aid in the selection of a proper device type from the multitude of type numbers available. New integrated circuit types are also tabulated for easy selection. Motorola Inc., Semiconductor Products Div., Phoenix, Ariz.

CIRCLE NO. 358

IR instrumentation

A complete line of photometers, radiometers, spectroradiometers, exposure control systems, detectors, filters, fiber optics and related accessories are described in an eight-page brochure. The handbook contains over 200 spectral response curves along with theoretical and practical detector information. International Light, Inc., Newburyport, Mass.

CIRCLE NO. 359

Power semiconductors

The Semiconductor Condensed Catalog lists the industry's widest variety of power semiconductor devices. The 16-page publication covers rectifiers, thyristors, transistors and prewired heat-sink assemblies, including the highest voltage ratings commercially available for industrial and military applications. The catalog's easy-to-use format refers the user to individual product line selector guides for more complete information on specific devices. Included are dimensioned drawings of standard packages, a brief description of manufacturing facilities and processes and a world-wide listing of facilities and sales outlets. Westinghouse Electric Corp., Semiconductor Div., Youngwood, Pa.

CIRCLE NO. 360

Silicon rectifiers

Standard and fast recovery silicon rectifiers for industrial, commercial and military applications are described in a six-page catalog. The catalog devotes individual pages to ratings and electrical characteristics as well as dimensional drawings of case styles for the company's bridges, high-voltage axial lead rectifier cartridges, high-voltage rectifier assemblies and miniature axial lead rectifiers. Electronic Devices, Inc., Yonkers, N.Y.

CIRCLE NO. 361

ROM simulator

A six-page brochure describes equipment which simulates large read-only memory subsystems. Operational advantages of the Model 1000A read-only memory simulator are discussed. Paragraphs describe the simulation modules contained in the simulator system, the data entry-and-control module, indicators and controls and the simulator's software. Signetics Memory Systems, Sunnyvale, Calif.

CIRCLE NO. 362

Power transistors

Specifications for a line of power transistors are offered in a 75-page catalog. A comprehensive listing of all electrical and mechanical parameters are included. RSM Electron Power Inc., Sensitron Semiconductor Div., Deer Park, N.Y.

CIRCLE NO. 363

A/d conversion handbook

The Analog-Digital Conversion Handbook has been compiled by the company's engineering dept. Converters, system components and a guide for the troubled are included. The price for a single copy is $3.95. For larger quantities of this book, a special carton sale only discount price of $110 has been established. Analog Devices, Inc., Rte. 1 Industrial Park, Norwood, Mass. 02062.

Stud-mount thyristors

Three technical data sheets give full rating information, curves and order instructions for three versions of the stud-mount thyristor. Westinghouse Electric Corp., Youngwood, Pa.

CIRCLE NO. 364

High-voltage pulser

A general-purpose high-voltage pulser suited to developing narrow high-power pulses for electro-optic modulators, photomultipliers, cavity oscillators and for triggering high energy equipment is described in a two-page data sheet. Instrument Research Co., Lincoln, Mass.

CIRCLE NO. 365

Thick-film resistors

Data Sheet No. 3306 features the series VA-305 Cermide thick-film, vernier-adjust variable resistor—a miniature 1/2-inch diameter front panel mount multi-turn design. The series VA-305 is rated at 3/4 W at 70 C. CTS Keene, Inc., Paso Robles, Calif.

CIRCLE NO. 366

Microwave products

High-powered microwave electronics are described in a catalog entitled "The High Power People." Included are microwave communications transmitters for earth to satellite applications; TWT microwave amplifiers for calibration and testing; microwave rf sources, industrial microwave heating equipment; microwave tube test equipment, crossfield amplifiers, and kylstrons; high-voltage, highly-regulated dc power supplies; and high-power pulse modulators. Cober Electronics, Inc., Stamford, Conn.

CIRCLE NO. 367

Power transistors

Basic features and performance capabilities of Versawatt power transistors are described in a 12-page brochure entitled "Versawatt—The Plastic Package for Power." The illustrations show the internal structure of the basic package, lead-configuration options, device performance ratings and production and testing facilities. RCA Solid State Div., Somerville, N.J.

CIRCLE NO. 368

Industrial semiconductors

Specifications are featured in a 16-page catalog for PUTs, thyristors, SCRs, ICs, power Darlingtons, transistors, diodes, rectifiers and bridges. Outline drawings are included. Unitrode Corp., Watertown, Mass.

CIRCLE NO. 369

Variable resistors

Complete electrical, mechanical and environmental specifications of the 450/45 Series, 15/16-inch commercial-composition variable resistors are described in a 20-page catalog. The most frequently requested constructions available to meet the majority of customer requirements are fully described. These include single, tandem, multisection and vernier-adjust types. Also included is a detailed section on the rotary, pull-push and push-push power switches used with the 450/45 series. CTS of Elkhart, Inc., Elkhart, Ind.

CIRCLE NO. 370

Modular power supplies

An eight-page short form guide to a power supply line is complete with specifications, dimensions and prices. Rack mounting capabilities are also included. ACDC Electronics, Inc., Oceanside, Calif.

CIRCLE NO. 371

Timing cells

Two engineering bulletins give application information on Koolometer electromechanical timing cells and operating considerations for these miniature timers. Sprague Electric Co., N. Adams, Mass.

CIRCLE NO. 372

bulletin board

Prices have been reduced to $2060 on **Digital Computer Controls D-112 12-bit minicomputer series.** The price reductions reflect a minimum decrease of 15% across the product line. A 4 k D-112 1.2-μs computer with TTY interface, programmer's console, power supply, chassis, slides and programmed I/O has been reduced $200 to $3490 from $3690. The same computer with 8 k of memory is now $4750, reduced from $5590 with a savings of $840. The 4 k D-112H 900-ns computer with TTY interface, programmers console, power supply, chassis, slides, and programmed I/O is $3640 compared to $5700, amounting to a reduction of $2060. The D-112 H/SC 200-ns computer with 1 k of semiconductor random access memory and 4 k of core memory has been reduced $2110 to $7290 from $9400.

CIRCLE NO. 373

Digital Equipment Corp. has reduced prices from 15-33% on its large-scale **DECsystem-10 computer line.** A new, low-cost core memory system and increased efficiencies in the production of the central processor are the reasons for the price cuts. At the same time, DEC revealed a new DECsystem-10 configuration—the DECsystem-1060—and also unveiled two new software packages and a new peripheral for the line. The company also announced that low-priced, used DECsystem-1040 systems would be marketed, and that an upgrade policy which gives substantial allowances on DECsystem-10 equipment replaced by more advanced hardware has been put into effect.

CIRCLE NO. 374

Foote Mineral Co. has restated the price of 50% **ferrosilicon** to be 16 cents per pound of contained silicon, F.O.B. producing plants. This rescinds a price reduction made earlier this year and restores the price to that which prevailed on January 1, 1971.

CIRCLE NO. 375

vendors report

Annual and interim reports can provide much more than financial-position information. They often include the first public disclosure of new products, new techniques and new directions of our vendors and customers. Further, they often contain superb analyses of segments of industry that a company serves.

Selected companies with recent reports are listed here with their main electronic products or services. For a copy, circle the indicated number.

ESB Inc. Batteries.

CIRCLE NO. 376

Datacraft Corp. Scientific computers, memory systems.

CIRCLE NO. 377

L. M. Ericsson Telephone Co. Telephone systems and equipment, data communications, military systems, traffic control, radio communications, components.

CIRCLE NO. 378

Cartridge Television Inc. Cartridge television systems.

CIRCLE NO. 379

Sola Basic. Air traffic control systems, transformers, meters, switches, communication systems and electronic control systems.

CIRCLE NO. 380

Magnetic Head Corp. Read/write magnetic heads.

CIRCLE NO. 381

Gates Learjet Corp. Avionics.

CIRCLE NO. 382

Orbit Instrument Corp. Servo repeaters, optical tracking head assemblies, transformers, potentiometers, ball trackers and joysticks.

CIRCLE NO. 383

Morse Electro Products Corp. Stereophonic systems.

CIRCLE NO. 384

Ultrasonic Systems, Inc. Ultrasonic motor-converter.

CIRCLE NO. 385

Hitachi. Dry batteries, sound tapes, communications and control equipment, consumer products and computer equipment.

CIRCLE NO. 386

Medtronic, Inc. Medical electronics.

CIRCLE NO. 387

Ampex. Audio-video systems, computer products and instrumentation.

CIRCLE NO. 388

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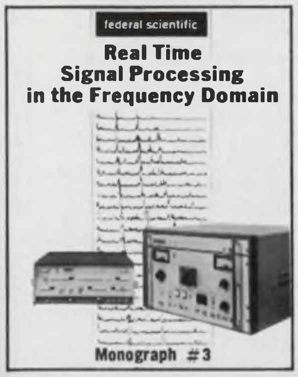

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CIRCLE NO. 171

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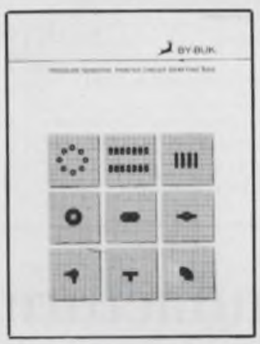
PC Drafting Aids Catalog



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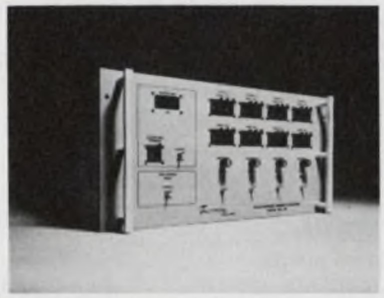

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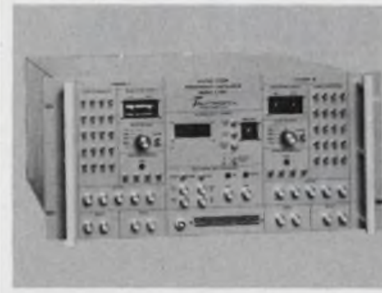

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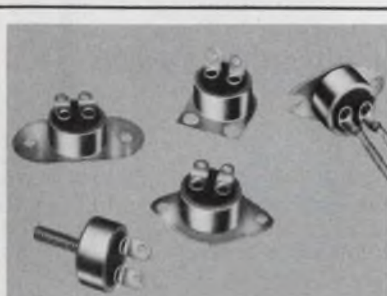

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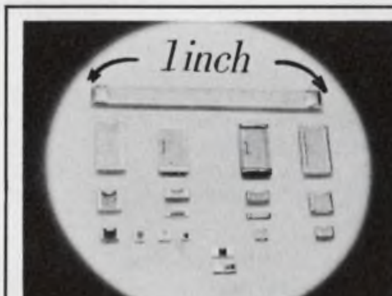

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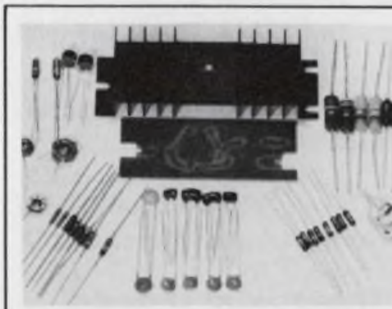

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INFORMATION RETRIEVAL NUMBER 189

product index

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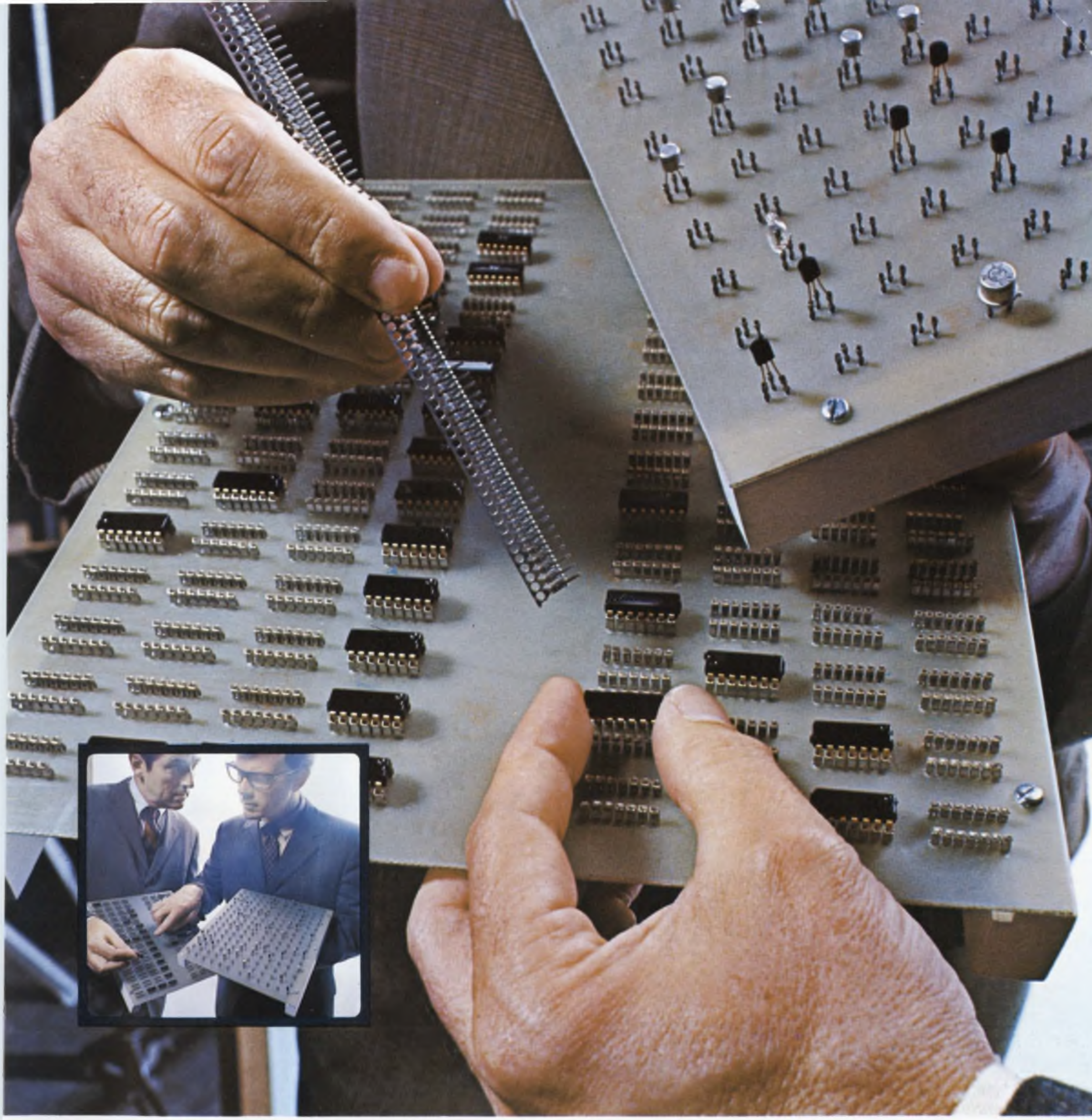
insulators, ceramic	114	342
polyethylene foam	115	345
socket, octagonal	115	343



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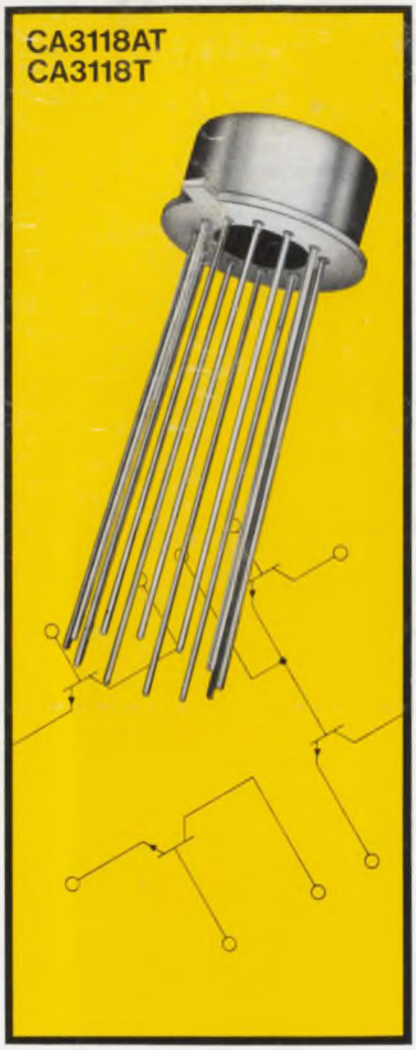

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Type	V_{CEO}	I_C (max.) mA	Package	Price (1000-unit level)
CA3118AT	40	50	12L TO-5*	$1.40
CA3118T	30	50	12L TO-5*	.98
CA3146AE	40	50	14L DIP**	1.40
CA3146E	30	50	14L DIP**	.98
CA3183AE	40	75	16L DIP**	1.50
CA3183E	30	75	16L DIP**	1.25

*Operates over full military temperature range of −55°C to 125°C

**Operates over ambient temperature range of −40°C to +85°C

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

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