

# Electronic Design<sup>®</sup> 25

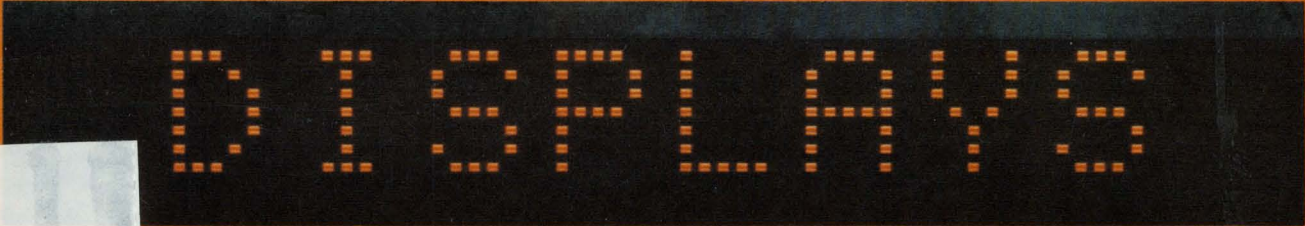
VOL. 25 NO.

FOR ENGINEERS AND ENGINEERING MANAGERS — WORLDWIDE


DEC. 6, 1977

**Numeric readouts predominate** in terms of variety and colors. But alphanumerics are catching up — and with intelligence, too. Display design is simplified by

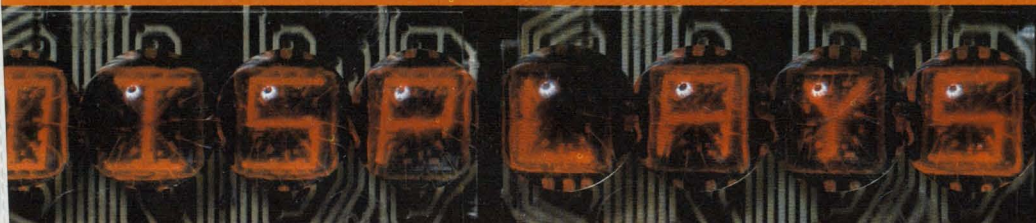
integrating peripheral circuits on array substrates. But technology improvements have bypassed the specs and display selection is tougher than ever. See page 56.



DISPLAYS



1 2 3 4 5 6 7 8 9



1 2 3 4 5 6 7 8 9 0



DISPLAYS



# Another Colorful Innovation...

## Conductive Plastic Trimmers at Carbon Prices.

Just when you thought "low cost" also meant "low performance", along comes the dazzling new Bourns® Model 3355. Compare it to the CTS 201, Mepco 46X or Piher PT15. Our revolutionary conductive plastic element vs. their carbon . . . fact is we outperform them all. To prove it, we spec important characteristics such as CRV at 1% and a TC of 500 PPM/°C . . . the others don't. And only the 3355 has board-wash capability, a UL-94V-1 flammability rating and an optional choice of nine rotor colors. The standard blue is priced at just 11¢ each (100,000 pieces) . . . about what you'd expect to pay for the lower performance carbon types.

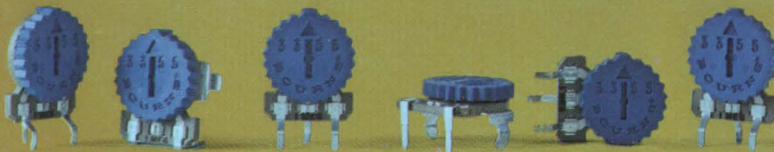
Send today for complete details on a colorful new way to design in superior performance for your cost effective needs — the Model 3355 Trimmer. Direct or through your local distributor.

TRIMPOT PRODUCTS DIVISION, BOURNS, INC., 1200 Columbia Ave., Riverside, CA 92507. Phone: 714 781-5050 — TWX: 910 332-1252.

### CATALOG SHEET SPECIFICATION COMPARISONS

CHARACTERISTIC	BOURNS 3355	CTS 201*	MEPCO 46X*	PIHER PT15*
Element	Conductive Plastic	Carbon	Carbon	Carbon
Temperature Coefficient	500 PPM/°C	No Spec	No Spec	1000 PPM/°C
Contact Resistance Variation	1.0% max.	No Spec	No Spec	No Spec
Power Rating	.25 W at 70°C	.25 W at 55°C	.25 W at 55°C	.25 W at 40°C
Flammability	UL-94V-1	No Spec	No Spec	UL-94
Board Wash Capability	Yes	No Spec	No Spec	No Spec

\*Source: CTS Series 201 Data Sheet, Mepco Data Sheet ME1004, Piher Data Sheet F-2002 Rev 7/73

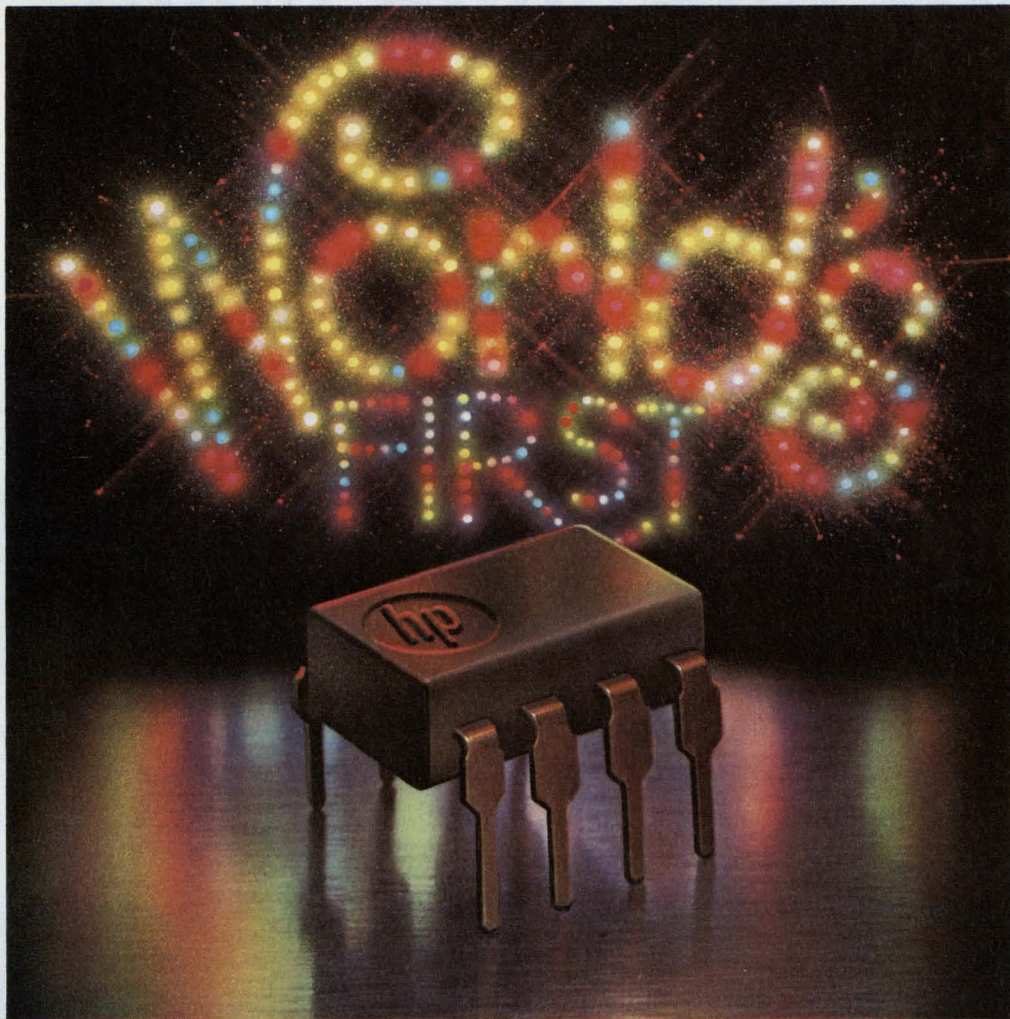


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For Immediate Application — Circle 130  
For Future Application — Circle 230



# SURPRISE!



## Introducing HP's New Optically Coupled Line Receiver

Eliminate troublesome system ground loops and increase long distance communication noise immunity with HP's new easy-to-use optically coupled line receiver. An internal IC regulator serves as a line termination and allows direct connection to transmission lines without any additional components.

Use of a high-speed, high-gain output photo IC permits data rates in excess of 10 Mbits/second. An internal shield provides excellent common mode rejection even at these high data rates.

The HCPL-2602 is designed for high-speed data transmission applications such as computer-peripheral interface, instrumentation, and simplex/multiplex data transmission.

Priced at \$6.65\* in quantities of 1000, the HCPL-2602 is in stock at any franchised distributor. In the U.S., contact Hall-Mark, Hamilton/Avnet, Pioneer Standard, Schweber, Wilshire or the Wyle Distribution Group (Liberty-Elmar) for immediate delivery.

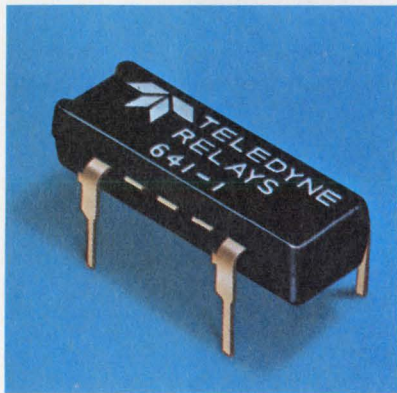
In Canada, just call Hamilton/Avnet or Zentronics, Ltd. \*U.S. Domestic price only

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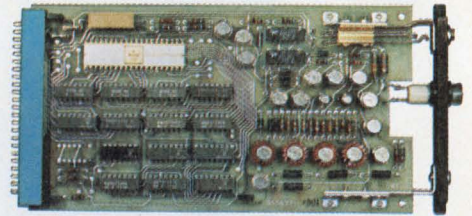


# Did you get the message about our solid state SerenDIP relays?



International telex communication switching systems often are expected to run on a 24-hour, seven-day shift. Continuous duty like that calls for dependable, long-life component reliability — the kind RCA requires from Teledyne SerenDIP® relays used in their trunk terminator modules. These all-solid-state DIP relays provide wear-free and bounce-free switching — features you don't get with electro-mechanical

or reed relays. What's more, our SerenDIP's offer high input/output isolation, low level logic input compatibility, and fast response time. And you get all of this in a low cost, low-profile TO-116 DIP package ready-made to replace any standard DIP reed relay. You also get your choice of output: bi-polar, AC (triac), or DC. There's lots more to a SerenDIP relay that you ought to know about. For detailed specs or applications assistance, contact your nearest Teledyne Relays sales office listed in EEM, Gold Book, or Electronic Buyers' Guide. You'll find we have the experience, products and technical support to meet all of your SSR needs.



RCA Trunk Terminator Module



RCA CCT-3 Series  
Telex Switching System  
(Courtesy of RCA/Camden, N.J.)

 **TELEDYNE RELAYS**

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Telephone (213) 973-4545

CIRCLE NUMBER 3



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Game timer generates coasting pulses, positively clamped to prevent a glitch.  
Put the resolution where needed in a digitally controlled tuning system.  
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**Cover:** Photos from top to bottom courtesy of Burroughs, Hewlett-Packard, Litronix, Monsanto and Beckman.

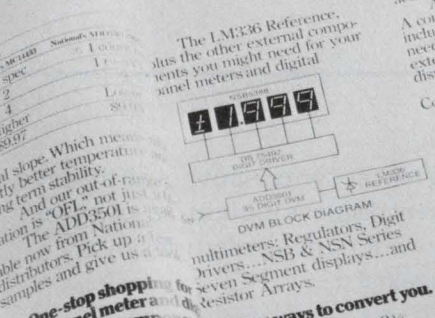


If this ad doesn't  
don't know what will.

# WHEN RAN THERE'S A THEY DIDN'T

Motorola MC14433	National ADD3501
No spec	± 1 count max
2	1 (+5V)
4	2
Higher	0
\$9.97	\$9.95

National introduces its answer to the Motorola MC14433. The ADD3501 3 1/2 digit A/D converter... manufactured using National's standard MM74C Series CMOS process. As you can see from the chart, it offers more performance and requires fewer external components than Motorola. Fewer components means lower system cost and greater reliability. The ADD3501 uses pulse width modulation as a conversion technique, rather than



accuracy (0.025%). And the bipolar ADU2579. A complete converter on a chip including the reference. All it needs are a few passive external elements and a display, \$7.95. The new monolithic A/D converters from National. Hello more reliability. Hello less cost. Goodbye Motorola.

multimeters, Regulators, Digit Drivers... NSB & NSN Series seven Segment displays... and Resistor Arrays.

Other ways to convert you.

In fact, there are several.

### A/D CONVERTERS

	Motorola MC14433	National ADD3501	Intersil 7106/7
Accuracy: 0° to + 70°C	No Spec	± 1 count max	± 1 count max
Power Supplies Required:	2	1 (+ 5V)	1 (+ 5V to + 9V)
Additional IC's required:	4	2	0
LCD Compatible	No	No	Yes
System Cost:	Higher	Lower	Lowest
Price @ 100 pcs:	\$9.97	\$9.95	\$9.25
All Display drives on chip:	No	No	Yes
Floating Differential Input:	No	No	Yes
Floating Reference:	No	No	Yes

**DELIVERY.** If price and performance aren't your only criteria, think about this: Intersil is shipping the ICL 7106 and 7107. Now.

**ONE CHIP.** LED or LCD. Intersil offers you one chip simplicity. Now. And a whole family of

A/D, D/A converters that mean you can stop beating the bushes for your converter needs.

**DRIVES LCD DISPLAYS.** Requires no active external components. Includes back plane drive circuitry.

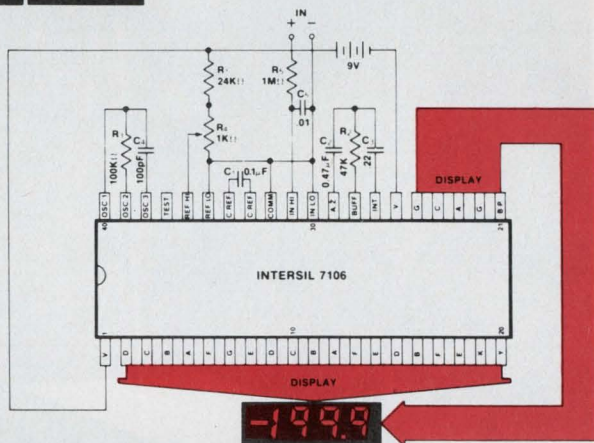
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# NATIONAL THIS AD, REASON MENTION US.



**TRUE DUAL SLOPE.** The ICL 7106 and 7107 are true dual slope...rather than pulse width modulation or digital auto-zero. Then, consider Intersil's better noise rejection and true integration of input signal. And they can handle differential inputs from 200mV to 2.000V full scale.

**4-1/2 DIGIT ACCURACY.** Other Intersil IC, 8052A/7103A, offer 20,000 count accuracy with immediate availability.

**THEIR AD SAID:** "The new monolithic A/D from National. Hello reliability. Hello less cost. Goodbye Motorola"

**OUR AD SAYS:** Goodbye National.

**HERE'S HOW WE MAKE IT STICK:** Prototype a working DPM for either \$24.95 (LED), or, \$29.95 (LCD). With our prototyping kits. Just send your check or P.O. to your local Intersil Distributor with the coupon below.

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CIRCLE NUMBER 4



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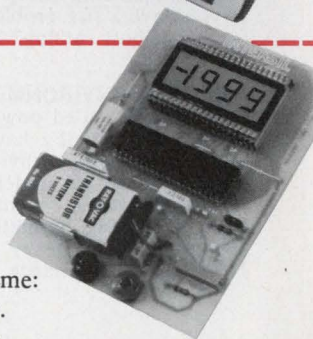
10710 North Tantau Avenue  
Cupertino, California 95014, U.S.A.  
Telephone: (408) 996-5000

You're talking tough. Here's your chance to prove it. Send me:

- Prototyping Kit #ICL 7106EV (LCD) \$29.95 complete.
  - Prototyping Kit #ICL 7107EV (LED) \$24.95 complete.
  - I believe you, send your App. Note: #A016, A017, A018, A023 and 7106/7107 D.S.
- I've enclosed a  check,  Purchase Order.

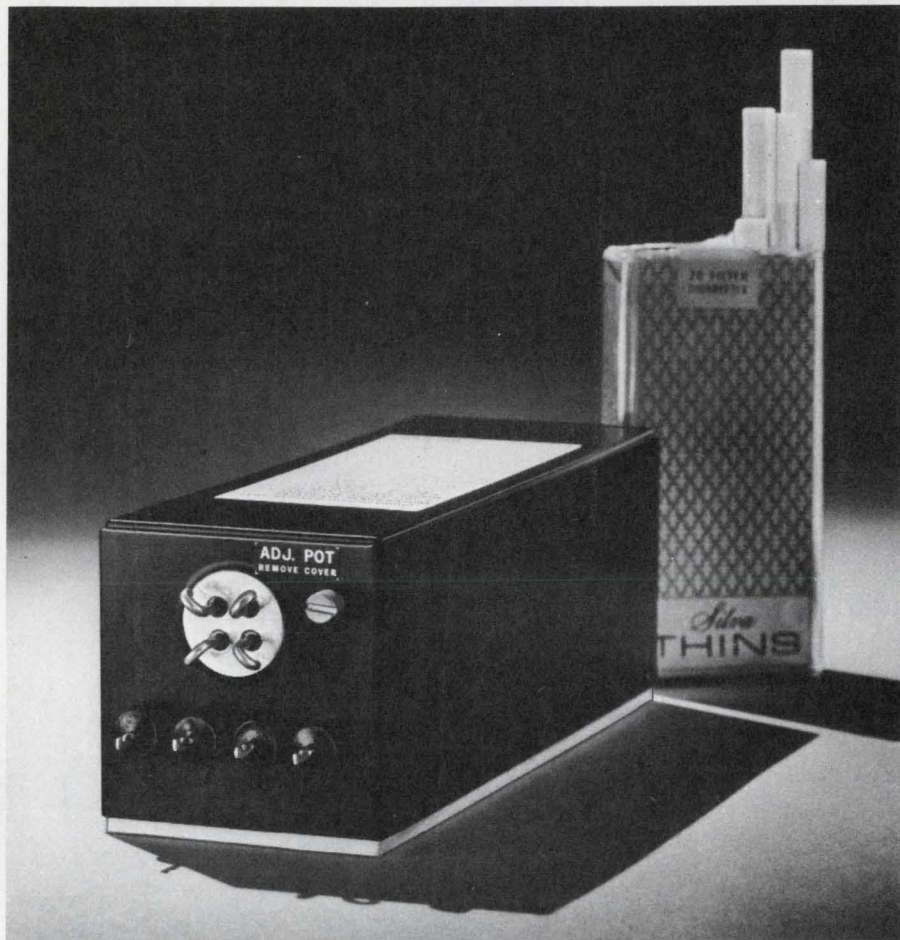
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(If outside the United States)





# A SMART WAY TO BEAT YOUR POWER SUPPLY SIZE PROBLEM



**2 1/2" thin, 2 3/8" narrow, 6 1/4" short**

yet this converter produces 50 watts of regulated DC power from an input of 20-32 VDC! It weighs less than 2 pounds. This is only one of our wide variety of many small lightweight converters, inverters and power supplies — there are over 3500 models listed in our newest catalog, including size, weight, and prices. If you have a size problem, why not send for an Abbott catalog?

**MIL SPEC ENVIRONMENT** — All of the hermetically sealed power modules listed in our new catalog have been designed to meet the severe environmental conditions required by modern aerospace and military systems, including MIL-STD-810C. They are hermetically sealed and encapsulated in heavy steel containers. New high performance units meet MIL-

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**RELIABLE** — Highest quality components are used in Abbott power modules to yield high MTBF's (mean time between failure) as calculated in MIL-HDBK-217. Typical power modules have over 100,000 hours MTBF — proving that the quality was built in from the beginning.

**WIDE RANGE OF OUTPUTS** — Any voltage from 5 volts DC to 740 VDC is available by selecting the correct model you need from our catalog with any of a variety of inputs including:

60  $\text{\AA}$  to DC  
400  $\text{\AA}$  to DC  
DC to DC  
DC to 400  $\text{\AA}$   
DC to 60  $\text{\AA}$

Please see pages 3156-3168 Volume 2 of your 1977-78 EEM (ELECTRONIC ENGINEERS MASTER Catalog) or pages 644-653 Volume 2 of your 1977-78 GOLD BOOK for information on Abbott Modules.

**Send for our new 60 page FREE catalog.**

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CIRCLE NUMBER 5

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Peter Coley

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ELECTRONIC DESIGN 25, December 6, 1977



# Across the desk

## A misplaced teleprinter

We would like to add some information that somehow was overlooked in your article on 1200-bps data communications (ED No. 20, Sept. 27, 1977, p. 28). General Electric introduced a 1200-bps teleprinter in 1972. The General Electric TermiNet 1200 printer has enjoyed success since that time and thousands of the units are now installed around the world.

Incidentally, General Electric's Information Systems Business Division in Rockville, Maryland, introduced a 1200-bps time-sharing service to its customers in 1973 and was among the first time-sharing companies to make the service available.

*Clifford F. Rockwell*  
Manager Advertising &  
Sales Promotion

General Electric Co.  
Data Communication Products Div.  
Waynesboro, VA 22980

## The price was wrong

We accidentally tacked an extra \$10 onto the price of Data Display Products' nifty little Ledy Bug indicators. Our New Product story (ED No. 20, Sept. 27, 1977, p. 130) quoted a 1000-quantity price of \$10.56 instead of \$.56. The tiny LED indicator lights have a flat-topped Fresnel lens that gives a viewing angle of over 180°. Interested now?

Circle No. 530

## A needle about a noodle

Thoroughly enjoyed your article on "The Telephone" (ED No. 18, Sept. 1, 1977, p. 42). It was quite informative and I particularly enjoyed the personal anecdotes and historical oddities.

But I have one question. Talking of

Harold S. Block's invention, his assistant said, "The invention of negative feedback had all the initial impact of a blow with a wet needle." Oh yeah? Didn't you mean wet noodle?

*Tracy L. Johnson*

Thiokol/Wasatch  
Box 524, MS 541A  
Brigham City, UT 84302

## Oops—too high a bottom

Contrary to your statement that TTL RAMs bottom out at about 50 ns (Focus on semiconductor memories, ED No. 17, Aug. 16, 1977, p. 56), there are TTL devices that have access times as low as 25 ns for a 64-bit RAM (AMD's 27S02A/03A) and 30 ns for a 1024-bit device (Fairchild's 93415A/25A).

*Eugene R. Hnatek*  
Manager, Product Marketing  
Monolithic Memories, Inc.  
1165 E. Arques Ave.  
Sunnyvale, CA 94086

## About that name

It happens often that companies we know well get merged into companies we know less well. So a reader of our Focus report on Power Supplies (ED No. 20, Sept. 27, 1977, p. 58) might have missed leading manufacturers like ACDC or Lambda because these appear as Emerson Electric, ACDC Electronics Co., Inc.; and Veeco Instruments Inc., Lambda Electronics. So if you miss your favorite supplier, look again, or check the Manufacturers' Directory in ELECTRONIC DESIGN'S GOLD BOOK for a cross-reference.

Interested now in Emerson Electric—that is, ACDC?

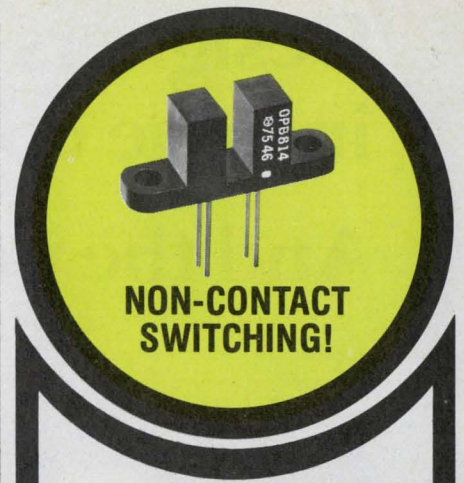
Circle No. 531

Interested now in Veeco—that is, Lambda?

Circle No. 532

(continued on page 14)

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, NJ 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld upon request.



## OPTICALLY COUPLED INTERRUPTER MODULES

OPTRON OFFERS IMMEDIATE DELIVERY OF NEW, LOW COST SERIES

OPTRON's new, low cost optically coupled interrupter module series combines non-contact switching and solid state reliability for applications requiring sensing of position or motion of an opaque object such as motion limit, paper edge or shaft encoding.

The new OPB 813, OPB 814 and OPB 815 consist of a gallium arsenide infrared LED coupled with a silicon phototransistor in an economical molded plastic housing. With a LED input of 20 mA, the OPB 813 and OPB 815 have typical unblocked current outputs of 2.0 mA and 3.0 mA, respectively. Typical output of the OPB 814 is 3.0 mA with a 10 mA input. The entire series is available from stock.

Background illumination noise is eliminated by a built-in infrared transmitting filter and dust cover in each device type. The OPB 813 also is available with a 0.010 inch aperture for high resolution applications.

New OPTRON optically coupled interrupter modules are interchangeable with similar products as follows:

OPTRON	GE
OPB 813	H13A1
OPB 813	H13A2
OPB 814	H13B1
OPB 814	H13B2

Detailed technical information on these and other OPTRON standard interrupter and reflective modules, as well as versions for specific applications is available on request.



OPTRON, INC.

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Carrollton, Texas 75006, U.S.A.  
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**Designers say we have the lead  
in edge connector design.  
And the performance to keep it.**





The reason why is clear. The contacts for AMP wrap-type edge connectors have unique strength and stress relaxation characteristics that assure long-term top performance. And they come in either leaf spring or cantilever types. Each incorporates full bifurcated design to achieve effective contact redundancy. A choice of contact alloys and selective gold platings is available too. The result is premium reliability and performance at a cost as low as 2 cents a line in quantity.

There's another reason you're ahead with AMP edge connectors, or any other AMP product for that matter. It's called technical support. It means you can call on us for assistance in research, product design, and production. We feel the professional engineer is entitled to it. After all, when he puts his confidence in us, we can do no less than back him fully.

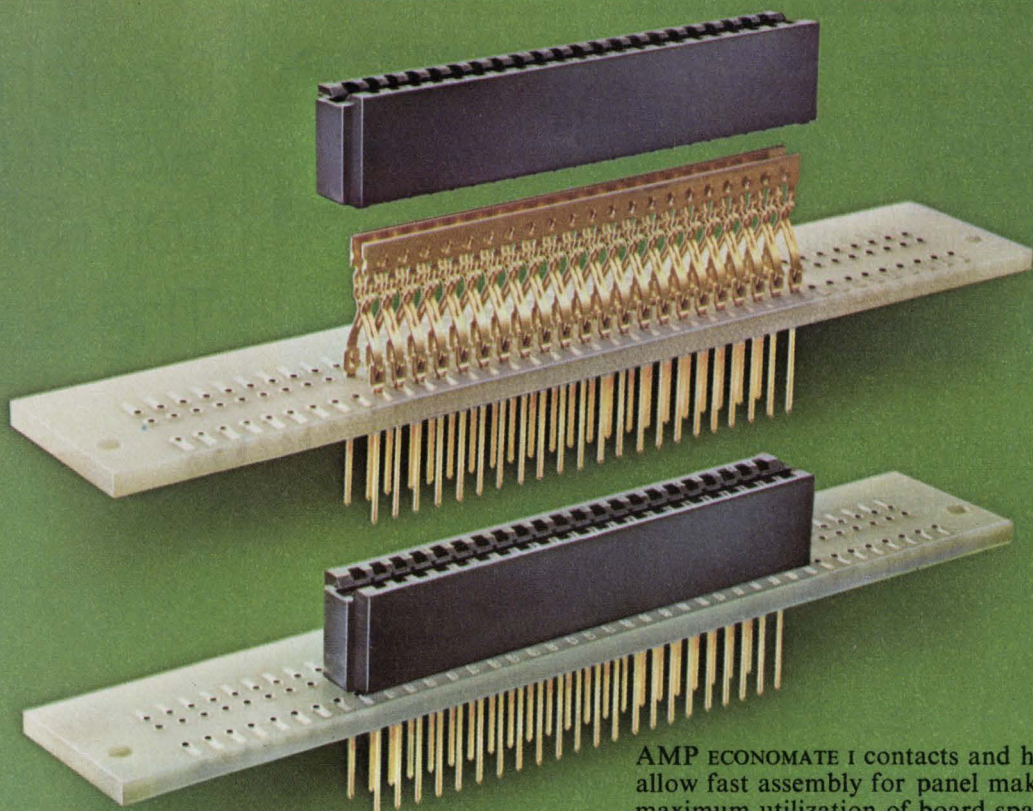
There are other advantages, too, with these AMP edge connectors. You can select from types for either rack or solder-to-board mounting. And if you're a panel maker, we've got ECONOMATE I connectors with outstanding insertion speeds and space savings.

For more information on these wrap-type printed circuit edge connectors, just call AMP Customer Service at (717) 564-0100. Or write AMP Incorporated, Harrisburg, PA 17105.

**AMP has a better way.**

**CIRCLE NUMBER 7**

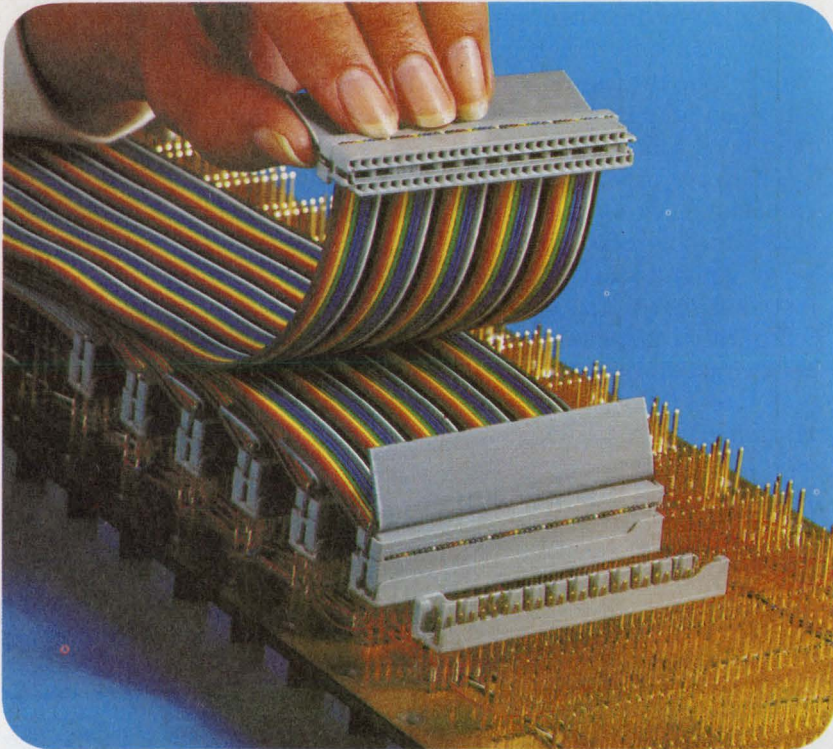
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INCORPORATED



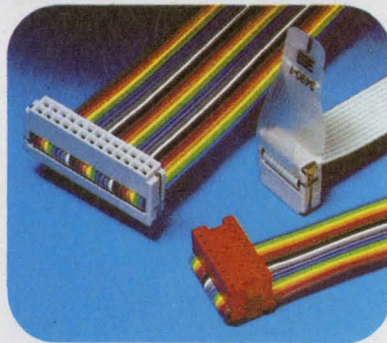
AMP ECONOMATE I contacts and housings allow fast assembly for panel makers and maximum utilization of board space.



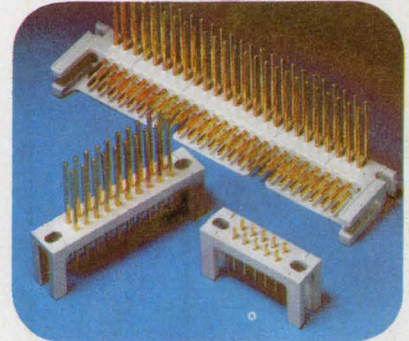
# Want simpler backplane connections? Come to the source.



Now, a unique Scotchflex brand Socket Connector and Keying Header system lets you interface directly with backplane wire wrap pins and provides for easy, positive polarization and keying. The header design allows for thousands of unduplicated polarizing combinations without loss of backplane pins. The 50-position connector mates with .025" square pins on .100" x .200" grid spacing. Header allows space for and protects two layers of wrap below it. System also provides polarizing keys and strain relief handles.



Need some other ways to simplify wiring and increase circuit density? 3M's Scotchflex line offers you a broad choice of mass terminating socket connectors, plus wire wrap or solder tail headers to suit your specific design problem. Keying capability is also provided.



There are several more things you can get only from 3M. The broadest range of flat cables and complete system components. Best off-the-shelf availability. Proven performance. And the unmatched experience of the people who pioneered this reliable mass termination system.

"Scotchflex" is a registered trademark of 3M Co.

## Scotchflex<sup>®</sup> systems from 3M. The source.



See our  
catalog in EEM,  
page 2256





## See, we sell all the parts together. Or all the parts apart.

If you are looking for complete telephones to use as part of a system, or if you need telephone parts to build into your product, GTE Automatic Electric is the logical source.

Why? Because we are the largest U.S. manufacturer of telephones and telephone subassemblies outside the Bell System.

So, if you are an OEM and you have quantity requirements for telephones or telephone components, we'll usually have what you are looking for. Telephones in a large variety of styles and colors. And components ranging from handsets and hookswitches to housings and hardware. If it goes into a telephone system, we probably make it.

Use the coupon for a complete catalog. Or, if you are in a real hurry, call John Ashby at (312) 681-7632.

When it comes to quality components, call **THE SOURCE: GTE AUTOMATIC ELECTRIC.**

Please send your catalog of communications components.

Please send more information and prices on \_\_\_\_\_ of \_\_\_\_\_.  
(Quantity) (Product)

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Title \_\_\_\_\_ Phone \_\_\_\_\_

Company \_\_\_\_\_

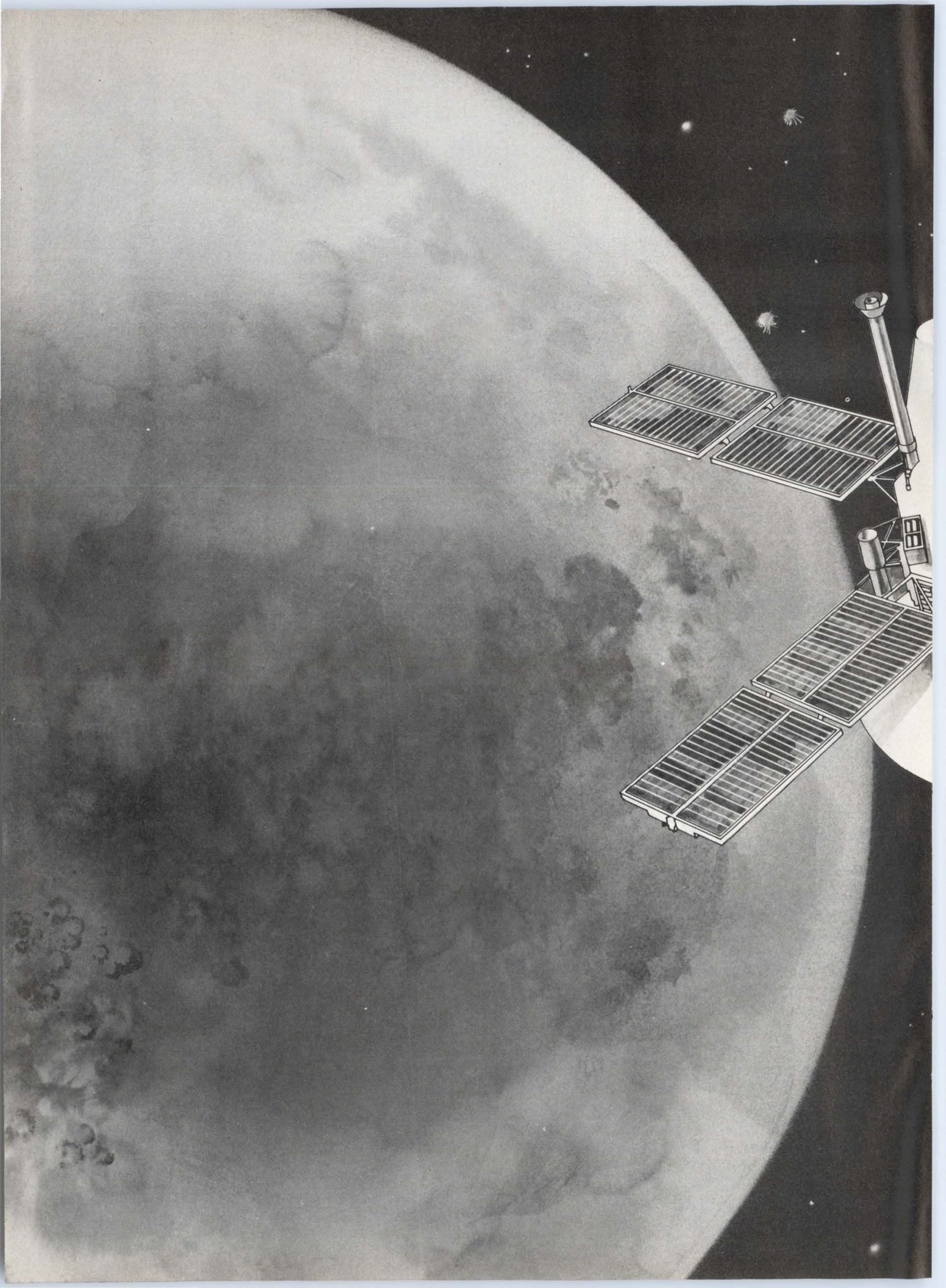
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Mail to: Mr. J. D. Ashby, B-4,  
GTE Automatic Electric, Northlake, Ill. 60164

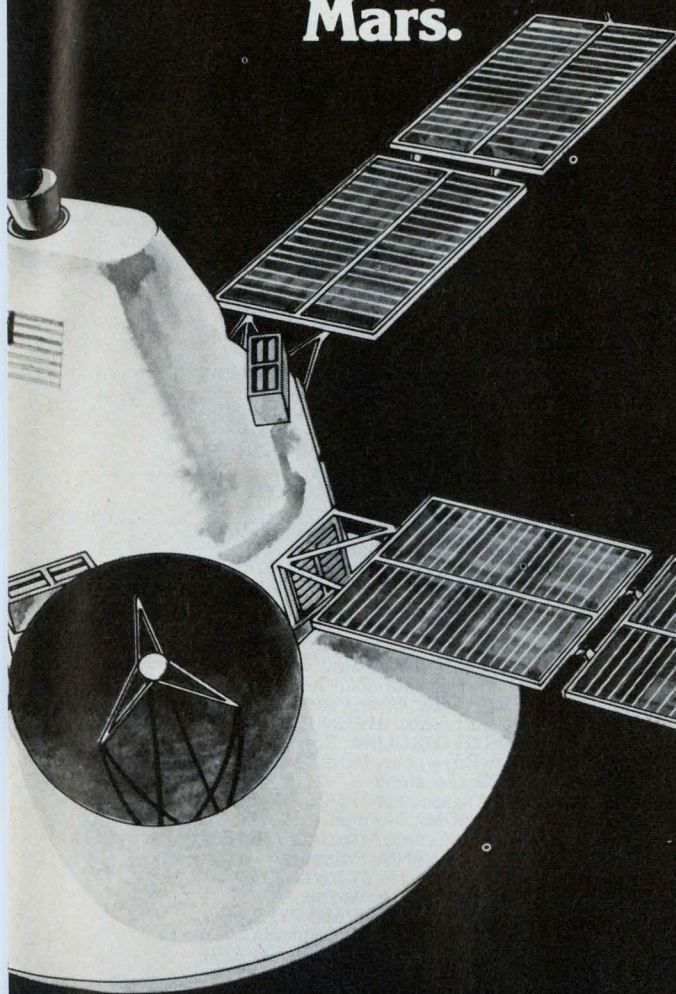
**GTE AUTOMATIC ELECTRIC**







# Why PMI's 6-bit DAC-01 wound up orbiting Mars.



When we first laid plans to make the world's first complete 6-bit monolithic DAC, they told us we were wasting our time. "Who needs it?" they said.

Well, the DAC-01 has been around since 1970—in modems, circling Mars (in the Mars Viking spacecraft), in advanced avionics, and in all sorts of applications. People just keep on buying it. Here's why.

There are at least five good reasons why designers prefer to specify the DAC-01 rather than build their own 6-bit digital-to-analog converter. First, its **reliability** is out of this world, as space contractors can tell

you. Second, it's **complete**—it contains its own precision internal reference and output op amp. You get an output that's ready to use.

Third, it's **fast**: 1.5  $\mu$ sec settling time (typ.). Fourth, it uses only **250 mW of power**. And fifth, it has a track record few parts can equal.

That's why PMI fully specifies and guarantees it. Linearity, for example, is guaranteed over the full temperature range, military or commercial.

## Electrical Characteristics

Parameter	DAC-01	DAC-01B	DAC-01F	DAC-01C	DAC-01H	DAC-01D	Units
Output Options	Unipolar Bipolar	Unipolar Bipolar	Unipolar	Unipolar Bipolar	Unipolar	Unipolar Bipolar	
Temperature Range	-55/ +125	-55/ +125	-55/ +125	0/ +70	0/ +70	0/ +70	°C
Nonlinearity 25 °C - Max.	±0.40	±0.40	±0.40	±0.40	±0.40	±0.78	% FS
Nonlinearity Over Temperature - Max.	±0.45	±0.45	±0.45	±0.45	±0.45	±0.78	% FS

So who needs six bits? Turns out lots of people do. And they'd rather buy than make—especially when they've got the tried and true DAC-01. And that's why it's up there going around and around.

Drop us a line on your company letterhead. We'll see that you get a sample and all the specs.



Precision Monolithics Incorporated  
1500 Space Park Drive  
Santa Clara, CA 95050  
(408) 246-9222 TWX: 910-338-0528  
Cable MONO.



# Across the desk

(continued from page 7)

## Misplaced Caption Dept.



Sophisticated software helps us speed completion of our key programs.

Sorry. That's "Saint Matthew," from the Lindisfarne Gospels in the London British Museum.

## Me an editor?

If you'd like to be among the first to know (and write about) what's going on in the electronics industry, you might enjoy being an editor.

We have openings at our home office in Rochelle Park, NJ. Call Ralph Dobriner at (201) 843-0550.

## An unreliable system?

When we edited the article "Predict System Dependability..." (ED No. 19, Sept. 13, 1977, p. 100), we found that our own quality control system wasn't completely dependable. The equation for the probability of n failures in a time period, t, should have appeared as follows:

$$P(n) = \frac{e^{-\bar{N}} \bar{N}^n}{n!}$$

where,

$$\bar{N} = \frac{t}{MTBF_t}$$

In the published version, we lost the bar over N.

Also, several readers had difficulty following the program steps in Table 2. Though the table was accurate as published, some of the program steps

appeared to be out of sequence. For example, it appeared that location 075 followed location 024 instead of location 074. The table is repeated here with heavy lines added to clarify the program sequence. Three columns of program steps are shown side by side. The sequence of steps follows the number sequence of the locations. Note that numbers are shown only at every fifth location.

Table 2. SR52 coding form

LOC CODE	KEY	LOC CODE	KEY	LOC CODE	KEY
000	46 LBL	025	44 SUM	050	75 —
18	C'	00	0	04	4
22	INV	02	2	17	B'
57	fix	02	2	95	=
04	4	17	B'	55	÷
005	46 LBL	030	20 1/x	055	04 4
17	B'	42	STO	17	B'
42	STO	00	0	65	x
01	1	03	3	03	3
09	9	81	HLT	17	B'
010	36 IND	035	46 LBL	060	95 =
43	RCL	12	B	81	HLT
01	1	85	+	46	LBL
09	9	01	1	14	D
56	rtn	17	B'	55	÷
015	46 LBL	040	95 =	065	53 (
11	A	55	÷	43	RCL
46	LBL	01	1	85	+
13	C	17	B'	01	1
57	fix	95	=	17	B'
020	02 2	045	20 1/x	070	54 )
42	STO	49	PROD	94	+/-
00	0	00	0	85	+
01	1	04	4	01	1
20	1/x	01	1	95	=
075	49 PROD	100	47 CMs	125	02 2
00	0	01	1	55	÷
05	5	42	STO	53	(
05	5	00	0	07	7
17	B'	04	4	17	B'
080	75 —	105	42 STO	130	75 —
01	1	00	0	06	6
95	=	05	5	17	B'
94	+/-	86	rset	85	+
92	STO	46	LBL	42	STO
085	00 0	110	15 E	135	00 0
04	4	57	fix	08	8
55	÷	00	0	01	1
05	5	42	STO	95	=
17	B'	00	0	42	STO
090	65 x	115	06 6	140	00 0
03	3	81	HLT	01	1
17	B'	42	STO	81	HLT
95	=	00	0	65	x
42	STO	07	7	53	(
095	00 0	120	81 HLT	145	43 RCL
03	3	57	fix	55	÷
81	HLT	02	2	02	2
46	LBL	42	STO	17	B'
16	A'	00	0	54	)
150	45 y*	85	+	95	=
08	8	01	1	42	STO
17	B'	17	B'	01	1
65	x	95	=	205	00 0
08	8	180	42 STO	94	+/-
155	17 B'	00	0	22	INV
29	x!	04	4	23	ln x
65	x	03	3	65	x
53	(	17	B'	210	43 RCL
06	6	185	81 HLT	01	1
160	17 B'	46	LBL	00	0
75	—	19	D'	45	y*
01	1	42	STO	00	0
54	)	00	0	215	17 B'
29	x!	190	09 9	55	÷
165	55 ÷	00	0	00	0
07	7	46	LBL	17	B'
17	B'	10	E'	29	x!
29	x!	42	STO	220	95 =
95	=	195	00 0	22	INV
170	42 STO	00	0	57	fix
00	0	09	9	81	HLT
03	3	17	B'		
55	÷	55	÷		
53	(	200	03 3		
175	43 RCL	17	B'		

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Intelligent Systems Corp.





**Intecolor 8031**  
Unretouched photo of screen.

## Two very sophisticated desk top computers with two very unsophisticated price tags.

We're Intelligent Systems Corporation and we've developed two brand-new stand-alone desk top systems. Both are capable of handling an incredibly diverse range of business, control, research and financial applications—in color. Both have a better price/performance ratio than any other compact computer system on the market.

Take a look at the Intecolor 8031. A compact 13-inch 8-color CRT, it comes complete with graphics hardware and software, a built-in mini disk drive for extra storage, plus "File Handling BASIC" which lets you create, delete, and retrieve program segments from storage, by name.

Now take a look at the Intecolor 8051. Perfect if your needs call for a large-screen format. It comes with the same standard features as the 8031, but it has a

big 19-inch diagonal screen and external mini disk drive.

We also have a variety of options available for both units, including a convenient bi-directional desk top printer and a new 2708/2716 PROM programmer.

Contact the ISC representative nearest you for a working demonstration of these two highly sophisticated, versatile and dependable desk top systems. Prices are based on a one unit, cash-with-order basis. Guaranteed 30-day delivery or your money back.



**Intelligent Systems Corp.**

5965 Peachtree Corners East  
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**Intecolor 8051**  
Unretouched photo of screen.





Made like a fine watch

## Inspired design... meticulous craftsmanship in a very low cost, very low profile relay

**The Guardian 1475 relay:** Engineered to work like clockwork in your most demanding single pole or double pole high density packaging applications. It switches currents from dry circuit right on up to 5 amps that could weld contacts on other small relays and reeds. All because of design features like these (indicated on the above illustration):

(A) Convoluted stationary contacts with built-in wipe because of (B) armature with off-center fulcrum. (C) .031" diameter terminal pins on .1" grid spacing for PC boards are molded into base with reinforced bosses around thick center section of pins. May be deformed without affecting adjustment. (D) Sealed thermoset glass-filled polyester housing and cover. (E) Built-in bosses provide air space between board and base for better heat dissipation. Plus U/L recognition... and more:

Sealed to shrug off 650°F wave soldering or immersion in cleaning solvents. Sealed to keep contamination outside—where it can't foul contacts. Fast acting, with typical attract time of 3.5 ms; release time, 2.2 ms at up to 50 operations per second. With contact bounce of less than 1 ms on N.O. contact. Shock and vibration resistant. Typical mechanical life of 100 million operations.

Each relay's performance and reliability are proven by nine—yes, nine!—individual tests. (Operation at normal, specified pick up and release voltages; time delay limits on attract and release; contact resistance limits; contact gap and pressure; and ground test.) The nine testing sequences are automatic on every relay. A single failure? Automatic rejection. To the scrap pile.

Ask your Guardian Angel for this free 48-page handbook and catalog.



This mark indicates recognition under the component program of Underwriters Laboratories, Inc.

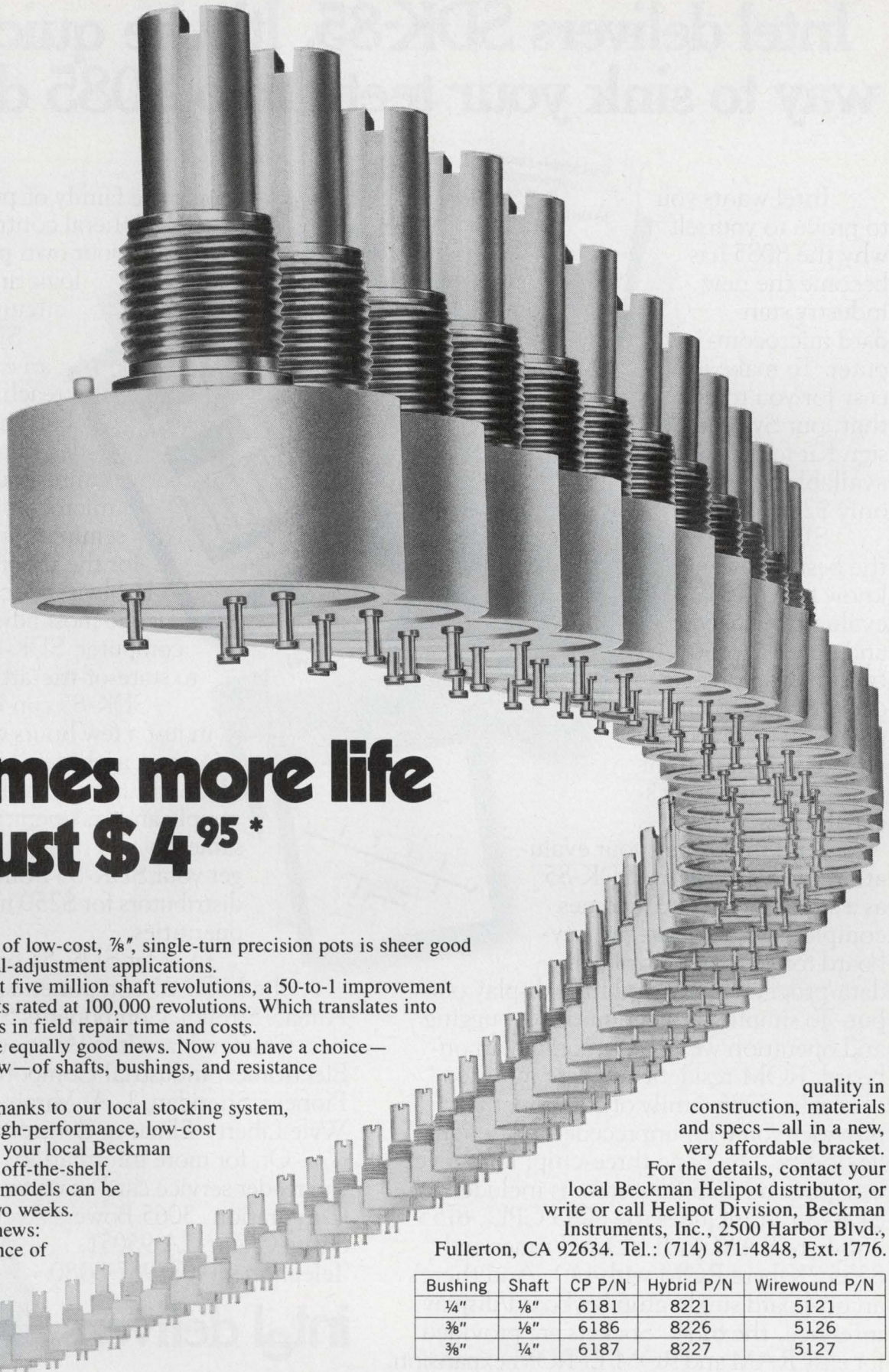


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CIRCLE NUMBER 12





# 50 times more life for just \$4<sup>95</sup>\*

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The options are equally good news. Now you have a choice—see the table below—of shafts, bushings, and resistance elements.

What's more, thanks to our local stocking system, you can get the high-performance, low-cost Model 6187 from your local Beckman distributor—fast, off-the-shelf. Samples of other models can be shipped within two weeks.

That's the big news: Beckman excellence of

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CP Versions

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For the details, contact your local Beckman Helipot distributor, or write or call Helipot Division, Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, CA 92634. Tel.: (714) 871-4848, Ext. 1776.

Bushing	Shaft	CP P/N	Hybrid P/N	Wirewound P/N
1/4"	1/8"	6181	8221	5121
3/8"	1/8"	6186	8226	5126
3/8"	1/4"	6187	8227	5127

# BECKMAN®

CIRCLE NUMBER 13



# Intel delivers SDK-85. It's the quickest way to sink your teeth into 8085 design.

Intel wants you to prove to yourself why the 8085 has become the new industry standard microcomputer. To make it easy for you to do that, our System Design Kit for the 8085 is available now for only \$250.

SDK-85 is the best way we know for you to evaluate MCS-85™ and develop prototypes of 8085-based designs, because it gives you a hands-on look at this important new microcomputer's capabilities.

And to simplify your evaluation, we've designed SDK-85 as a stand-alone kit. It comes complete with an integral keyboard for system control and data/program entry, and LED display output. To simplify programming, debugging and operation we've incorporated an on-board, ROM-resident software monitor.

The 8085 family of components provides you with unprecedented design flexibility. The basic three-chip, high level integration MCS-85 system is included in SDK-85. It includes the 8085 CPU, 8155 256-byte RAM with I/O and timer and 8355 2K-byte ROM with I/O. And there's an on-board single-chip keyboard/display interface, the 8279. Sockets are provided for easy RAM and ROM/EPROM expansion. And there's ample free space laid out for easy wire wrap expansion using Intel's

complete family of programmable peripheral controllers and your own prototype logic and special circuitry.

SDK-85 makes an excellent teaching aid for both microprocessor design and programming courses, for microcomputer design seminars and as a project for the progressive hobbyist. Because the 8085 is the most advanced microcomputer, SDK-85 is the key to state-of-the-art knowledge.

SDK-85 can be assembled in just a few hours with a soldering iron and a few basic tools. Hook it up to your 5V power supply and it's operational the same day you receive it. You can get your SDK-85 from any of Intel's distributors for \$250 in single unit quantities.

To order SDK-85 or any of the MCS-85 components, contact: Almac/Stroum, Components Specialties, Cramer, Hamilton/Avenet, Harvey Electronics, Industrial Components, Pioneer, Sheridan, L.A. Varah, Wyle Liberty/Elmar or Zentronics.

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# The IC Tester that's in a class by itself has graduated to MPU.

It's the 48-pin IT-200 bench-top tester. The most flexible integrated circuit tester around. Handles virtually all digital devices.

Now its flexibility stretches to MPU's.

All it takes is our new special test head, which is compatible with all existing IT-200's.

IT-200 will perform DC parametric as well as functional testing via standard factory programs. It can also use an associated MPU instruction set to perform customer specified test routines.

Test the 6800 or the 8080, just to name two of the MPU's which the IT-200 can now handle.

All this plus its original IC test versatility. The 100 kHz functional capability, coupled with a powerful DC parametric capability, allows testing of CMOS, NMOS, PMOS, ECL, and TTL devices of any complexity. The particularly powerful DC parametric test capacity provides current ranges from  $\pm 200$  na to  $\pm 200$  ma, and voltage ranges up to  $\pm 20$ V.

Check out the IT-200. You'll find the specs are truly in a class by themselves and the price is surprisingly low.

For more information on what IT-200 can do for you, write or call Cliff Small, Siemens Corporation, Measurement Systems Division, 3 Computer Drive, Cherry Hill, New Jersey 08034. (609) 424-2400.

## SIEMENS



IT-200 is manufactured by Imperial Technology and marketed by Siemens.

CIRCLE NUMBER 15



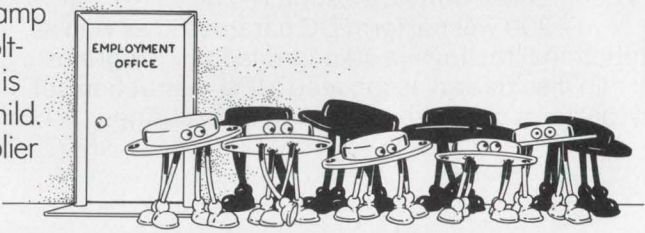
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## OUR NEGATIVE 5-AMP ADJUSTABLE REGULATOR IS PUTTING A LOT OF 1-AMPS OUT OF WORK.

Throw away the shoehorn! It no longer takes five 1-amp voltage regulators and a handful of components to get to 5 amps. Which means you can get better specs. In less time. Using less room. At less cost.

And get this: The part that makes it all possible, a negative 5-amp adjustable voltage regulator, is available from Fairchild. A major hybrid supplier capable of high volume production.



### NOT JUST YOUR REGULAR REGULATOR.

Our  $\mu A79HG$  is a general purpose regulator capable of supplying in excess of 5 amps over a  $-24\text{ V}$  to  $-2.2\text{ V}$  output range. It has full thermal overload and short-circuit protection. It's packaged in a hermetically sealed 4-pin TO-3 package that provides 50 W power dissipation.

The regulator consists of a monolithic chip driving a discrete series pass element and short-circuit detection transistors. And that's not all. Our  $\mu A79HG$  needs no electrical insulator because its case is isolated.

**ELECTRICAL CHARACTERISTICS:  $T_J = 25^\circ\text{C}$ ,  $I_{OUT} = -2.0\text{ A}$  unless otherwise specified**

CHARACTERISTIC	CONDITION	MIN	TYP	MAX	UNITS
Input Voltage Range		-40		-7.0	V
Nominal Output Voltage Range	$V_{IN} = V_{OUT} - 5\text{ V}$	-24		-2.23	V
Line Regulation	$V_{IN} = -7\text{ V to } -40\text{ V}$		0.4	1.0	% (V <sub>OUT</sub> )
Load Regulation	$V_{IN} = V_{OUT} - 10\text{ V}$ , $I_{OUT} = -10\text{ mA to } -5\text{ A}$		0.7	1.0	% (V <sub>OUT</sub> )
Control Pin Current				3.0	$\mu\text{A}$
Quiescent Current	$V_{IN} = -10\text{ V}$			5.0	mA
Ripple Rejection	$V_{IN} = -8.5\text{ V to } -18\text{ V}$ $V_{OUT} = -5\text{ V}$ , $f = 120\text{ Hz}$		50		dB
Output Noise Voltage	$10\text{ Hz} \leq f \leq 100\text{ kHz}$ , $V_{OUT} = -5\text{ V}$			200	$\mu\text{V}$
Dropout Voltage	$I_{OUT} = -5\text{ A}$			2.0	V
Peak Output Current	$V_{IN} = -10\text{ V}$			8	A
Control Pin Voltage (Reference)	$V_{IN} = -10\text{ V}$	-2.35		-2.11	V

### SO MUCH FOR SO LITTLE.

With all this performance, you'd expect a large price tag. But our  $\mu A79HGKC$  costs only \$7.15 in quantities of 100. That's about 30% less than equivalent hermetic 1-amp regulators.

To find out more about our negative 5-amp adjustable voltage regulators (or any of our other hybrids), write or call your Fairchild sales office, distributor or representative today. Or, use the number at the bottom of this ad to call our Hybrid Products people direct. Fairchild Camera & Instrument Corp., 464 Ellis St., Mountain View, CA 94042. Tel: (415) 962-3771. TWX: 910-379-6435.

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**CALL US ON IT.**  
**(415) 962-3771**



## I<sup>2</sup>L performance will be improved several ways

Faster speeds, higher power outputs, greater circuit densities, and more compatibility with analog devices on the same chip can all be achieved for integrated injection logic. These findings will be presented this week at the International Electron Devices Meeting in Washington, DC.

One way to improve I<sup>2</sup>L performance will be described by John M. Herman, III, member of Texas Instruments' technical staff in Dallas. A buried-collector implant can be used to fabricate Schottky devices on collectors decoupled from the other devices by a p+ implant. With the Schottky devices, gate speeds were improved 40 to 70% over that of second-generation I<sup>2</sup>L devices, Herman reports.

The Schottky devices function over the full military temperature range, -55 to 125 C. For a chip with five decoupled gate collectors, a constant speed-power product of 0.16 pJ was achieved at injector currents of 10  $\mu$ A/gate, and 0.7 pJ at 100  $\mu$ A.

High current levels of milliamperes instead of the microamperes of typical I<sup>2</sup>L circuits would help increase the speed and provide greater immunity to radiation. But a standard I<sup>2</sup>L layout—rows of structures—is burdened by uneven collector-current characteristics, which lead to losses that won't permit these high currents.

So L.J. Rangone and N.T. Yang, staff engineers at General Electric, have fabricated a 2 x 2 array of collectors in a square structure with a base contact in the middle. This, they will report, reduces collector losses to about one-quarter that of a worst-case conventional four-collector arrangement. And more than 4 mA of current have been obtained.

What's more, the square structure, which incorporates symmetrical injectors, produces collector currents that enable this configuration to be used in d/a conversion systems that are off-limits to standard I<sup>2</sup>L.

Speed and current for I<sup>2</sup>L aren't the

only things going up. With electron-beam lithography instead of conventional photolithography, the speed-power product has been upgraded five times over that of conventional five-collector, "stick" geometry, n+ guarding devices, according to S.A. Evans of Texas Instruments. In addition, the potential number of gates per unit area increases from 400/mm<sup>2</sup> to 2000/mm<sup>2</sup>.

"We achieved 0.13 pJ at 5  $\mu$ A," Evans reveals. "And this can be reduced below 0.1 pJ."

Another advantage in using E-beam technology is that simple I<sup>2</sup>L structures with greatly improved performance can be obtained—in contrast to the increasingly complex devices that have been developed over the past couple of years to get the performance needed by I<sup>2</sup>L to compete with TTL and ECL logic. These complex devices use input and output Schottky devices, clamps and double epitaxial layers.

Efforts are under way to combine analog devices and I<sup>2</sup>L digital devices on the same chip. But up to now, the thin, highly doped, epitaxial layers needed to produce good I<sup>2</sup>L have limited the voltage-breakdown characteristics of the analog circuitry. But with a new process, researchers at the University of California at Berkeley have raised I<sup>2</sup>L breakdown voltages from 15 or 20 to 40 or 50 V.

"We start with epitaxial material that is good for analog devices," notes Professor R.G. Meyer. The material is 12 to 14  $\mu$ m thick and 5 $\Omega$ -cm resistivity, which gives good breakdown characteristics. Next, the section of the wafer that will contain the I<sup>2</sup>L circuitry is ion-implanted with phosphorus. After subsequent high-temperature processing, the implant rediffuses to a concentration of about 0.2  $\Omega$ -cm, which gives excellent I<sup>2</sup>L characteristics. The I<sup>2</sup>L portion has a breakdown of about 3 V.

"The key to this process," Meyer points out, "is to choose the proper level of the initial ion implant."

## Businesses to test satellite communications

Rockwell International Corp., Texaco Inc., and Montgomery Ward and Co. Inc. have signed on for a three-month experiment at transmitting business communications via satellite. Data will be gathered on user requirements, equipment performance, and applications and opportunities for satellite communications. An evaluation will be published in a report to NASA and the Federal Communications Commission.

Project Prelude, to be coordinated by Satellite Business Systems, McLean, VA, will use the Communications Technology Satellite maintained by NASA and the Canadian Department of Communications. The satellite system will transmit voice and high-speed digitized data, facsimile, and teleconferencing directly between businesses' premises. Rockwell began experiments in November with transmissions between Pittsburgh and Seal Beach, CA. In December, Texaco will transmit between Harrison, NY, and Bellaire, TX. And in January, Montgomery Ward will transmit between Chicago and Catonsville, MD.

At each pair of sites, SBS and Comsat Laboratories (Clarksburg, MD) will install a small earth station consisting of a trailer with an 8-ft dish antenna and a control center. Transmissions will take place at 12 and 14 GHz, with bandwidths of 85 MHz and data rates to 1.544 Mbps.

Transmission experiments will be conducted several days a week, at pre-arranged times. Tests will be made of full-motion color television as well as of digital applications of the system, such as data communications, freeze-frame video, and facsimile. Color freeze-frame pictures are transmitted via satellite in half a second, compared with 2½ minutes via telephone lines, according to SBS, and can convey photographs of conference participants, charts and other visuals typical of business conferences.

Equipment to be used in Project Prelude includes Advent large-screen projection television systems, Arvin/Echo freeze-frame storage systems, Dacom/Rapifax facsimile systems, Harris modems, Hewlett-Packard data-processing networks, Ikegami Electronics (USA) color-television cameras, NEC America freeze-frame transmission systems, and Comsat Labs rf terminals.



SBS, a partnership formed by IBM, Comsat General, and Aetna Life & Casualty, expects to have an all-digital satellite system for business communications in operation by 1981.

## Logic monitors add data-stream comparison

Two CRT display units that store digital data in two sets of memories enable any logic analyzer to compare the output of a unit under test with that of a known-good system. The LM 208 and LM 216 logic monitors can display up to eight and 16 channels, respectively, of digital data from a logic analyzer in timing-diagram, binary, octal, or hexadecimal format. Each channel is 256 bits deep.

Data can be fed into the monitor's A memory, then transferred into B memory to serve as a reference, or fed directly into the B memory via an RS-232 port. A second set of data can be fed into an A memory, and any differences between the A and B memories can be seen in reverse video on the CRT screen.



The LM 208 and LM 216 also allow mixed-expansion displays in which the data beyond an adjustable cursor is displayed in a  $\times 10$  mode. This feature, like the comparison mode, has been available on other logic analyzers, but not in a separate display unit that can hook up with analyzers lacking such capabilities.

The units, designed by Dolch Logic Instruments in West Germany, are built and marketed in the United States by E-H Research Laboratories Inc., Oakland, CA. Controlled by F8-type microprocessors, the LM 208 is priced at \$2200 and the LM 216 at \$2600.

CIRCLE NO. 319

## Electronics in cars must be as reliable as in space

Contrary to popular opinion, electronic devices on drawing boards or

under development for cars of the 1980s must be as dependable as devices used in space.

There is a general belief that if electronics can operate reliably in the harsh environment of space, it can perform much more easily in a car. Therefore, less reliability is required.

"No way," says Eugene Karrer, vice president and general manager of Ford Motor Co.'s Electrical and Electronics Div. "The automobile is one of the most difficult design environments, with extremes of heat and cold, high humidity, variations in power, vibrations and severe road jolts."

Addressing a seminar at the American Society for Quality Control in Southfield, MI, Karrer noted that the aerospace designer can spend huge amounts of money to build a protective environment for his electronics, as well as a fully redundant backup system. This luxury is denied to the automotive systems designer.

Still, Ford is speeding up the application of electronics to engine controls, because "this is the only way we can see to meet the Federal requirements for emission control and fuel economy," Karrer explains.

"Not only do we have the problems of meeting emission and fuel economy standards, which are severe enough," Karrer continues. "But we also must consider safety and consumer protection regulations, which require very accurate power-train control and inherently high reliability."

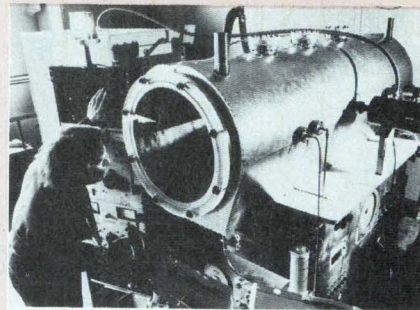
The solution to the problem of reliability is not repairability, concludes the Ford executive, but a return to the fundamentals of design and production.

## UV excitation doubles efficiency of CO laser

High-power lasers with efficiencies greater than 50%—twice that of other high-power lasers—are being studied at the Westinghouse Research and Development Center in Pittsburgh under Air Force contract.

Instead of using electron beams to sustain the laser, the Westinghouse design uses an ultraviolet-initiated electrical discharge. The method consists of radiating a low-ionization-potential "seedant" in the laser gas with ultraviolet light, which photoionizes the seedant molecule. The photoelectrons initiate and stabilize the glow discharge at high power levels.

Ultraviolet radiation is generated



**Doubling the efficiency** of high-power CO lasers is the goal of an Air Force project.

with a multiple-arc-gap structure. "Since the UV-producing arcs can be generated with simple gap structures, this technique should produce an extremely rugged and maintenance-free design compared to the fragile foil 'windows' on electron guns," says Dr. S.A. Wutzke of the Westinghouse research center. In addition, he says, "the theoretical conversion efficiency of electric-discharge carbon monoxide lasers is at least twice as good as any other high-power laser concept envisioned today."

"If the physics of the UV-initiated CO laser now being investigated prove promising, we must next demonstrate its scaling possibilities to the power levels required for industrial and military applications," says Wutzke. The research contract is funded by the Defense Advanced Research Projects Agency and is monitored by the Air Force Weapons Laboratory at Kirtland Air Force Base, NM.

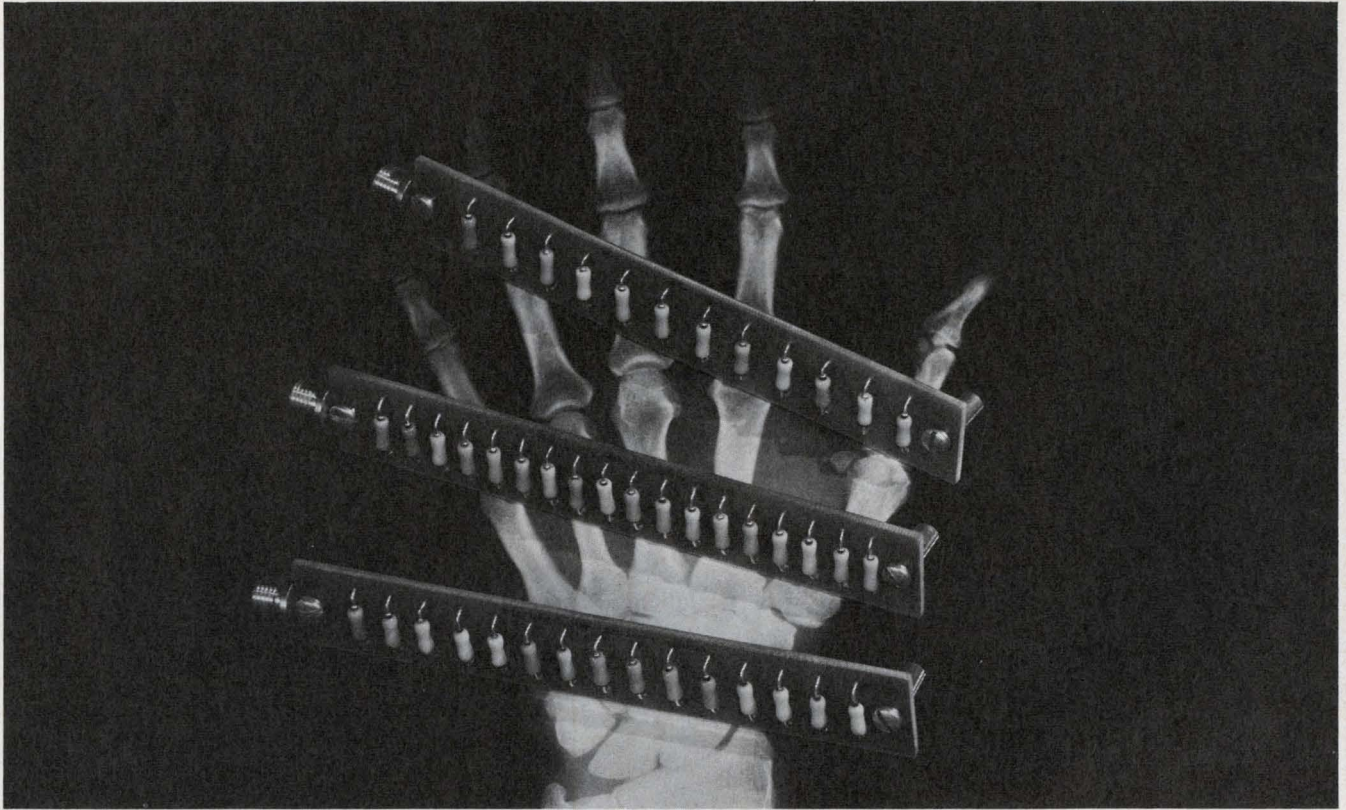
## Driving shocks electronically softened

An electronic shock-absorbing system is designed to provide a smoother-than-ever ride for the nation's motorists and truck drivers.

Developed by Monroe Auto Equipment Co., Troy, MI, the electronic ride-control system is designed around a pair of Monroe air-adjustable shock absorbers, one of which contains a photocell unit that constantly senses vehicle height.

As the vehicle is loaded and the shock absorbers compress, the photocell senses that this body position is below normal. The computer, monitoring this change, activates an electric air compressor that adds air to the rear air shocks, and levels the vehicle automatically. When the vehicle is unloaded, the computer automatically returns the body to its proper height by bleeding air from the system.





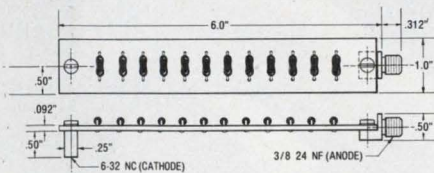
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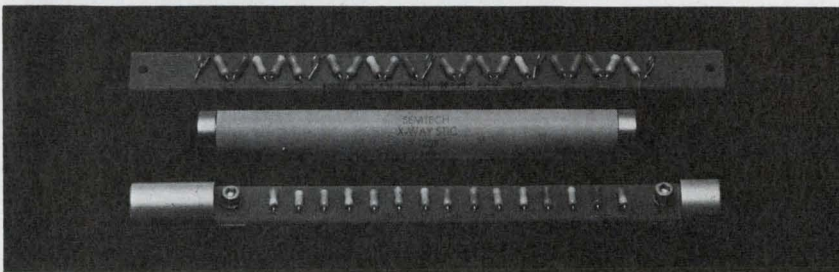
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CIRCLE NUMBER 17





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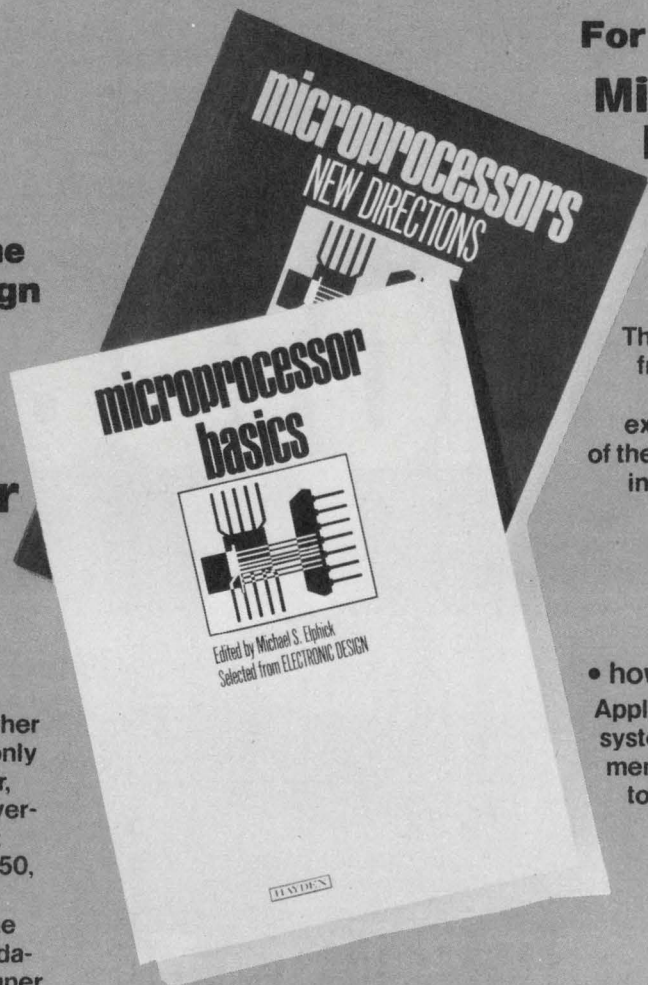
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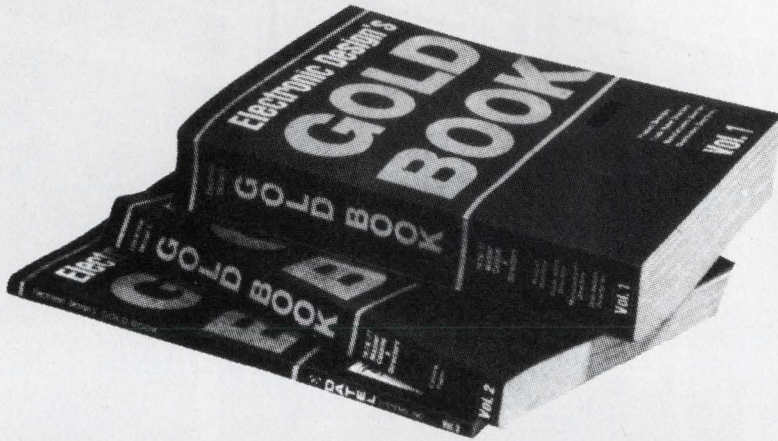
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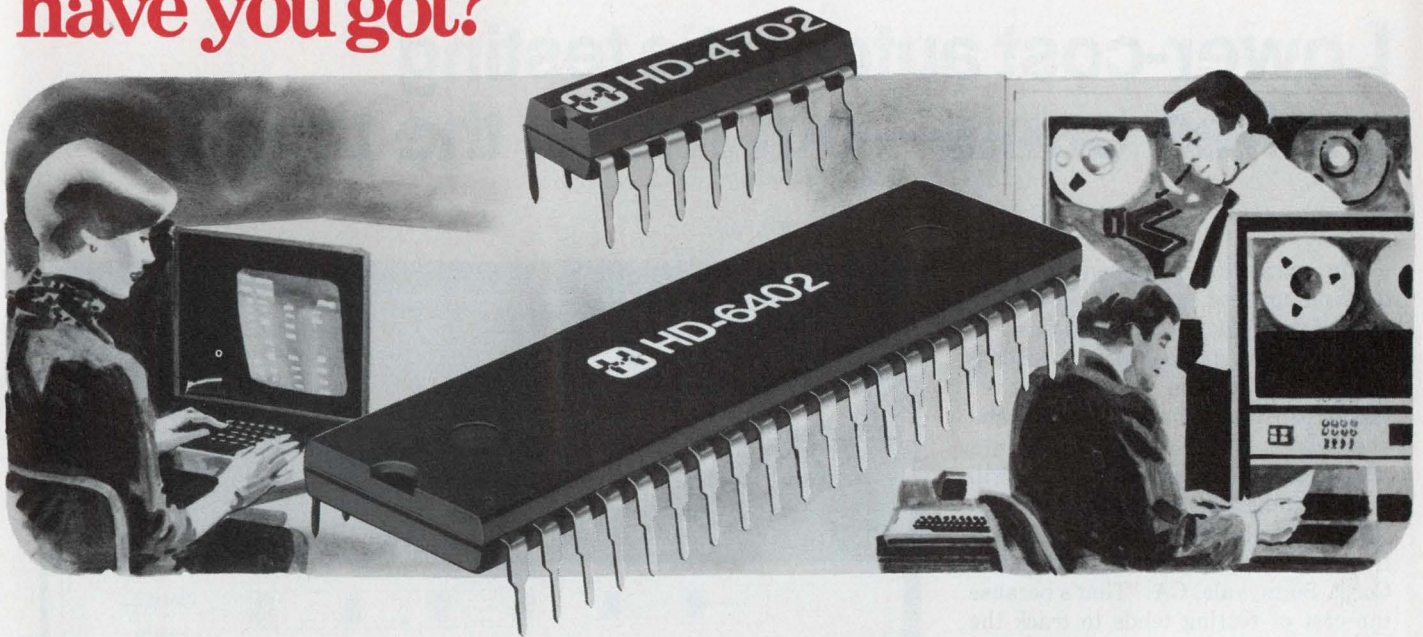
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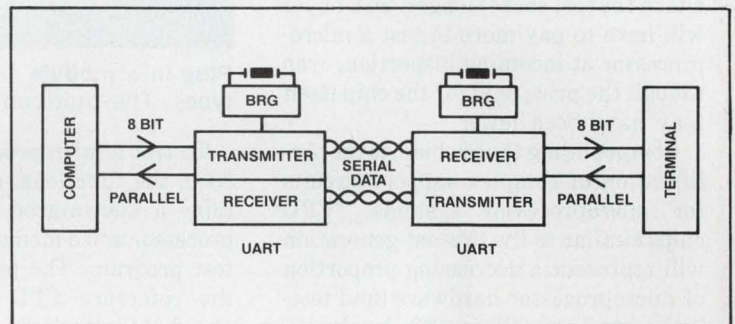
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CIRCLE NUMBER 22



## Lower-cost automatic testing makes cents—but not all the time

Automatic-test-equipment users are demanding less expensive ways to check integrated circuits and printed-circuit boards, and equipment vendors are responding with products that are less expensive to buy, maintain, and operate.

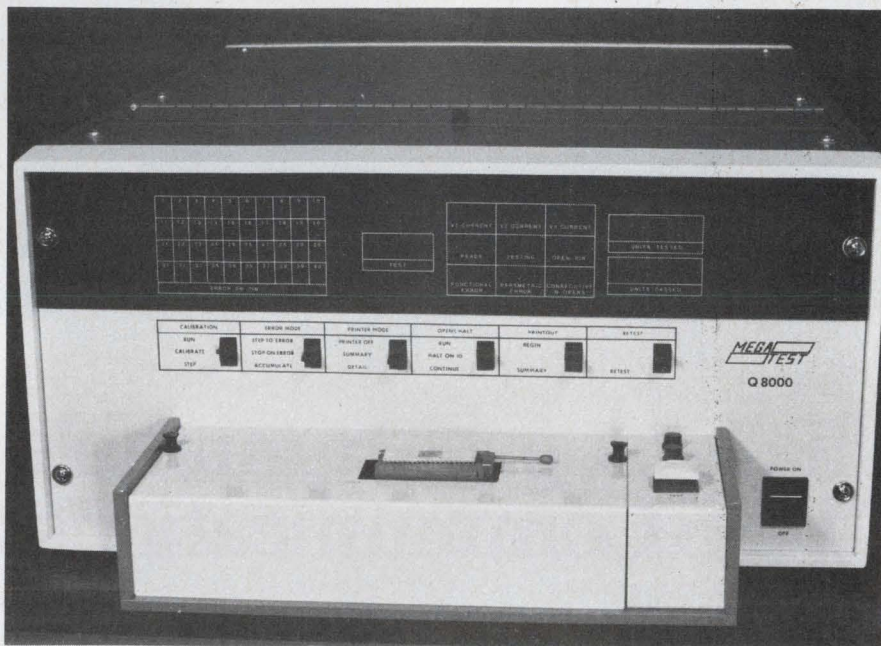
"The cost of testing is already or will soon become the single largest contributor to the cost of a device," says Stephen Bisset, president of Megatest Corp., Sunnyvale, CA. "That's because the cost of testing tends to track the complexity of the device you're testing," he explains, "but the price of the device itself keeps dropping."

Writing a program to test a microprocessor takes longer than writing a program to test a less complex IC, such as a memory, and the microprocessor sits in the test socket longer. So a buyer will have to pay more to test a microprocessor at incoming inspection, even though the price paid for the chip itself may have been lower.

Compounding the problem is the proliferation of complex support circuits for microprocessor systems. "CPU chips similar to the present generation will represent a decreasing proportion of microprocessor hardware (and testing) costs," says Bisset. "To be significant, a testing approach must cover such devices as CPUs, I/O controllers, floppy-disc controllers, CRT controllers, serial communications chips and, last but not least, single-chip microcomputers with RAM, ROM (or EPROM) and I/O on the chip."

In its Model Q8000 tester, Megatest joins a mainframe controller to plug-in "functional data modules," which tailor the tester to specific device types and generate the patterns needed to exercise the device under test. The mainframe goes for \$26,000 and plug-ins average \$3500.

**Andy Santoni**  
Associate Editor



Plug in a module and configure the Megatest Q8000 to test different device types. The unit can handle microprocessors, memories, and random logic.

To test a microprocessor such as an 8080, the functional-data module contains a known-good reference microprocessor and a memory that stores the test program. The program is run on the reference CPU one clock cycle ahead of the device being tested, so that timing measurements are independent of the characteristics of the known-good device. The outputs of the two ICs are compared to determine if the device under test is good.

The reference device operates in a benign environment in which timing relationships, drive and sense levels, and power supplies are at the most favorable values. Otherwise, a faulty device might pass a test because the reference as well as the device itself cannot meet the test conditions.

Similar comparison testing is used in Adar Associates' Model MX-17 device test system. With what Adar calls "conditioned natural environment" testing, "worst-case or stress conditions are seen only by the device under

test," explains Herb Thaler, senior systems analyst at Adar in Burlington, MA. Thaler described the technique at the Semiconductor Test Symposium in Cherry Hill, NJ.

### Lower system cost demanded

"In order to be available to the user market, a system must be low in price," says Thaler. "Programming costs and efforts must be reasonable. In particular, the software must permit easy access and total utilization of the system by design engineers familiar with the microprocessor language."

Programming the Adar system is simplified by separating test-sequence generation from system-controller programming. Bit patterns used in testing are generated by instructions that are written in the language of the microprocessor to be tested, and can be modified to reflect different operating requirements.

The Adar technique meets the defini-





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**By comparing against a known-good device,** the Adar MX-17 can tell whether a test device's responses to a set of stimulus signals are right or wrong.

tion of low-cost testing, says Thaler, because "as currently implemented, the CNE test system is well below a \$50,000 ceiling."

For the majority of incoming inspection test needs, a small, low-cost tester fits the bill, says Walt Luciw, test engineer with Sperry Univac, Blue Bell, PA. But before choosing a test system, he adds, "you have to decide if you're going to do incoming inspection only, or if you're going to do characterization, or both."

Device characterization includes measurements of a device's voltage and timing capabilities, as opposed to simpler go/no-go testing, which only determines whether a device is good or bad by some set of standards. Complete characterization tests require a high-speed—and expensive—tester such as the Fairchild Sentry VIII (see "News Scope," ED 24, Nov. 22, 1977, p. 21).

### **Expensive systems have a place**

Standing up for more sophisticated, more expensive, test systems, James Healy of Fairchild Instrumentation and Systems Group, Wiesbaden, West Germany, believes that programming and analyzing test data rather than test hardware constitutes the major portion of the cost involved in testing microprocessors. A tester must be able to characterize so that either faults can be corrected in the manufacturing process or simple tests for such faults can be developed.

"The \$350,000 general-purpose tester usually provides test capability for all kinds of logic, mass-storage peripherals for programs and test result data, and numerous 'nice-to-have' but hardly necessary features like graphics," says Healy. Hardware costs can be reduced substantially by limiting voltage swings and dedicating certain tester pins to specific functions, replacing disc memory with magnetic tape, or simplifying pattern generators—though the last would increase test time. Still, price would then be jacked down to about \$200,000, Healy says—about the same as for multiple dedicated test systems for microprocessors, memories, and peripheral chips.

"The general-purpose tester in a low-cost configuration to test microprocessors and related peripheral devices is probably the most cost-effective microprocessor-testing solution today," Healy maintains, adding that the gap in hardware cost between a general-purpose type and a dedicated stand-alone microprocessor tester is justified.

### **Who needs it?**

An IC user can take advantage of the general-purpose tester's capabilities to examine a prospective vendor's parts thoroughly before the vendor is added to the user's qualified-source list. The user can also monitor the quality of the parts received from different vendors to see if any should be dropped from

the list. The detailed test data available from a general-purpose tester can also be valuable to design engineers, who can use data on the traits of particular microprocessors.

A general-purpose system can perform characterization tests important to device manufacturers, users of high volumes of different types of devices, and manufacturers of equipment that must be highly reliable, says Doug Smith of Tektronix Measurement Systems Division, Beaverton, OR. And such a system can even save money. The device manufacturer pays for the system by using its results to improve processes and increase yields. High-volume users of mixed device types save by standardizing on a single system type instead of programming and maintaining different special-purpose testers, and by increasing the throughput of devices being tested. High-reliability manufacturers, of course, cannot afford failures, so they need the exhaustive tests a general-purpose system performs so effectively.

When shopping for an automatic test system, a prospective buyer should be looking for four things, says Smith: the highest performance possible at whatever the price; reliability, since down time on expensive test systems can dramatically increase testing cost; the ability to generate enough patterns to test devices thoroughly; and easy programmability, since programming cost is a high percentage of a test system's operating cost.

### **Generating patterns faster**

The last point makes automatic pattern generation a necessity in automatic test systems, Smith goes on. Hand-coding test sequences takes so long that it can eat away at whatever saving is achieved at purchasing time, and might even take long enough for the manufacturing of the final product to be held up. Moreover, human error in a lengthy test sequence is unavoidable, and documentation can be confusing and useless. Automatic pattern generation, on the other hand, provides simpler documentation and more flexibility, since a simple change in the generation program changes the entire test sequence.

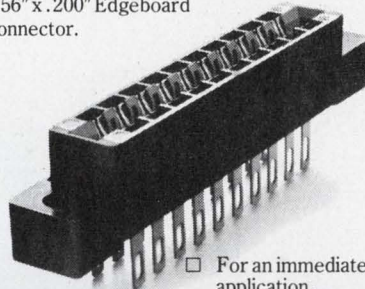
But for simpler test programs, less expensive pattern-generating techniques can suffice, since, after all, "the tester really doesn't care where the pattern comes from," says Megatest's Bisset. ■



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**TEXAS INSTRUMENTS**  
INCORPORATED



# Sturdy electromagnetic element displays in color, saves power

A rugged visual display element may have considerable impact on the design of large-character displays, annunciators and status indicators. A display array using this element consumes about 97% less power than an array of incandescent lamps. Moreover, the new element lends itself to mixing character displays with graphics—both discrete charts and continuous-tone pictorials.

Developed by Heath and Co. in Los Angeles, the TeleMatrix is a three-position rotary device with only one moving part. Built around a cylindrical permanent magnet, the element floats on a stationary armature.

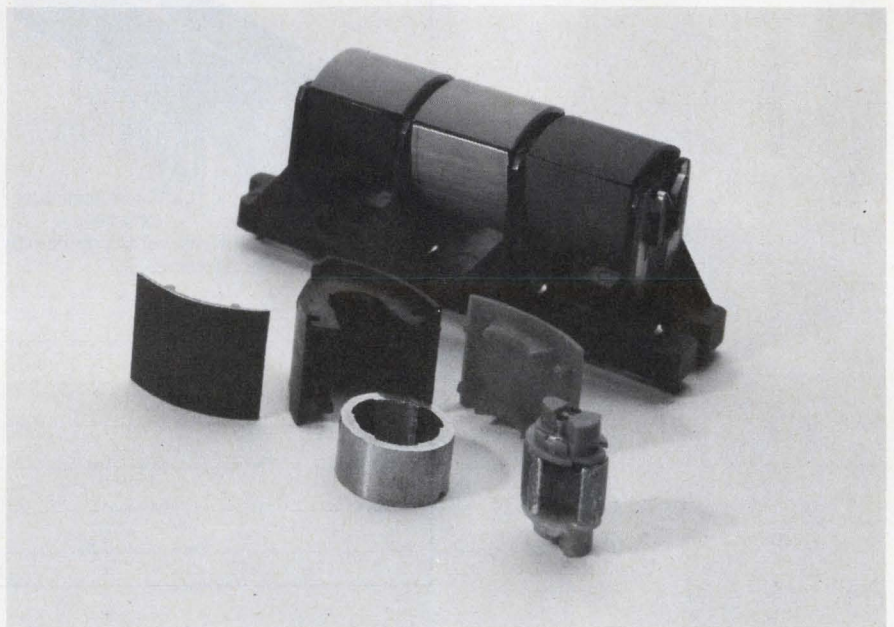
## A nonvolatile memory

Pulse one of the three coils in the armature, and the element rotates to show the face desired. The magnet locks the element in place, even after power is removed, in addition to providing the torquing and damping effects that control the motion. The element takes about 50 ms to move, and goes "the short way"—that is, the element turns 120° either way in response to a pulse, never 240°.

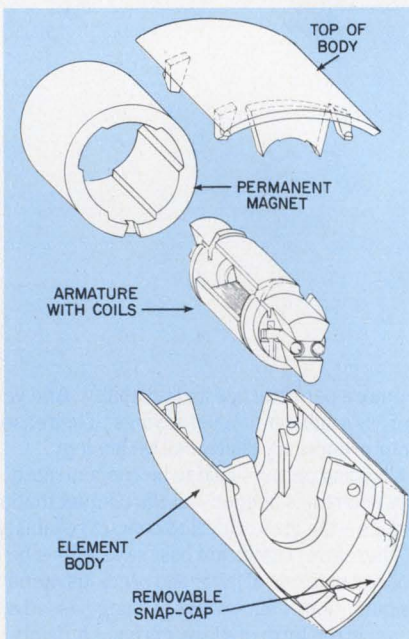
Heath has used arrays of TeleMatrix elements to build full-color message boards with a microprocessor controlling the displayed message. The TeleMatrix elements are also finding their way into outdoor advertising signs, scoreboards, bus-destination signs, and highway signs. The elements are also suitable for smaller displays and for indoor uses, like silent paging, airport-information systems, and brokerage boards. This fall, Heath, a division of Fischbach and Moore, began offering the display elements for OEM use.

Available as unmounted components or in arrays assembled on Standard PC

**Dave Barnes**  
Western Editor



This color display element with one moving part features interchangeable snap-on faces. It comes in arrays or as an unwanted component.



A permanent magnet "floats" a three-faced display element on a stationary armature. Current pulses turn the element so that different sides are visible to the viewer.

boards, the new element is made 1/2 in., 2 in., or 3 in. high. The body is made of injection-molded plastic for the 1/2-in. unit, and of plastic foam for the larger sizes. So rugged is the element and its holder that one can walk across the face of an assembled array without doing damage.

## Mix and match

Face colors may be specified differently, but current production provides black and yellow faces that are permanent parts of the body, and a third face fitted with an easily removed "snap-cap." The cap can carry a third color, a graphic element, or a pictorial segment made by dicing a picture or poster. Programming selects black characters on a yellow background, or yellow on black, or either on a pictorial background, and so on.

Defective elements can be popped out of the plastic holders, and replacements snapped in. Since the rotor



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Choose from three new op amps with high slew rates. One specifies the industry's lowest noise:  $4nV/\sqrt{Hz}$ !

The next time you find yourself searching the specification tables for a high-performance op amp, be sure to search ours. You'll find a broad offering—more than 60 models, each with package and temperature options. You'll also discover three new entries, one of which is likely to provide that exceptional spec you need.

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When you compare the SE/NE5534 with standards like the  $\mu$ A741 and LM307, you'll find that it offers superior performance—spec for spec. This outstanding op amp is internally compensated for gains equal to, or greater than, 3. And if you want to optimize frequency response for unity gain, capacitive load, low overshoot, etc., you can do so easily with an external capacitor.

**Two For High Slew.** For those designs demanding high slew rates, you should look into our super-fast performers—the SE/NE530 or SE/NE538. Internally compensated, both of these devices have excellent input characteristics.

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 High Slew SE/NE538  
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phone me at once: (     )     ext.     \_\_\_\_\_

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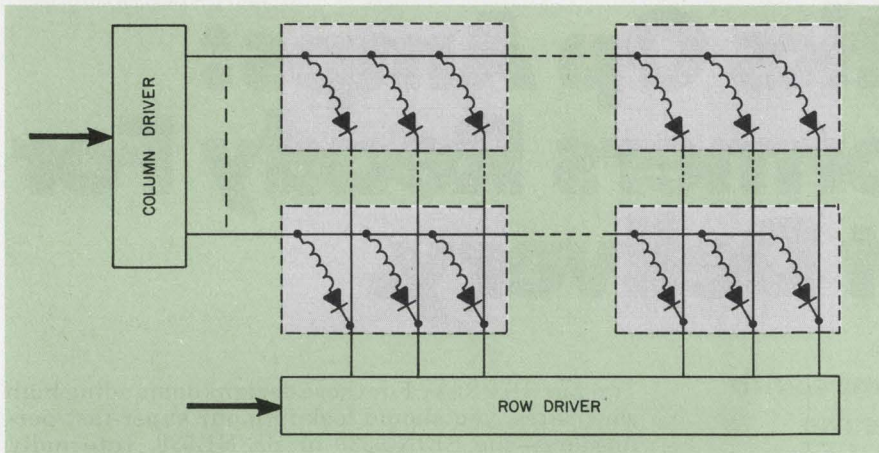
Address \_\_\_\_\_ MS \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

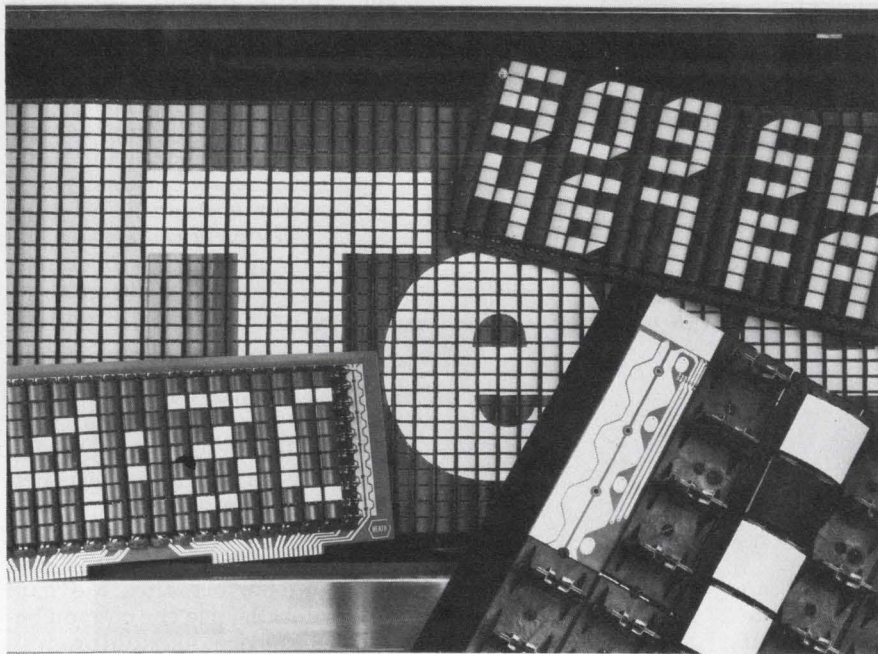
I'm also interested in any other op amps you offer for this application: \_\_\_\_\_

ED126





**Series diodes built into the element** steer 250-mA, 24-V pulses to selected coils in a matrix circuit.



**Assembly of 2-in. elements** (lower right) shows detail of PC board and die-cast plastic holders with snap-in connectors. Partially assembled PC board (lower left) holds  $9 \times 22$  array of 1/2-in. elements. The legibility of special font (upper right) is obtained from the diagonal pattern of the elements' third side. Painted pictorial (background unit) uses the elements as quasicontinuous surface.

containing the coils is stationary, there are no sliding or wearing contacts.

"The plastic body centers the magnet on the armature so that side forces cancel out," says Greg De Smet, Heath's director of electronic development and inventor of the innovative display. "Since the plastic is just a guide, not a bearing, wear is slight, and the elements have a very long life."

For size, the TeleMatrix character displays begin where most LEDs and LCDs leave off. For letters 2 1/2 in. high up to billboard size, the elements can form character fonts in many ways.

A full ASCII alphanumeric font us-

ing only a  $4 \times 5$ -element pattern is legible (see photo) because of diagonal patterns on the third face. With only 20 elements to drive, as opposed to 35 for a conventional  $5 \times 7$  matrix, this font can save money. In addition, a numeric font has been developed with only five elements that are horizontal and triple the normal width. "We keep on finding new fonts," De Smet grins.

### Won't wash out

By working *with* the available ambient light, the TeleMatrix approach gets away from the tendency of incandescent bulbs to wash out to low con-

trast in sunlight, yet produce troublesome glare at night.

"Sunlight tries to wash out any self-illuminated display, and you use power to combat it. But ambient light works with our reflective elements, not against them, explains Tim Brosnahan, national manager of electronic systems at Heath. "So visibility and contrast are free in the daytime. At night you use a few inexpensive fluorescent lamps to light up the whole sign.

### Blackouts of 1975

When the energy crunch hit two years ago, Brosnahan goes on, outdoor signs across the country were turned off. "We couldn't even give away the conventional incandescent signs, so we searched for something new that would cut power usage dramatically."

The older Heath designs already had been modernized with SCRs and triacs to dim and switch the tungsten bulbs. Then many techniques were evaluated to see if they would do the message-board job and save power. Electroluminescent, electrochromic, electrophoretic, electrostatic-vane, magnetic-disc and magnetic-particle approaches were all weighed.

"None of these technologies was really ready to go, what with the wide temperature range and intense ultraviolet bombardment that outdoor signs have to withstand, so I went back to basics and invented an answer," De Smet explains.

The TeleMatrix element has advantages over all other available elements and saves kilowatts of power.

### It's bright to cut power

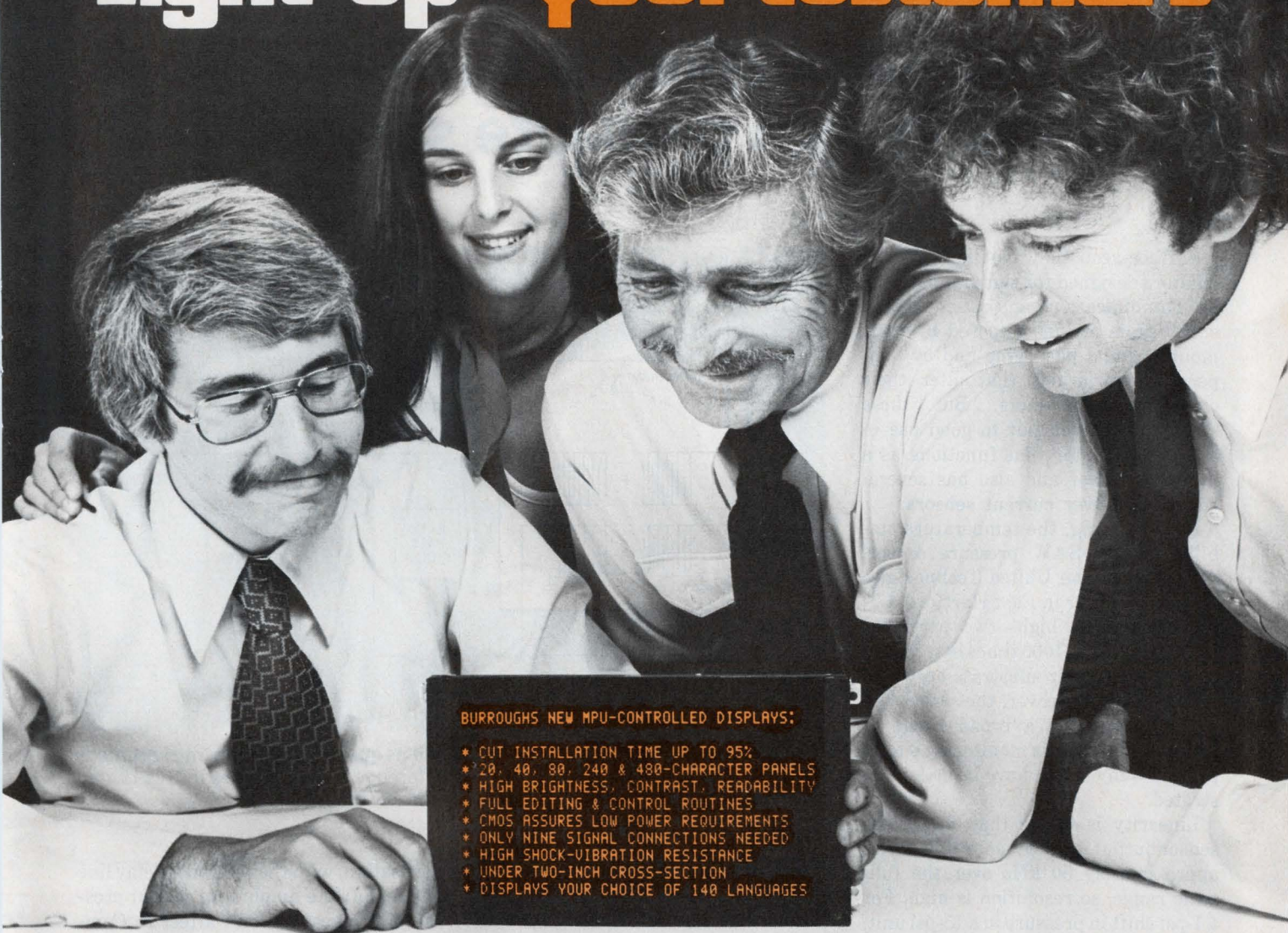
In one Heath comparison test that is typical for large signs scaled for 1000-ft visibility, 2160 TeleMatrix 3-in. elements were pitted against 2160 33-W incandescent lamps; updating of all elements every five seconds was assumed. Both approaches provided two lines of 24 programmable  $5 \times 7$  characters 21 in. high. Each sign was double-sided, about 2 1/2 ft high and 30 ft long.

Twelve hours of day operation and six hours of night operation were assumed. The lamp system was cut back from full power to half power at night, when less brilliance was needed.

At three cents per kilowatt-hour, electric power costs \$481 a month for the incandescent-lamp sign—and \$16 per month for the TeleMatrix sign. ■



# "Light-up" your customers



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The display's built-in microprocessor memory and control eliminate the need for you to design, develop and build circuitry to effect display operation. Just feed in appropriate 8-bit signals for the characters and control commands and you're in operation. Large system manufacturers save 95% of the engineering and development time formerly required and small system producers can now use displays since "design-in" cost is no longer a significant factor.

Adapting the Burroughs displays to your needs is as easy as a change in software. Their operation can be tailored for any product and changed for others with different display requirements.

The display subsystem operates off an 8-bit bi-directional buss or a TTL buss. Data can be entered at rates up to 1 MHz. and, with the addition of a keyboard and communication interface, it becomes a low-cost, compact data terminal!

The system's edit and control routine allows insertion, deletion and blinking of letters or lines, increasing or decreasing brightness, right-to-left data entry, etc.

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You can **see** the difference

# Burroughs

Distributed by Hamilton/Avnet and Cramer Electronics





# SAW oscillator takes strain by working as a pressure sensor

Surface-acoustic-wave filters and oscillators designed for signal processing in communications and radar usually suffer from strains imposed by their mounting and packaging and by temperature variations that alter their operating parameters. But these strains have been put to good use in a SAW oscillator that functions as a pressure sensor and also has several advantages over current sensors.

For one thing, the temperature stability of the SAW pressure sensor, developed at the United Technologies Research Center in East Hartford, CT, is exceptionally high—two parts per billion per °C, or 1000 times better than that of the quartz substrate on which it is formed. Moreover, the sensor can be fabricated for a broad range of pressures, and units monitoring 0 to 15 psi and 0 to 600 psi have been demonstrated.

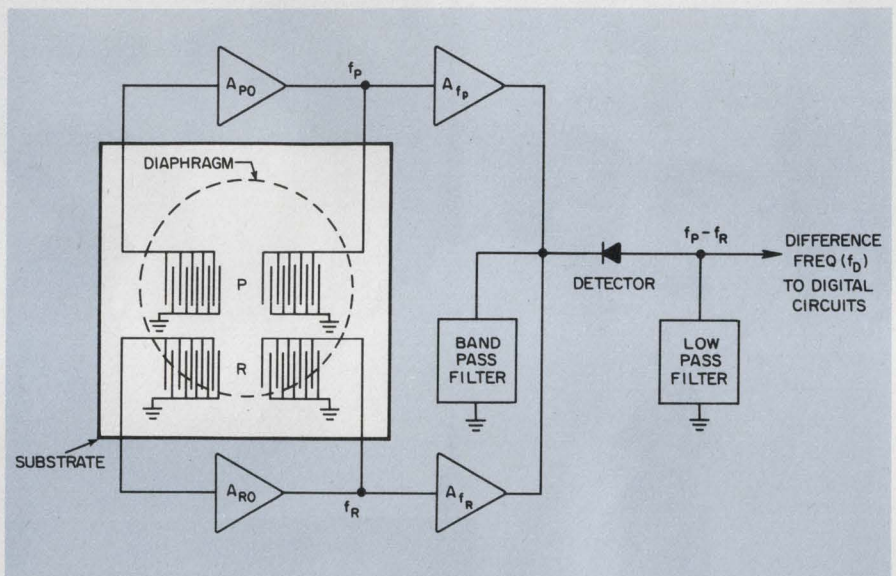
Linearity is better than 0.1%. The sensor output is a frequency that varies approximately 50 kHz over the full-scale range, so resolution is high. For a 1-psi shift in pressure in a 15-psi unit, the frequency change is over 3 kHz. For a 600-psi device, the output is 83 Hz per unit-pressure variation.

Because its output is a frequency rather than a voltage level, the United Technologies device is compatible with digital circuitry.

Originally developed as a digital airborne sensor for the Naval Air Systems command, the sensor may prove useful for pressure monitoring in jet engines, in large-building climate-control systems and in remote weather-monitoring stations, Donald Cullen, United Technologies research scientist, believes.

## Sensor has quartz substrate

The pressure sensor is formed of two saw delay lines on a stable YX quartz substrate. The quartz is ultrasonically milled to produce a circular diaphragm a few mils thick. Actual thickness de-



**This SAW pressure sensor converts strain on its quartz diaphragm** into variations of two SAW-oscillator frequencies. The difference in frequencies in this United Technologies device provides pressure measurement.

pend on the maximum pressure to be measured. The SAW delay lines are formed on the substrate surface by depositing 0.15- $\mu\text{m}$  thin-film, interdigitated patterns via standard photolithographic techniques.

One delay line, P, is aligned with the diaphragm's center line. The second (R) is offset to one side (see figure). The close proximity of the delay lines not only provides temperature compensation but also increases the pressure sensitivity over that of a single delay line. The delay-lines' outputs are fed to amplifiers that drive the delay-lines' inputs and consequently form two SAW oscillators.

Normally, the oscillators operate at 78 MHz. But under pressure, the mechanical strain in the diaphragm changes the velocity of the acoustic waves and consequently the oscillator's frequencies. For a full-scale strain, the difference between the two oscillator frequencies increases to about 50 kHz.

The dual acoustic channel was originally conceived for temperature com-

ensation, with the reference delay line placed off the diaphragm so that pressure changes wouldn't affect it. Compensation was obtained by subtracting the reference frequency from the pressure signal.

But sensitivity was found unexpectedly to increase—and substantially—by moving the reference transducer partially over the diaphragm, Cullen recalls. With the present arrangement, temperature compensation has been improved from the 22 ppm/°C of the basic quartz substrate to better than 2 ppb/°C.

The outputs of both pressure and reference oscillators are fed to buffer amplifiers, which drive a single mixer diode that selects the sum and difference frequencies. The sum frequency is rejected by the low-pass filter and the difference frequency is fed to a following amplifier.

Accuracy of the present SAW sensors is better than 0.5%, with further refinement expected to increase it to 0.1%. ■■



# THE BEST VOLTMETER YOU CAN BUY ISN'T A VOLTMETER.

The Fluke 8500A is an advanced measurement system, but most people buy it because it's the finest high speed 10 ppm voltmeter built.

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Simply because all other digital voltmeters have been nothing more than that, voltmeters. As quickly as technology advanced or needs changed, the unit became obsolete. Not so with the 8500A.

The 8500A employs a unique analog/digital bus in conjunction with an internal micro-processor to control measurement and interface modules. The function modules, such as resistance, current, IEEE-488 interface, etc., can be plugged into any available slot in the bus by the user.

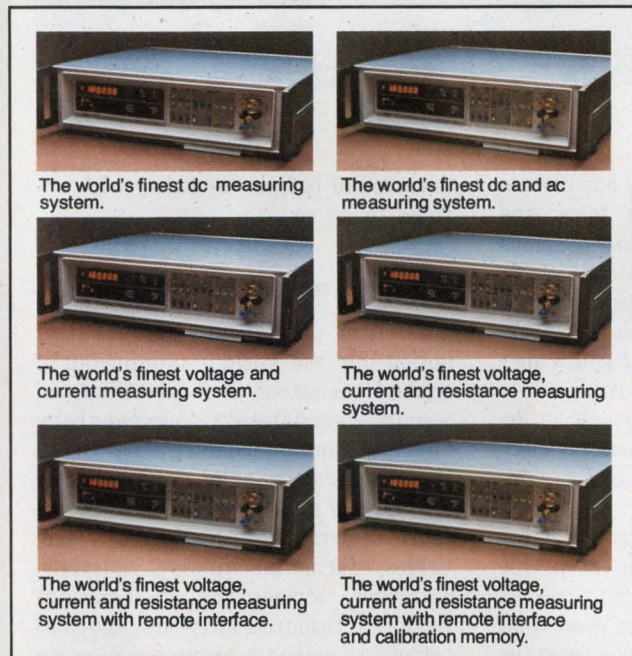
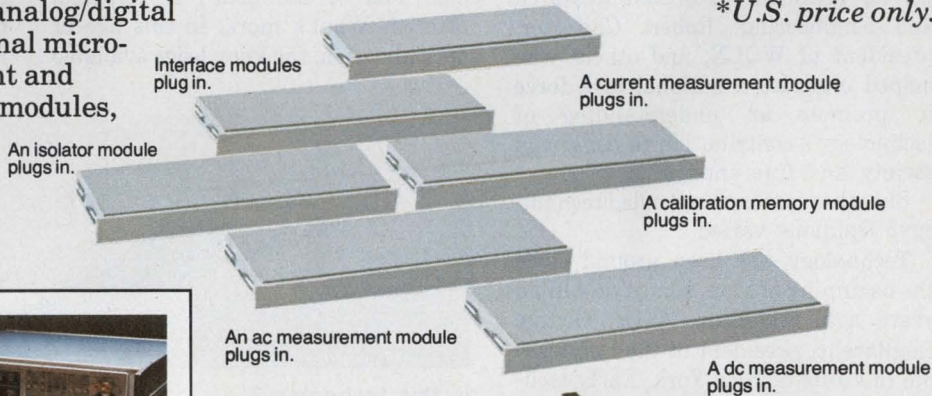
The controller then senses the module and measures the new parameter or performs the new function.

So as technology or your needs change, so does the 8500A. You won't be stuck with a dead-ended instrument.

All for a basic system price of \$2,695\*.

Obviously, there's a lot more to tell. For data out today, dial our toll-free hotline, 800-426-0361.

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The 8500A can be whatever you want it to be, so it's never obsolete.



The heart of the 8500A is a universal architecture with a unique analog/digital bus.



# Technology: With society or against it?

"Is technology a friend or foe of people—and the free-enterprise system?" Leaders of industry and education offered answers at the recent National Symposium on Technology and Society. The symposium, sponsored by Lord Corp. of Erie, PA, and WQLN, Public Broadcasting of Northwest Pa., featured luminaries like Donald Altstadt, Lord's president; Dr. Edward David, president of Exxon Research and Engineering; Robert Chitester, president of WQLN; and others who helped organize a national task force to promote an understanding of technology's contribution to American society and free enterprise.

But what is this thing called technology? Opinions varied.

Technology has been around since the beginning of man, some two-billion years ago, according to Dr. George Bugliarello, president of the Polytechnic Institute of New York. Early technology, starting perhaps with the use of sticks, led to villages, agriculture and collective security. But technology has also been an instrument of terror and alienation, Bugliarello added.

## It's not machines

Dr. Lewis Branscomb, vice president and chief scientist of IBM, saw technology as an extension of human experience—in other words, much more than machines. Dr. Herbert Hollomon, director of the Center for Policy Alternatives at MIT, agreed. An automobile isn't technology, he observed, nor is a pump or computer. Instead, technology is a body of art, knowledge and technique. When people complain about technology, according to Hollomon, they are really complaining about the way institutions have used technology. And since technology was used, they reason, technology is bad.

On the other hand, problems arise, Branscomb suggested, because technology is what everybody does with what a few people know. Everybody drives a car, but only a few people know how to design and manufacture one. Another problem, Branscomb ob-

served, is that people now have choices they didn't have before—and they may not know how to deal with them.

## It's like a spouse

For that matter, western society may be providing disincentives to innovation because its system is based on obsolete knowledge, Fletcher Byrom, chairman of the board at Koppers, offered. What's more, in this age of specialization, the knowledge available

perhaps, they should be doing something else. "We may be suffering from a fundamental failure in the education process," Byrom observed. "We must educate people to be amenable to change, instead of being desperately afraid of it."

A more optimistic note was sounded by Dr. Allen Wallis, chancellor of the University of Rochester, who argued that material technological developments have brought to hundreds of millions of people a quality of life never



## Is this technology?

is beyond the scope of any one person.

Yet technology offers tools and capabilities to address an enormous range of problems. In one sense, though, Byrom quipped, technology is like a spouse who helps you with problems you wouldn't have if you hadn't gotten married in the first place.

Nevertheless, technology is an irresistible, irreversible force. Society may be dragged, kicking and screaming, 25 years behind it, noted Branscomb, but technology never becomes a thing apart from the people who exploit it. "We should no more ask if technology is a force for good than we should ask if people are a force for good," Branscomb stated. In fact, he added, from the viewpoint of some endangered animals on this planet—like whales and seals—they're not.

But there is a conflict between society and technology, Byrom rejoined, because Americans operate under a decidedly Calvinist ethic, which simply says that people should work—that is, participate in an activity that produces material goods. A lot of effort is devoted to making work for people when,

dreamed of before—and they will continue to do so.

## It makes natural resources

First, he pointed out, the prevalent notion that the world is running out of natural resources is absurd—natural resources are natural resources only by virtue of human technology. Farmland in the central valley of California, for example, is a useful resource only because of irrigation, fertilizers, insecticides, farm machinery, railroads, highways, refrigeration, etc. Uranium wasn't a resource 40 years ago and petroleum wasn't a resource 125 years ago. They became resources thanks to human technology.

Wallis didn't agree with the popular conception of automation, either. Automation doesn't simply eliminate employment, he said. It redistributes employment in time. For example, a pin-setting machine for bowling eventually eliminates man-hours of pin-setting labor, but it also increases employment while it is being manufactured. So automation replaces a long trickle of



future employment with an initial splash. But this splash doesn't lead to a subsequent drought because the total amount of work that is to be done in the future is infinite.

Looking from a different angle, J.M. Leathers, vice president of manufacturing and engineering technology at Dow Chemical, hailed technology for increasing leisure time and for liberating wives from the drudgery of the kitchen and washboard. And thanks to technology, he said, there is less disease and pestilence, essentially no famine, and more of many amenities that are taken for granted.

But the people who reached maturity in the 1960s can see only the unsolved problems, Leathers went on. Reared by television, that instant problem solver, they disapprove of the fact that all problems haven't been solved. So they have become anti-institution, anti-business, anti-everything—education, law, government.

Now they have worked their way into legislature and other organs of power, Leathers continued, where they devote themselves to regulatory strangulation of technology and bureaucratic destruction of the free-enterprise system. Yet only technology can provide the necessary tools for making man's labor more productive, Leathers insisted.

### A false plateau

Examining technology from an historical perspective, Dr. C. Lester Hogan, vice chairman of the board of Fairchild Camera and Instrument, recalled that the prevalent view of economists in the 1930s was that the United States had reached a plateau in its growth. Since it had conquered the new frontiers of land and natural resources, it would never again see such a fantastic growth rate.

But those economists failed to realize that there was a never-ending new frontier—technology itself. Their predictions came during the depths of the Depression, Hogan noted, when it was very difficult to be optimistic. That was long before the unparalleled growth of the 1950s and 1960s, when economists put on the other shoe and explained why such rapid growth was now the norm and would continue forever.

"In industry, too, we predict a marvelous year when we're in the middle of one," said Hogan. "And in bad years we become prophets of gloom. In the same way, our view of technology can change." ■■

# Be sure you're using the most up-to-date GE miniature lamp design data.

Out-of-date information could affect your designs adversely and new data on new lamps could lead the way to new ideas. Take a minute to check the dates on these seven catalogs be sure you've got the most up-to-date information at your fingertips, and help you pick the best GE miniature lamps for each of your design needs.

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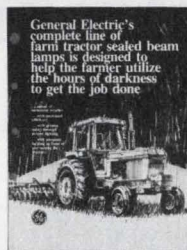
**#3-5257-R Halogen-Cycle Lamps**  
Revised April, 1977. The 12 pages feature greatly expanded data including lamp specifications, characteristics, design considerations and selection guide.



**#3-7070 Miniature Lamps**  
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**#3-5259R2 All-Glass Wedge Base Lamps**  
Revised March, 1977. Contains all specifications and data for 11 newest wedge base lamps plus revised drawings and engineering specifications on the full line.



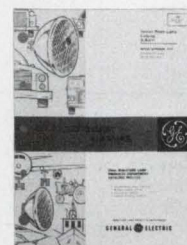
**#3-6383 Farm Tractor Sealed Beam Lamps**  
Revised September, 1976. Four pages feature the expanded line farm equipment, including diagrams of lamp beam patterns.



**#3-6016 Sub-Miniature Lamps**  
Revised May, 1976. Includes latest data on more than 194 lamps of 1/4" diameter and smaller, 28 pages.



**Form 5000 Miniature, Sealed Beam and Glow Lamps**  
Revised February, 1976. Features 36 pages of technical lamp data covering 950 lamps, both miniature and sealed beam. Lists lamps in numerical order.



**#3-5211 Sealed Beam Lamps**  
Revised September, 1975. Lists electrical and physical specifications, applications and numerical index in 16 pages.

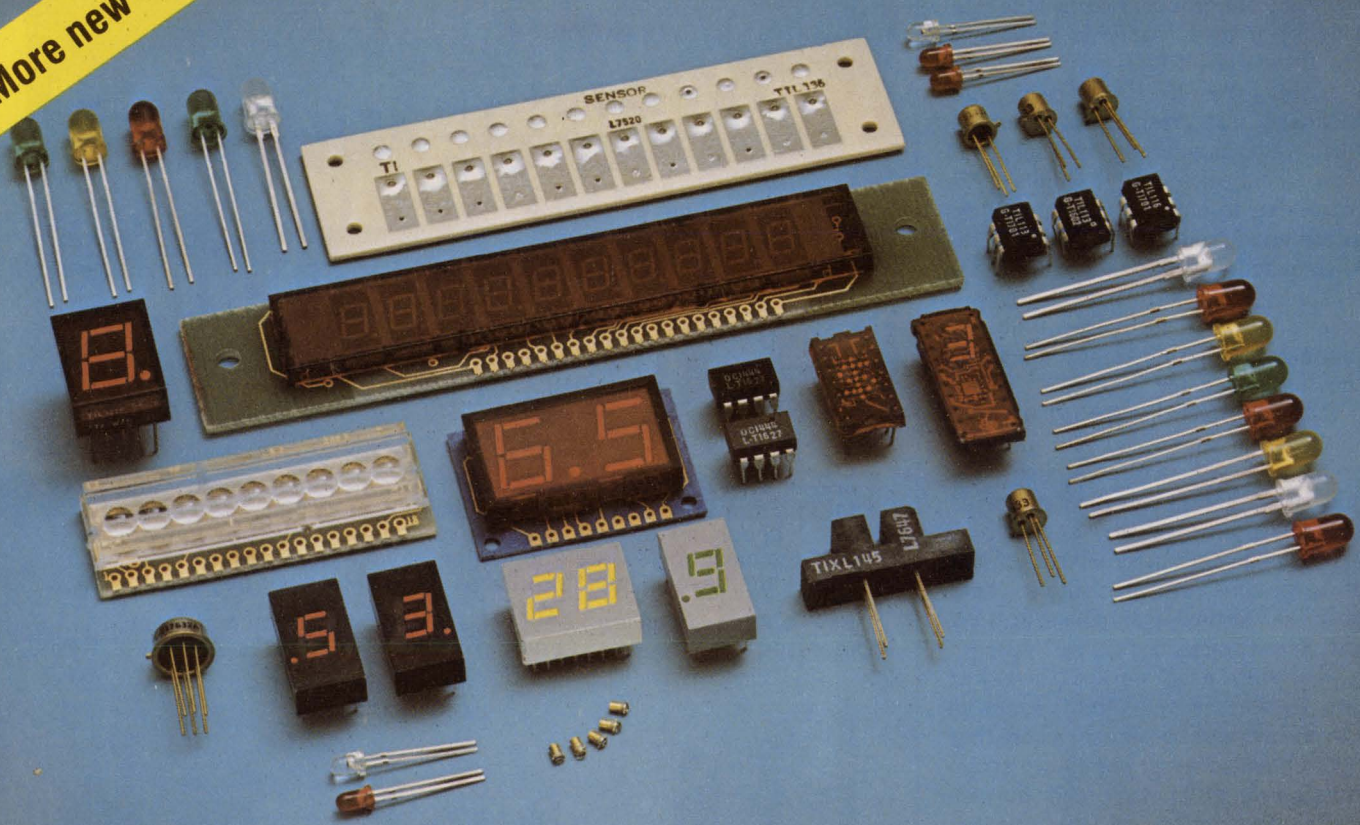
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Device	Source Color	Lens Color	Package Outline	Typical Brightness @ 20 mA	100-Piece Price
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TIL216-2	Red	Red	T-1	4.0 mcd	.37
TIL228-1	Red	Red	T-1 3/4	3.0 mcd	.32
TIL228-2	Red	Red	T-1 3/4	7.5 mcd	.41
TIL228-3	Red	Red	T-1 3/4	18.0 mcd	.74
TIL212-1	Yellow	Yellow	T-1	1.0 mcd	.28
TIL212-2	Yellow	Yellow	T-1	4.0 mcd	.37
TIL224-1	Yellow	Yellow	T-1 3/4	3.0 mcd	.32
TIL224-2	Yellow	Yellow	T-1 3/4	7.5 mcd	.41
TIL224-3	Yellow	Yellow	T-1 3/4	18.0 mcd	.74
TIL232-1	Green	Green	T-1	0.8 mcd	.28
TIL232-2	Green	Green	T-1	1.5 mcd	.37
TIL234-1	Green	Green	T-1 3/4	1.0 mcd	.32
TIL234-2	Green	Green	T-1 3/4	2.5 mcd	.41
TIL234-3	Green	Green	T-1 3/4	6.5 mcd	.74



### Low-Cost Displays

Device	Character Height & Color	Type Characters	Connection	100-Piece Price
TIL312	.3" - Red	7 Segment - r&lhd	Common Anode	1.36
TIL313	.3" - Red	7 Segment - rhd	Common Cathode	1.36
TIL327	.3" - Red	± 1 - lhd	Common Anode	1.36
TIL314	.3" - Green	7 Segment - r&lhd	Common Anode	2.85
TIL315	.3" - Green	7 Segment - rhd	Common Cathode	2.85
TIL328	.3" - Green	± 1 - lhd	Common Anode	2.85
TIL316	.3" - Amber	7 Segment - r&lhd	Common Anode	2.85
TIL317	.3" - Amber	7 Segment - rhd	Common Cathode	2.85
TIL329	.3" - Amber	± 1 - lhd	Common Anode	2.85
TIL321	.5" - Red	7 Segment - r&lhd	Common Anode	1.47
TIL322	.5" - Red	7 Segment - rhd	Common Cathode	1.47
TIL330	.5" - Red	± 1 - lhd	Common Anode	1.47

### High-Performance Displays

Device	Type Characters	Character Height	Package	100-Piece Price
TIL302-304	7 Segment	.27"	Standard	4.85
TIL305	5x7 Dot Matrix Alphanumeric	.30"	Standard	4.58
TIL306-309	7 Segment with Logic	.27"	Standard	9.15
TIL311	4x7 Hexadecimal with Logic	.27"	Standard	9.40
4N41 (TIL501)	7 Segment	.27"	Hermetic	47.37
TIL505	5x7 Hexadecimal with Logic	.27"	Hermetic	66.03
TIL506	7 Segment with Logic	.30"	Hermetic	57.41
TIL507	5x7 Alphanumeric with Logic	.30"	Hermetic	69.72
TIL560	3-Character 5x7 Alphanumeric with Logic	.50"	Hermetic	254.26

### Seven-Segment Display Sticks

Device	No. of Digits	Character Height & Color	Feature	100-Piece Price
TIL361	2	.50" - Red	PCB - Edge Conn.	4.05
TIL364	4	.50" - Red	12-hr Clock	5.92
TIL370	4	.50" - Red	24-hr Clock	6.15
TIL804	12	.27" - Red	PCB - Edge Conn.	11.65
TIL807	2	.30" - Red	CA - Plug-in Pkg	2.88
TIL808	2	.30" - Red	CC - Plug-in Pkg	2.88
TIL809	2	.30" - Amber	CA - Plug-in Pkg	4.35
TIL810	2	.30" - Amber	CC - Plug-in Pkg	4.35

### Opto-Coupled Isolators

Isolator Family	Part Numbers	Isolation Voltage	Package	100-Piece Price
P-DIP	TIL111 - TIL119	Up to 2.5 KV	6-Pin DIP	from \$0.74
Dual	MCT6 & MCT66	Up to 1.5 KV	8-Pin DIP	from 1.69
JAN, TX, TXV	4N22 - 4N24	1.0 KV	TO-5 MC	from 5.19
Hi-Rel	TIL120, TIL121	1.0 KV	TO-72 MC	from 3.75
UL Listed	TIL153 - TIL157	3.5 KV	6-Pin DIP	from 0.93
Hi-Voltage	TIL124 - TIL128	5.0 KV	6-Pin DIP	from 0.99

### Low-Cost Displays.

Continuous uniform segments, high contrast and brightness make the difference in TI's cost-effective single-digit VLED displays.

Red, green and amber .3" characters are available in 14-pin dual-inline packages. Large .5" red devices are available in 10-pin DIPs.

### High-Performance Displays.

Versatile capabilities for specialized applications. TI has a specialty display to fit the job you're doing.

- Alphanumeric
- Hexadecimal
- Built-in logic
- Hermetic packages
- Combinations

### Seven-Segment Display Sticks.

Two-digit combinations for digital indicators including television and CB radio channel readouts. Four-digit sticks for 12 and 24-hour digital clocks. And the 12-digit TIL804 stick (red, .270" characters); the most digits on a single stick.

### Opto-Coupled Isolators.

Six complete families for any opto switching need: P-DIP couplers, metal-can devices, duals, high voltage isolators, JAN and UL listed parts. Call TI or your distributor for complete specifications.

### IR Emitters/Detectors.

High efficiency, spectrally matched infrared emitters and photodetectors for card and tape readers, encoders, intrusion alarms, level indicators and more.

Also available: nine and 12-channel arrays for precise alignment in card and tape readers and single-package assemblies for counting, flow and weight control, position sensing, timing and speed control.

Take advantage of the savings and convenience you'll find in TI's complete opto capability. For more information write Texas Instruments Incorporated, P.O. Box 5012, M/S 308, Dallas, Texas 75222. Please identify the device you are interested in by giving its TI part number.



**TEXAS INSTRUMENTS**  
INCORPORATED



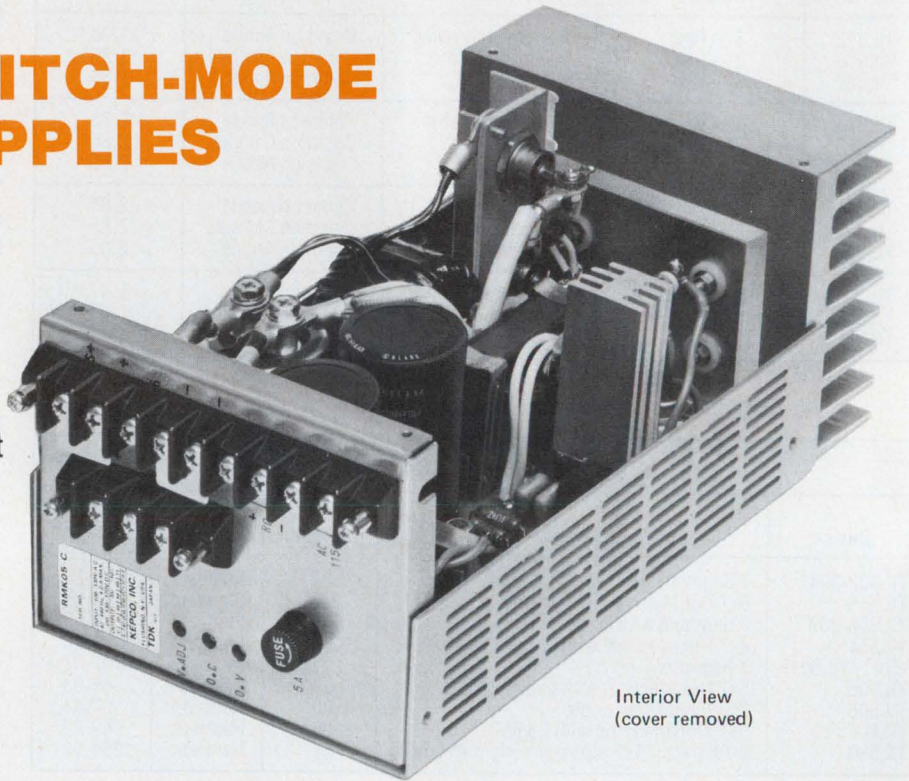
from KEPCO by TDK

the series

**RMK**

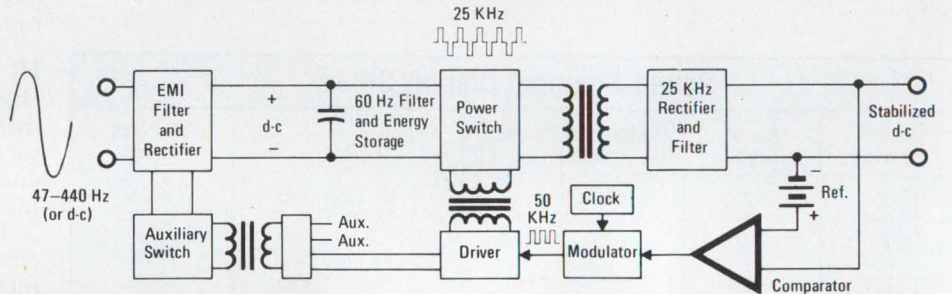
## 25 KHz SWITCH-MODE POWER SUPPLIES

- 75% efficiency
- 90-130V a-c input (brownout protection)
- d-c input
- ±10% output adjustment
- adjustable current limit
- adjustable overvoltage
- logic level on-off
- 1 millisecond recovery



Interior View (cover removed)

BLOCK DIAGRAM OF THE RMK SWITCH-MODE POWER SUPPLY



50°C OUTPUT RATINGS FOR THE KEPCO RMK POWER SUPPLIES

PKG.	5V	9V	12V	15V	24V	SIZE	WGT.	PRICE
"A"	10.0 A	6.0 A	5.0 A	4.0 A	2.5 A	2 3/16" x 5 1/8" x 7 1/2"	3.0 lbs.	\$179.00
"B"	26.0 A	15.0 A	12.0 A	10.2 A	7.5 A	3 3/32" x 5 1/8" x 8 3/4"	4.75 lbs.	259.00
"C"	30.0 A	17.2 A	14.6 A	12.3 A	8.0 A	4 1/16" x 5 1/8" x 8 3/4"	5.25 lbs.	299.00

## other switching power supplies from KEPCO/TDK

- 115/230V a-c input switching power supplies, Series RMX offers the same outputs in the same package sizes as RMK.
- Triple output switchers, Series RMT combines a 5V, 10A output with your choice of: ±12V @ ±1A or ±15V @ ±1A or +12V @ 1A, -5V @ 1A or +15V @ 1A, -5V @ 1A or +12V @ 1A, -9V @ 1A.

Ask your Kepco Rep to show you the clean layout, and cool operation of the KEPCO/TDK switching power supplies. Compare performance, stability, noise, temperature rise . . . compare the Kepco 5-Year Warranty!

For complete specs, write Dept. BTF-05

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CIRCLE NUMBER 32



# Washington report

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## Sinai cease-fire monitoring system upgraded

The State Department is adding a new jam-resistant data link and a day-and-night television monitor powered by a solar-cell array to its monitoring system in the Sinai Desert. The system has been used since Feb. 22, 1976, to police the cease-fire line established after the 1973 war between Israel and Egypt.

The additions are aimed at reducing manpower and improving detection accuracy. The present monitoring system, operated under contract by E-Systems of Dallas, is a network of acoustic sensors and watchtowers. All the sensors will be tied by the data link into a central monitoring station so that observers can view all intrusions simultaneously and get a better idea of how serious they are.

To implement this plan, five Army relay units will be installed. Known as the "Exray" system, they will be modified by the Combat Surveillance and Target Acquisition Laboratory of the Army Electronics Command to be less vulnerable to intentional or unintentional radio interference.

The complete centralized sensor-readout system is scheduled to be installed by mid-February, with six months of evaluations to follow before it is declared operational. The system should cost \$75,000, the State Department estimates (not including surplus Army relay units).

Meanwhile, the State Department's Sinai Support Mission, which is responsible for the monitoring system, also plans to install a remotely controlled TV camera overlooking that part of the Giddi Pass that has no watch station. The Army's Night Vision Laboratory is developing this equipment, which the State Department estimates will cost \$250,000 and will be operating by next May. These TV images will be relayed to a central monitoring station as well.

In both cases, solar arrays will be used rather than diesel-powered electrical generators because they will require less maintenance in the rugged desert.

## Cruise missiles won't have ECM, Pentagon says

For now, electronic countermeasures will not be used on Defense Dept. cruise missiles, but a proposed second-generation cruise missile is still being studied.

ECM is not needed on current cruise missiles, according to top defense officials, because the missiles have a tiny radar signature. They look up to 4000 times smaller than a B-52 bomber to an enemy radar and would have looked 500 times smaller than the canceled B-1 bomber.

One problem with ECM is that its jamming signals would attract attention to the missiles, according to the officials. An enemy could build a passive receiving "home-on jam" system to track the jamming signal and direct antimissile missiles against the incoming cruise missiles.

Currently, only one Soviet radar is believed capable of detecting cruise missiles: a large high-frequency, over-the-horizon radar known by the NATO code name "Buzz Saw." This radar could be jammed by penetrating bombers or knocked out by the bombers' own short-range attack missiles, defense officials say. The



Russians also have about 10,000 air-defense radars, but their range is limited to line of sight, and the officials doubted that they could cope with a saturation attack by the nearly 3000 cruise missiles that would be employed in a U.S. strategic deterrent.

If the Soviets were to upgrade their radars—which the defense officials doubt could be done before 1985—the U.S. could then deploy a second-generation cruise missile with sophisticated ECM, supersonic speeds and an even smaller radar cross-section. Exploratory research is under way on all three improvements.

## Navstar accuracy surpasses Air Force requirements

The Air Force claims its Navstar navigation satellite being developed for use in the next decade has already surpassed its required accuracy of 33 feet (10 meters) during tests at the Army's Yuma, AZ, test range.

In the tests, an instrumented C-141 aircraft first locked onto signals from an orbiting Navy Navigation Technology Satellite (NTS-2) incorporating Navstar components, then onto signals from three simulated Navstar satellites placed on the ground at the Yuma range. After the results were checked with a laser-tracking system, the position of the aircraft was computed within 11 ft (3.36 m) in the east-west axis, within 13.5 ft (4.18 m) in the north-south axis and within 12 ft (3.6 m) in the vertical axis. The final results may have been even better, say Air Force officials, who think some of the vertical error may have come from the laser tracking system.

## ILLIAC IV computer will analyze Landsat resource data

The ILLIAC IV supercomputer will be used to analyze earth-resources data from the multispectral scanner in the National Aeronautics and Space Administration's Landsat satellite. The required program is being written by the University of Illinois' Center for Advanced Computation, which developed the computer.

Landsat will survey crop conditions, locate mineral deposits and find water sources by scanning four spectral bands: green (5000 to 6000 Å), red (6000 to 7000 Å), far-red (7000 to 8000 Å) and near-IR (8000 to 11,000 Å). Each frame from the camera will contain 7.5-million picture elements called "pixels." Each pixel will correspond to 1.14 acres, each frame to 8.5-million. The frames will be preprocessed by NASA's Goddard Space Flight Center, Greenbelt, MD, and sent to the ILLIAC at Mountain View, CA, for image processing.

**Capital Capsules:** The two Tiros-N weather satellites to be launched by NASA next year for the National Oceanic and Atmospheric Administration will contain **a new sensor to monitor charged particles that are emitted by the sun** and stream in the vicinity of the satellite's orbit 250 miles above the earth. The 28-lb monitor is being developed by the Western Development Laboratories of Ford Aerospace & Communications Corp. at Palo Alto, CA. . . . The Federal Aviation Administration reports that **all 63 major U.S. airports now have the Minimum Safe Altitude Warning (MSAW) system**, which automatically flashes a warning on a flight controller's display screen when an aircraft is closer to the ground than it should be. Successfully field-tested at Denver's Stapleton Airport, it has been added to FAA's automated radar-terminal (ARTS III) installations. . . . **The Department of Energy has launched a research effort to develop better materials and fluids for solar-energy collectors.** These materials will include new surface coatings and glazings and better insulating and sealing methods.



# Mini-misers.



## Amphenol Micro-Miniature Connector Series. Minimum size at a miserly price.

Reduced size. *And* reduced weight. Those are just two good reasons for choosing your connectors from this economical trio:

**Amphenol 220 Series connectors.** For high-contact density rack-and-panel applications. Sturdy monoblock body, injection-molded polycarbonate, 52 or 104 contacts.

**Amphenol 221 Series multi-purpose strip connectors.** Polycarbonate or nylon, 4" and 6" strip lengths, on .100", .075" and .050" contact centers, in contact arrangements of 60, 53 and 80. Use as is, or cut the strips to lengths (or stack) as desired.

**Amphenol 223 Series connectors.** For circuit modules

potted-in or surface-mounted; also for rack-and-panel, cable-to-cable, and cable-to-panel. Polycarbonate or nylon bodies, 5, 9, 17, 25, or 33 contacts.

**More savings: new Econo-Tac™ contacts.** Gold-over-nickel plating. Stamped, crimp-removable contacts, supplied on 20,000-contact reels or loose. Ideal for high-volume production with the Amphenol semi-automatic termination equipment.

**Get most popular sizes immediately from your Amphenol Industrial Distributor.** Or for more information, call Harry Jaeger, (312) 986-3770. Or write Amphenol North America Division, Bunker Ramo Corporation, Dept. C27A, 900 Commerce Drive, Oak Brook, Illinois 60521.

The right idea  
at the  
right time.

**BUNKER  
RAMO**

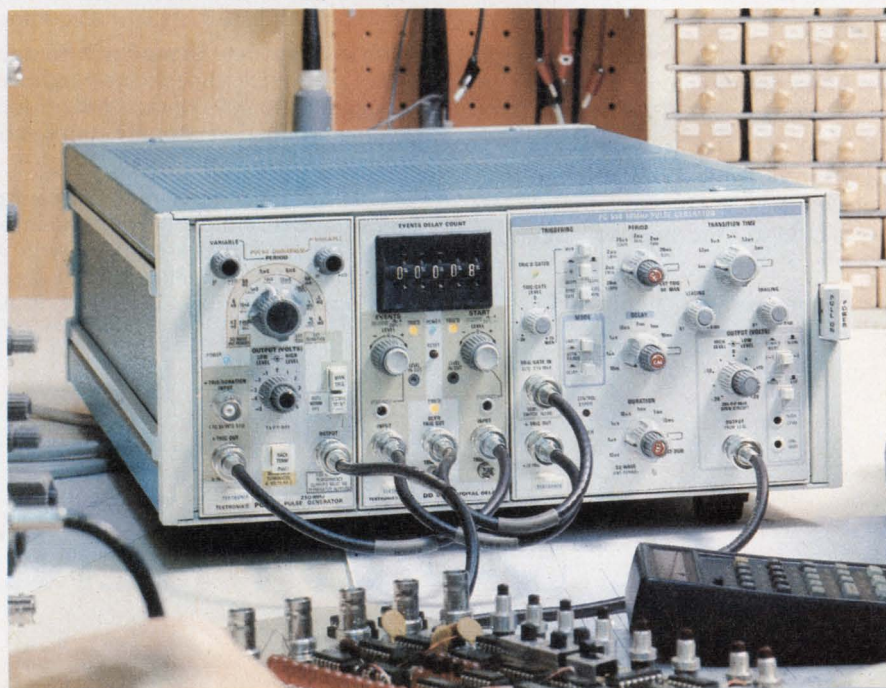
**AMPHENOL®**

CIRCLE NUMBER 33





**Think about expanding  
your pulse generation capabilities...  
think about TM 500.**

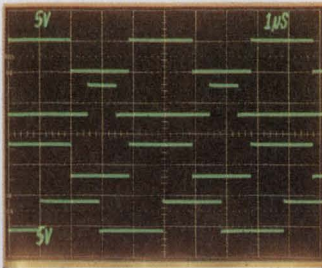




## More waveforms for more applications.

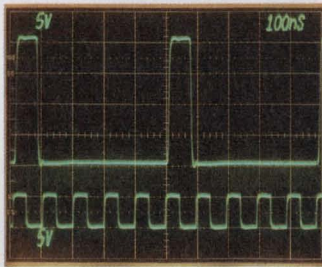
When you're working with today's logic systems, involving a variety of implementations, you need instrumentation built to perform complex functions. This TM 500 pulse generator is such an instrument.

Advanced stimulus functions such as overlapping and non-overlapping bi-phase clocks help solve race problems and determine critical timing.



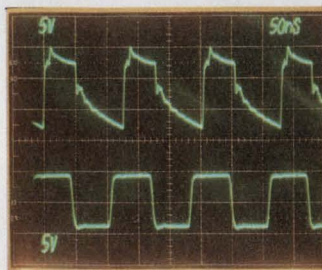
*Biphase Clocks*

When working with mixed logic systems, two-frequency synchronous clocks operating at different frequencies and different logic levels can be configured.



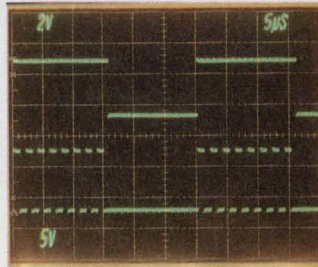
*Two Frequency Synchronous Clocks*

Also, this instrumentation provides translation capability between common logic families; CMOS to ECL or TTL to CMOS, for example. A unique pulse restoration or superbuffer capability, with high or low input impedance and 50Ω output impedance, helps you produce low aberration signals in unterminated lines.



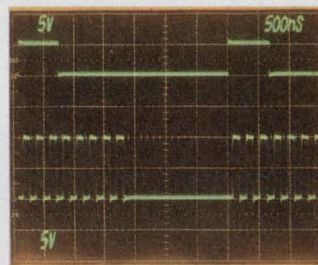
*Pulse Restoration*

Dual pulse generation within one unit provides self contained burst generation. In this mode, burst rate and width, and pulse rate and width within each burst can be individually controlled.



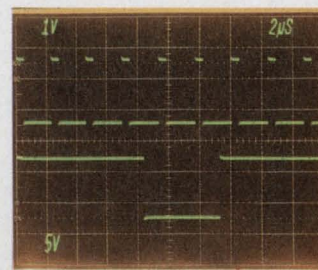
*Self Contained Burst*

A counted burst feature, with thumb-wheel switches, gives exact control when selecting pulses for use with shift registers, CCD delay lines and data transmission. With this instrumentation it is not necessary to reset burst control if width and duration is changed within the burst. When working with a large number of pulses, more stability and ease of resolution is assured.



*Counted Burst*

When desired, two pulse generators are operable as independent instruments. Both outputs provide true and complement pulses, and other types of mixed pulses. Both outputs are controlled by independent high and low dials.



*Independent Pulse Generation*

Frequency capabilities are 50 MHz at 20V for MOS and CMOS logic and 250 MHz at 5V for ECL and Schottky TTL. Square wave trigger outputs can be viewed when narrow pulses decrease scope visibility, and simplify counter triggering.

Tektronix has designed a TM 500 pulse generator system capable of these functions and more. Two pulse generators (PG 508 and PG 502) and an independent digital delay (DD 501), packaged together in a versatile mainframe, meet a wider range of applications.

As a single package it's compact, portable and easily adapted to the lab or field. As part of the highly configurable TM 500 line its mechanical and electronic performance can be adapted to suit your specific needs.

If you prefer a bench set-up the three plug-ins (PG 502-PG 508-DD 501) can be installed in a TM 500 mainframe to sit conveniently and neatly on a bench top. When your needs demand a portable test unit, the three plug-in modules can be packed in the small-as-a-suitcase TM 515 Traveler Mainframe.

In addition to this mechanical configurability, your pulse generator unit can be combined with other TM 500 modules to expand your present test and measurement library.

A powerful combination of TM 500 modules—PG 502, PG 508, DD 501 and a mainframe—work for you in two ways: together to surpass their own individual limits, independently to continue meeting your instrumentation needs.

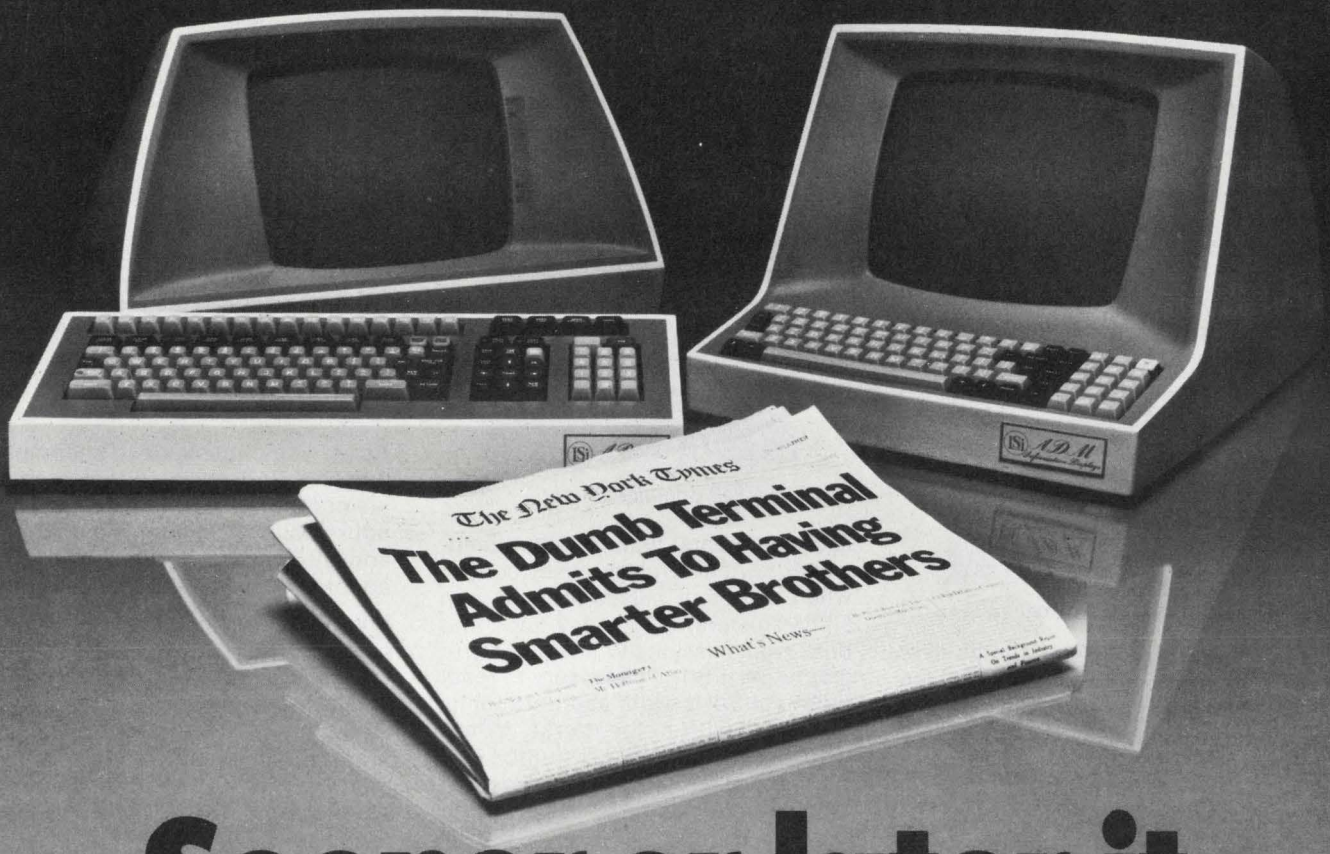
For further information or a demonstration of the TM 500 family of instruments, write or phone: Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077, (503) 644-0161 Ext. 5283. In Europe: Tektronix Limited, P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.

**Tektronix**  
COMMITTED TO EXCELLENCE

For Technical Data circle #34 on Reader Service Card  
For Demonstration circle #35 on Reader Service Card

**TM 500...designed for configurability.**





# Sooner or later it was bound to get out.

Yes, the Dumb Terminal™ really does have two smarter brothers.

At first, they weren't quite as well known, because their Dumb Brother's smashing success was stealing the show. Although they had been selling quite well all along, even without getting constant headlines, like their Brother.

Now, however, Dumb Brother has pulled them into the limelight. And ADM-1 and -2 have decided, after all, that perhaps it's time you knew a little more about how smart they really are.

ADM-2 is the more intelligent of the two, providing you with flexibility of format, security, editing, interface, and transmission. You'll find, among a variety of other outstanding features, up to 8 screen status indicators and a numeric key pad. And a detachable keyboard with 16 function keys. Which give you the ability to access your special program, or form, or instruction.

The ADM-2 is also available in a model compatible with your Burroughs TD-800 Series. The ADM-2B. The ADM-2B adheres to the standard Burroughs poll and address line discipline.

On top of all that, we've made the ADM-2 micro-programmable. And taken all the mystery out of the procedure. Which makes user-micro-programmable simple, quick, and cost-effective. The ADM-2's versatility is limited only by your imagination.

You could call the other Smarter Brother, ADM-1, the "with-or-without" terminal. Starting with some pretty smart standard features, like a standard 24-line display, a field protection feature with dual-intensity and switch-selectable operating modes — block mode and conversation mode — you build up from there. With options like a hardcopy printer interface, and display editing capabilities (line insert, line delete, line erase, character insert, and character delete). Just add the options you need, and leave the rest of the "bells and whistles" for someone else. That way, it's more systems adaptable. And it's up to you just how smart you want it to be.

The Smarter Brothers have it all. Intelligence, appropriate functions, and sensible cost-per-performance.

So, you might as well get used to seeing more of the ADM-1 and -2 in the future. Because we suspect they're going to be in the spotlight from now on.

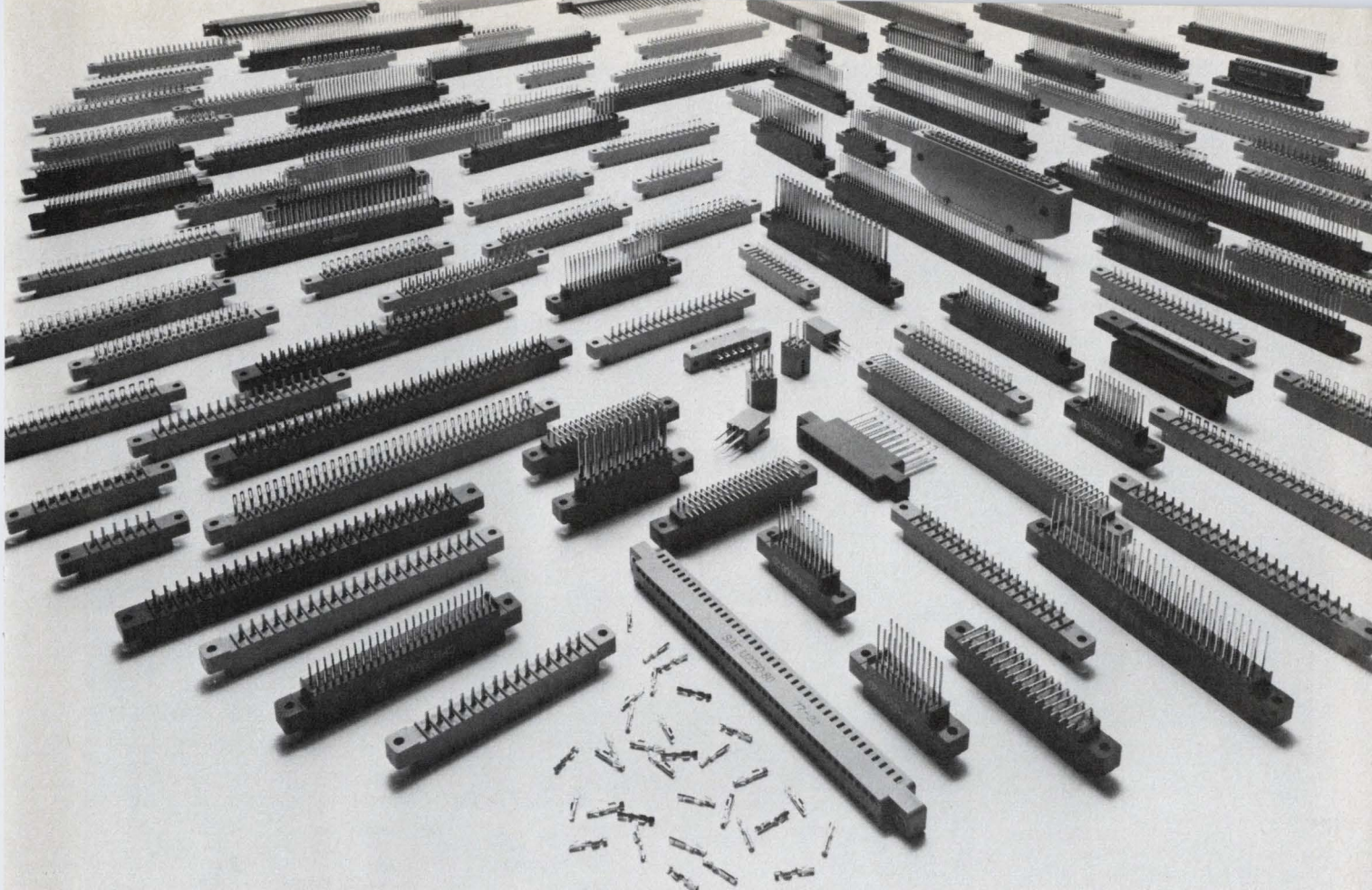
After all, there's really nothing wrong with exposing your Smarts.



**The dumb terminal's smarter brothers.**

Lear Siegler, Inc., E.I.D./Data Products, 714 N. Brookhurst St., Anaheim, CA 92803; (800) 854-3805. In California (714) 774-1010. **CIRCLE NUMBER 36**





# WE HAVE THE FITS

You'll find a fit for every PC board contact when you browse SAE's inventory. Study this list and imagine the combinations, permutations and amalgamations that make up the broadest line of edge connectors in the industry.

#### **An abundance of contact spacings**

Contact to contact, row to row, we've got a lot of numbers: .100/.125, .100/.150, .125/.250, .156/.140, .156/.188, .156/.200, .125/.145. There's more, but we don't have room in this ad.

#### **A bunch of contact designs**

Our most common is the bifurcated bellows, but we also offer modified bellows (leaf spring) and cantilever types.

#### **A multitude of terminal configurations**

Single row and dual row, wire wrap, dip solder, solder eyelet, insulation displacement (mass termination), right angle and clip wiring (.031/.062). Enough said.

#### **A passel of plating options**

Selective gold, gold inlay, gold over nickel, tin. Want more? Just ask.

#### **A batch of housing materials**

Thermoplastic polyester, glass filled nylon, phenolic and diallyl-phthalate.

#### **And finally, a legion of options**

Shorting contacts (make-before-break/break-before-make), polarizing keys, custom wire wrap tail lengths, hood assemblies, special markings. And you can have any connector with or without mounting ears.

#### **All this and quality too**

SAE does everything in house. From contact stamping and plating to injection molding and automated assembly. That's how we maintain the strictest quality control.

For a good fit in edge connectors, specify SAE. You can enjoy any combination of our unique design features and still have complete interchangeability with other brands.

SAE edge connectors are available through a nationwide network of representatives and distributors. See our product data in EEM, page 2213, and call in your order.

We're Stanford Applied Engineering, 340 Martin Avenue, Santa Clara, California 95050. 408/243-9200.



The OEM Connection

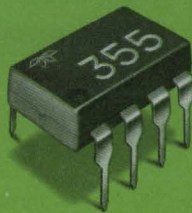
CIRCLE NUMBER 37



# THIS WILL SOLVE SOME 555 TIMER PROBLEMS



# THIS WILL SOLVE THEM ALL

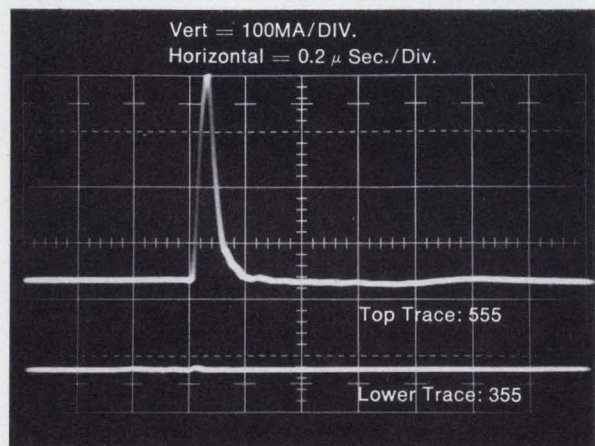


When the output of a 555 timer switches high, a large current spike is generated which can drag down your power supply and upset your flip-flops. One way to cure it is with several hundred  $\mu\text{F}$  of capacitance. But that's awkward and space-consuming. Teledyne's new 355 timer is a better way.

The 355 Timer is a pin-for-pin substitute for the 555. It is part of Teledyne's High Noise Immunity Logic (HiNIL) family. It, too, generates a current spike — but only on the order of 1 mA, as compared to 300 mA for the 555.

Two other problems encountered with the 555 are a potential failure to reset on command, and a tendency to exceed the power dissipation ratings when running at 15V. The Teledyne 355 is designed specifically to answer these two potential problems as well.

If you'd like full technical information on our new 355 Timer — or any other members of the Teledyne HiNIL family of logic — call us at (415) 968-9241, or contact your local Teledyne Semiconductor distributor.



**TELEDYNE SEMICONDUCTOR**

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Kowloon, Hong Kong 3-240122; Tokyo, Japan 03-405-5738



## The shell race

Charlie knew his company had severe morale problems. They affected everything. The reject rate on the factory floor seemed to get worse every week. His people in the field couldn't sell. And his engineers had lost their flair. Even the newer engineers had lost the spark and enthusiasm they had brought with them when they joined the company.

Everybody wants to work for a winning company but, it seems, everybody felt that Charlie's company was a loser. So there was general malaise.

Charlie recognized the importance of morale, so he worried about it a lot. What to do? Finally, he got the brainstorm—competitive sports. He would organize some sports competition against representatives of all the other companies in the area.

Everybody loved the idea. The sport they chose, since they lived in a riverside community, was shell racing—a fine competitive sport requiring skill and teamwork. Teamwork! That's what builds morale.

Came the big day and the river bank was mobbed. Thousands upon thousands of sons and daughters, uncles and aunts, sisters and brothers, wives and mistresses crowded the shores, screaming encouragement to their favorites.

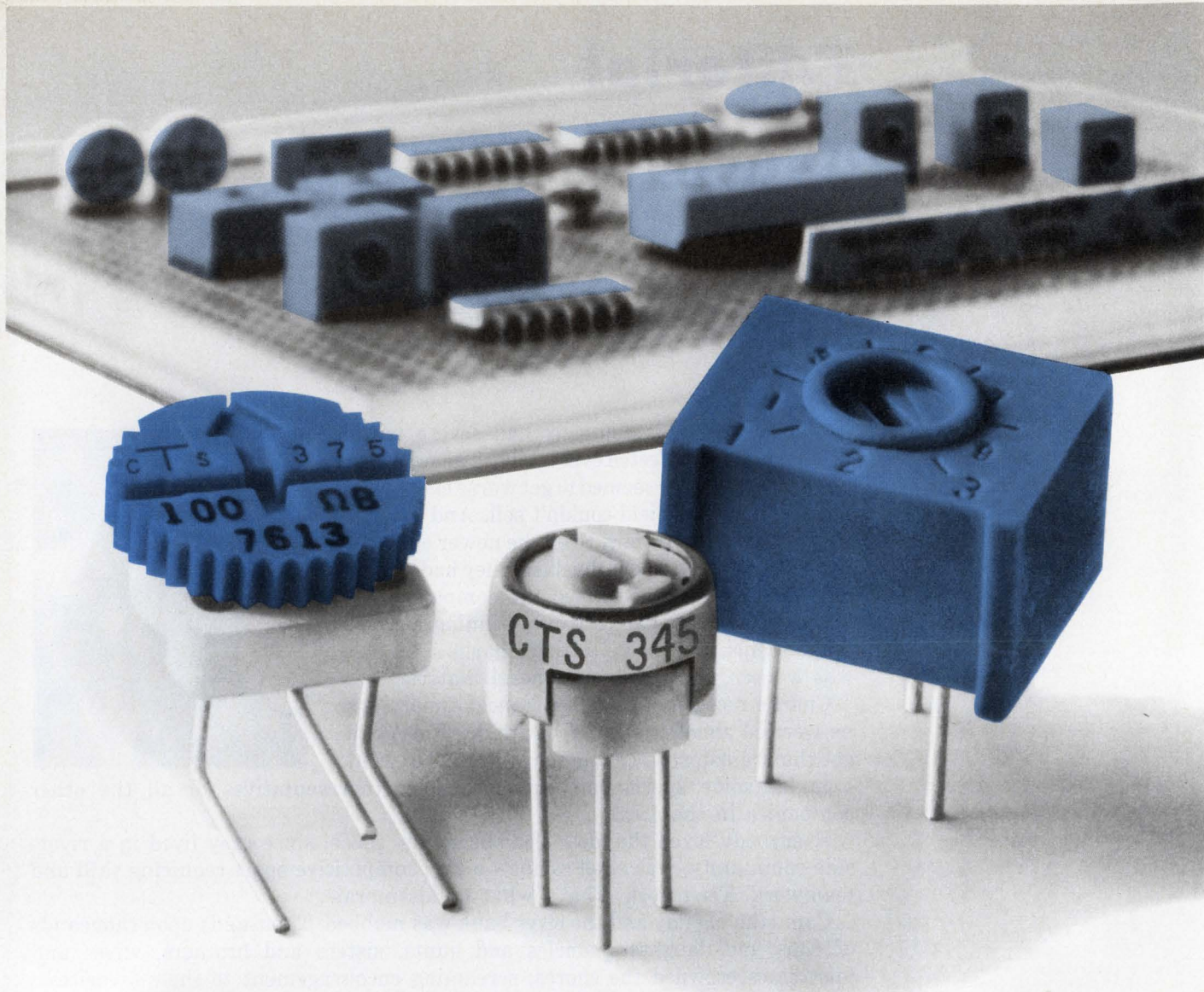
When the first boat came to the finish line, alas, it wasn't Charlie's. Nor was the second or third boat, which came close behind. In fact, long after all the other boats had crossed the finish line, Charlie's still was not to be seen. When it finally appeared it was zigging and zagging toward the finish line. As the shell came closer, Charlie could see activity on the shell more clearly. Eight executives were shouting orders to one man with an oar.

Charlie fired the oarsman.



GEORGE ROSTKY  
Editor-in-Chief





## Overspecifying your cermet trimmer needs?

Why use multiturn trimmers when CTS single turns provide settability accuracy of .03%...approaching that of a 20-turn trimmer. Compactness, economy and excellent performance add up to a lot of efficiency in product design. You get all these benefits when you rely on CTS *single turn* cermet trimmers.

For example, the  $\frac{3}{8}$ " diameter Series 375 is available in six popular terminal styles. And they're priced as low as 25¢ each in production quantities.

The CTS Series 345 is a "mini"  $\frac{1}{4}$ " round design featuring low .180" profile, sealed construction and production priced at just 70¢ each.

The  $\frac{7}{16}$ " square Series 360 satisfies a wide range of critical OEM applications. Eleven popular grid spacings include both top and side adjust .100", .125", .150" and TO-5 centers. Low priced, too. Under 40¢ each in production quantities.

All available off the shelf from CTS Industrial Distributors. CTS single turns handle nearly every trimmer application...economically! You be the judge. Call for your *Free Sample*. **CTS of West Liberty, Inc., 6800 County Road, West Liberty, Ohio 43357. Phone (513) 465-3030.**

**CTS CORPORATION**

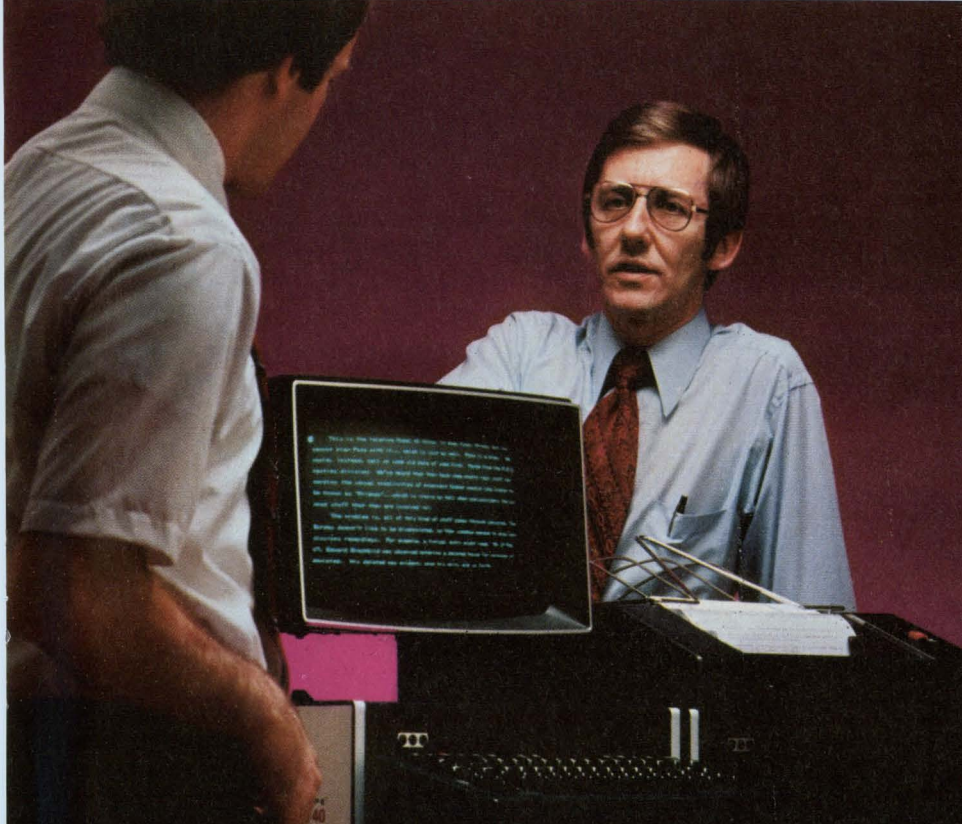
A world leader in cermet and variable resistor technology.



CIRCLE NUMBER 39

ELECTRONIC DESIGN 25, December 6, 1977





## IF THE TELETYPE® MODEL 40 SYSTEM EVER MALFUNCTIONS, IT'S DESIGNED TO TELL YOU WHAT'S WRONG.

Even though we probably go to more trouble to insure uninterrupted reliability than anyone else, we're still realistic enough to admit that sometime something's going to go wrong.

So instead of burying our heads in the sand and pretending it won't, we've concentrated our efforts on what can be done to make downtime as short and painless as possible.

For starters, we gave the model 40 product line its own diagnostic capability. To tell you quickly what's wrong. Then, to make it easy to fix, we used a modular design concept. The result is an average mean-time-to-repair of only 3/4 hour.

We also made sure that when something does go wrong, you'll never be alone. We've got a nationwide service network standing behind every product with the Teletype name on it. We offer on-call repair service, maintenance contracts, and even an exchange repair service on components and parts.

The way we look at it, building something the best way humanly possible is only half our job. The other half is being ready for the unexpected.

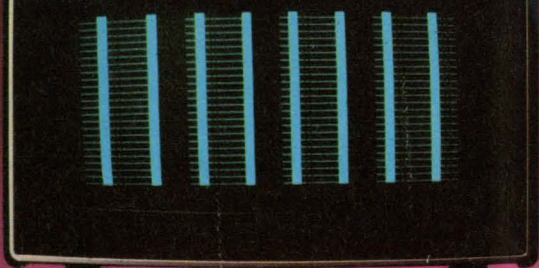
For more information about the Teletype model 40 product line, write: Teletype, 5555 Touhy Ave., Skokie, IL 60076. Or call: 312/982-2000.



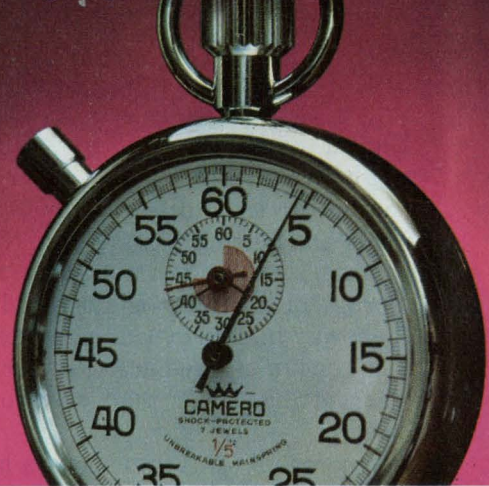
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CIRCLE NUMBER 40

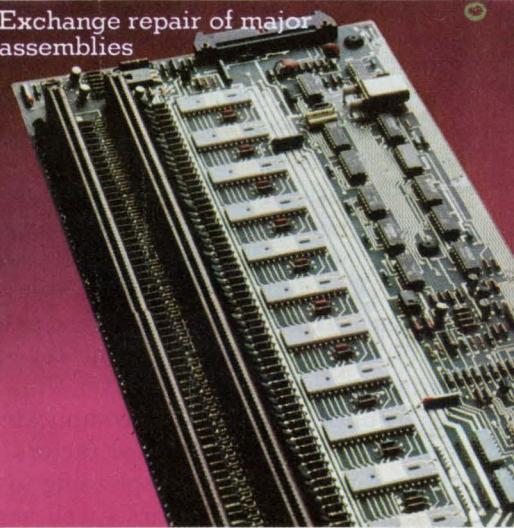
Built-in diagnostics pinpoint trouble



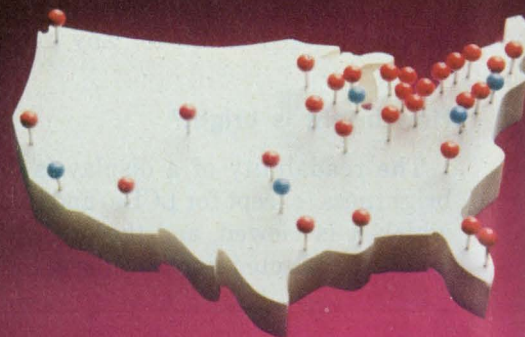
Average repairs take only 3/4 hour



Exchange repair of major assemblies



Nationwide service





# FOCUS

on  
Readouts

Digital and alphanumeric readouts and displays are getting bigger, brighter, better—and more of a problem to select—as they find their way into an expanding variety of new industrial and consumer products. Paradoxically, displays are also getting easier than ever to incorporate into a design.

Whereas a few years ago you had to piece together single-digit LEDs or single fluorescent-tube readouts—hoping all the while for uniform brightness and performance—now you can buy prefabricated displays with uniform visual elements. And circuitry formerly spread around in IC chips is being integrated into newer displays.

But with all these improvements, choosing the right display is harder than ever—display specs haven't been comparably improved. Rather, the opposite is true. You will probably encounter specs that in many cases are confusing, misleading, or downright useless. And specs that should define key elements are sometimes missing altogether.

Your task is further complicated by both physiological and psychological factors that affect visual perception: What looks pleasing to one user may not to another; what one can see well, someone else cannot. For example, some individuals, particularly those with astigmatism have difficulty in focusing on, or looking at, red LEDs for any extended period.

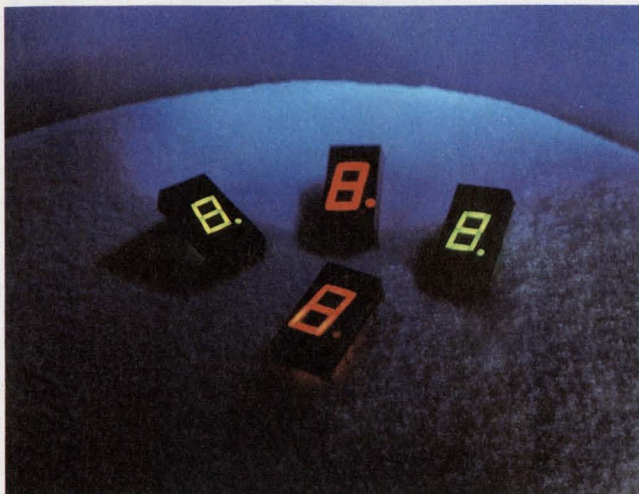
## How bright is bright?

The readability of a display is determined by its brightness (except for LCDs) and color, the angle from which it is viewed, and the presence (or absence) of ambient reflected light, or glare. But as important as

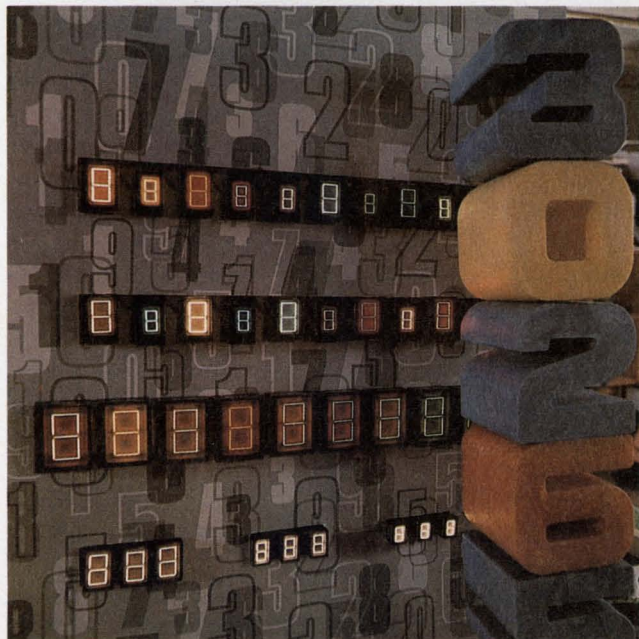


**Liquid-crystals use the lowest power** of all displays. This clock display by Hamlin draws only a few microwatts with all digits energized.





**Four colors of seven-segment LED readouts**—red, orange, yellow and green—are now available. The 0.3-in. multi-color devices by Monsanto are mounted in arrays with 0.4-in., center-to-center spacing.



**Incandescent displays are the brightest** and with the proper filters can give any desired color. Pinlites by Refac can be dimmed easily for night operation.

brightness is, the way it's specified on data sheets makes it virtually useless to you.

First of all, brightness is spec'd in quantities that don't tell the whole story. On most LED sheets it's given in terms of luminous intensity in milli or microcandelas, derived from the foot candle. Brightness data for fluorescent, incandescent or gas-discharge displays are usually given in terms of luminance in foot-lamberts. And in one manufacturer's literature, it's expressed merely as the maximum distance that the display supposedly can be read. But just how readable the display is at that distance, or

whether being in a dark room or using binoculars would improve readability, isn't included.

The problem is that brightness is a relative quantity that can't be measured simply in numbers. The light coming from an illuminated digit segment, for example, is automatically compared in the eye to the brightness of adjacent areas of ambient reflected light.

What may seem low brightness, then, can under some conditions have a visual intensity way out of proportion to what the spec indicates. For example, a LED watch display that is almost invisible in sunlight can be brilliant in darkness.

Good readability in a display usually requires a brightness ratio, or contrast, of no less than 5:1 between the light source and surrounding unlit areas. Higher contrasts are preferred. The light output from an "off" display element is reflected ambient light, while that of an "on" element is the sum of the ambient plus that of the illuminated portion. So an effective ratio accounts for the intensity of ambient light, the reflectivity of the display's front surfaces, and the intensity of the light emitted by the display.

But don't forget the Polaroid or bandpass optical filters you'll probably use to increase the ratio. These filters do improve readability, but they also attenuate the display's brightness.

#### Filters are mandatory

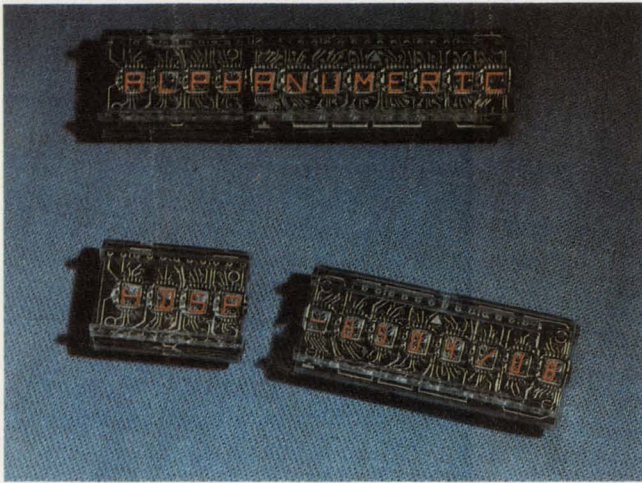
Just how much filters attenuate the optical output is difficult to evaluate with current brightness specs. Invariably, you are given the most favorable value for brightness—in other words, without filters. But filters are required for just about every display. (One reason—not obvious—is that they mask out distracting details of the unlit element structures.)

The display vendors' hearts are at least in the right place. Filter numbers and filter manufacturers are referenced copiously in the display literature. But from that point on, with rare exceptions, you are on your own—a tacit admission by vendors that you really should buy a selection of filters and try them out.

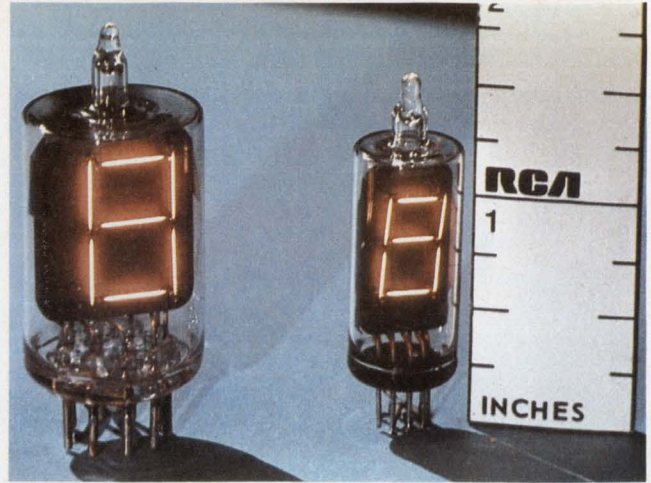
Another problem in specifying brightness—and a number of other display specs—is that it is generally specified in terms of "average" or "typical" values, with maximums and minimums frequently missing. But no manufacturer guarantees these typical values, so make sure you get guaranteed *minimum* figures. You don't have to worry about maximum brightness—except possibly for one manufacturer who pointedly specs "no upper maximum limits" for one of his LED displays. Don't look at that one without dark glasses.

Watch out for buzz words like "high brightness" and "high intensity" and "viewable in sunlight." Take these claims with a grain of caution. Even comparing displays by their rated luminous output can be deceiv-





**Sixteen-segment alphanumeric displays** are mounted in four and eight-character dual-in-line packages. The HP devices can display a 64-character ASCII set as well as a number of other special characters.



**The rugged construction of these Numitron incandescent-filament** digital readouts by RCA gives them high reliability and a life expectancy of 100,000 hours. The readouts are compatible with 5-V IC decoder-drivers.

ing. For example, because of integration of light, a luminous area of low intensity can appear just as bright to the eye as a much brighter point source.

The best way to compare displays is to get hold of several samples, hook them up, and look at them under the ambient light in which you expect them to operate. P.S. Don't forget the filters.

#### Contrast equals brightness for LCDs

For liquid-crystal displays—which don't emit light—brightness is never used as a spec. The reason? The LCD readouts depend upon either reflected or refracted ambient (or other) light for their operation. So to tell how bright the figures or letters are against the display's background, LCDs employing reflected light use the term "contrast," while those using refracted light are described by the spec, "transmission ratio." Either contrast or transmission ratio should be specified in the order of 15 or 20:1 or higher.

But the contrast or transmission ratio of LCD devices is usually specified looking directly at the display, whereas these factors decrease as the observer moves to one side or the other. For this reason, the only meaningful way to determine an LCD's effectiveness is to look at it under the expected ambient lighting of the application.

Another factor affecting display readability is the human eye's varied sensitivity to different colors. Eyes are least sensitive to the narrow-bandwidth radiation of red LEDs (see figure). From the standpoints of aesthetics and eye-fatigue, reds are lowest on the display-desirability totem pole.

The oranges, yellows and greens, in that order, have been proven in countless tests to be progressively more attractive. And a user's eyes are progressively more sensitive to these colors, so that, for example, less optical energy is needed for green to have the same effective brightness as orange.

Because of the narrowband radiation produced by displays like LEDs and vacuum-fluorescent panels, and to a lesser extent gas-discharge displays, you are pretty much limited to the color of the device you select. But the broadband output of incandescent displays permits them to be used with a wide variety of color filters. Consequently, your display can have any color you want—simply select the proper filter.

Readability isn't the only big problem in choosing a display. Try finding documented lifetime figures these days. A few years ago, when many of the now-mature displays were in the first few thousand hours of their lifetimes, the vendor's specs were loaded with detailed (although not necessarily credible) extrapolations—based on, say, 5000 hours of accelerated tests. The claims were that devices would last 50 or 100-thousand, or even a million hours till half-brightness. And the good or bad effects of operating conditions on device life were described in detail. But not in today's specs.

A review of up-to-date specs from about 60 vendors reveals that when it comes to specifying device life-



**Gas-discharge display modules** are supplied with the indicators and decoder-drivers in this CE-3000 series by Canyon. The display is designed with an integral bezel fitted with an antireflective filter.



time there are apparently two philosophies: "Follow the leader" and "Don't worry about it." Thumb through the literature from half a dozen liquid-crystal suppliers and you'll see the same quote: "Expected lifetime 50,000 hours." Look at the specs of incandescent-filament display vendors and the lifetime appears to be universal: 100,000 hours. But don't expect to find evidence.

Surprisingly, the spec sheets of several major semiconductor-LED-readout manufacturers have dropped lifetime altogether. One vendor does condescend to claim "rugged, long operating life" for his LEDs.

One gas-discharge-display manufacturer lists a figure of "30,000 hours at rated operating conditions." But "catch 22" operates here—nowhere in an otherwise comprehensive sheet will you find data entitled "Rated operating conditions." In another gas-discharge-display producer's data, the only reference to lifetime can be found in one note in a list of 20 fine-print spec qualifications; the note says, "Values beyond which the life of the device may be reduced." But this note goes on to send you to a "Table of Absolute Maximum Ratings," which leaves you as much in the dark about how long the displays will last as when you started looking for lifetime numbers.

Ironically—and fortunately—the manufacturers do have comprehensive data on device lifetime and factors affecting it—most of which is stored away in special application bulletins and in the files of the vendors' engineering staff. To get this information, you'll have to contact application engineers personally.

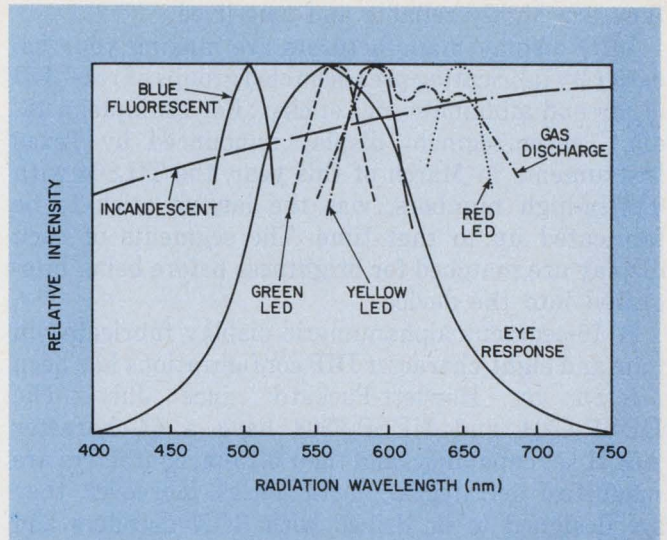
Even when a display appears to meet your design requirements, the cost remains an important, overriding factor. The price sheets may give you a cost-per-device that appears low, particularly for the bare-bones single or multiple-element displays. But these prices can be deceptive.

Displays also need mounting and packaging hardware, filters, decoding and driving electronics and power supplies. When the extras are added up, the cost can skyrocket. In some cases it may be better to buy than build. Displays or display subsystems may actually be more economical when purchased from one of the many manufacturers who put a large part or the entire package together for you.

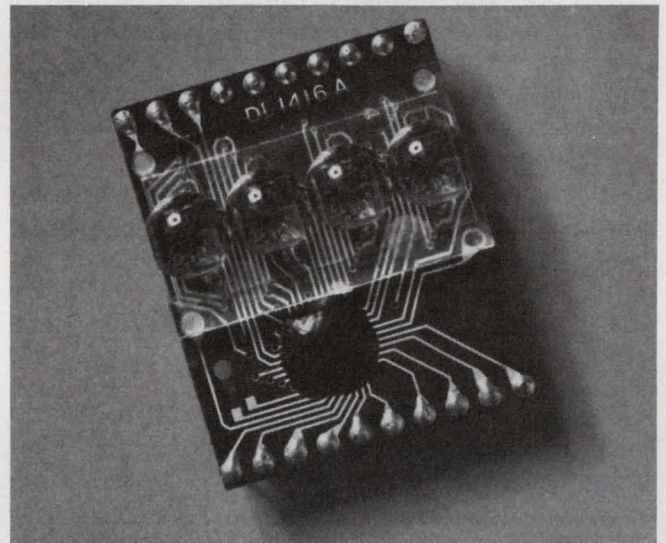
### A matter of style

Meanwhile readouts and displays have evolved into three general styles. The most popular presents a single line of numeric data ranging from three or four digits up to 17 or 18. A second and rapidly growing style displays a single line of alphanumeric data, while a third presents a number of lines of alphanumeric data.

To choose one display from the popular types available today—LEDs, liquid crystal, vacuum-fluorescent devices, incandescent displays, gas-dis-



**Optical radiation bands of LED, vacuum-fluorescent, gas-discharge and incandescent displays are compared with the bandwidth sensitivity of the human eye.**



**The four-character, end-stackable, 16-segment alphanumeric DL1416 by Litronix eliminates discrete interface components when used with microprocessors. The interface circuitry—a CMOS IC that includes memory, an ASCII ROM and multiplexing features—is incorporated on the display substrate.**

charge displays and plasma panels—be ready for tradeoffs among a number of display requirements. These include display cost, brightness, operating speed, power consumption, reliability and environmental stability.

### LED readouts top the list

LEDs remain most popular in the USA, although renewed interest in liquid-crystals promises to increase their share of the market. Besides low cost, LEDs have a number of desirable features for display design. Their low operating voltage makes them TTL-compatible, and they can be readily multiplexed. Also,



they are highly reliable and long-lived.

LED display manufacturers are making your job easier by fabricating preassembled groups of red-LED digits and alphanumeric "sticks." For example, a 12-digit, seven-segment display announced by Texas Instruments in March of this year, the TIL804 with 0.27-in.-high numbers, was the largest stick to be fabricated up to that time. The segments of each display are matched for brightness before being integrated into the device.

A 16-segment alphanumeric display fabricated in four and eight-character DIP configurations has been offered by Hewlett-Packard since July. The HDSP-6504 and HDSP-6508 have a 64-character ASCII set capability, and their 0.15-in. characters are magnified by integral plastic lenses. Moreover, they are designed to be driven with ROM decoders and drivers for easy interfacing with microprocessors and LSI circuitry.

Red numeric arrays with magnified digits are available from National Semiconductor in sticks of 6, 7, 8, 9, 10, and 12 digits. Designed to be used in calculators and instrumentation, they are TTL, DTL or CMOS-compatible.

An eight-character, 14-segment alphanumeric display recently announced by Monsanto—the MAN2815—reduces system cost to about half that of 5 × 7 dot-matrix systems. This display can be stacked to give multiples of eight characters. With built-in plastic magnifiers, characters are 0.135-in. high.

For more comfortable viewing, lines of single-device, seven-segment digits in orange, green and yellow are now available. Alphanumeric displays are still, however, restricted to red.

Monsanto's MAN50A, 3600A and 80A series are being produced with 0.3-in. digits in orange, yellow and green, while its MAN6600 series boasts a 0.56-in. digit. Xciton is offering green and yellow in its 3050 and 3080 0.3-in. series, and in its 6500 series a green display that is 0.6-in. high.

HP's entries are 0.3-in. and 0.43-in. digits in its high-efficiency yellow, green and red, seven-segment 5082 series. The 0.3-in. units operate with as little as 3 mA per segment.

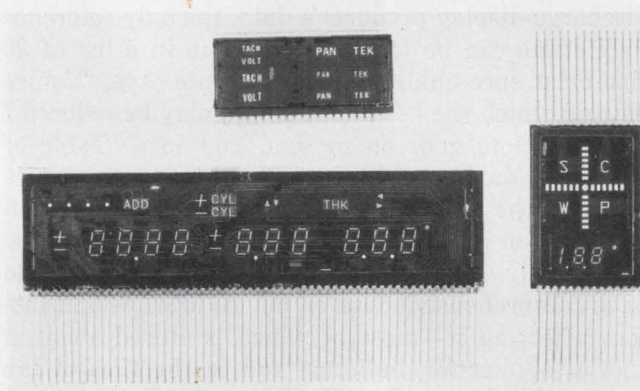
Meanwhile, brightness of segmented LED displays has been upped industrywide with improved LED materials and packaging. The light from radiating elements is carried by plastic light pipes or reflector configurations that concentrate the light from the LED chip more efficiently at the surface of the digit. Litronix even uses computer-generated reflector designs to optimize optical efficiency.

The latest of seven-segment entries in the brightness race are HP's "sunlight-viewable" red and yellow digits for DIP-solderable PC-board mounting. The red HDSP 3530/3750 series and yellow HDSP 4030/4130 series of devices are produced in 0.3 and 0.43-in. digits. The red units are rated at a typical brightness of 2300  $\mu\text{cd}/\text{segment}$  at 100 mA peak and 20 mA average, while the yellow units have an output

of 2700  $\mu\text{cd}/\text{segment}$  for the same current ratings.

One limitation of LEDs is that, being fundamentally semiconductor diodes, they are temperature-sensitive. Operating much above 85 C degrades life and decreases output. But some spec sheets aren't too clear on exactly where a safe upper temperature boundary is, particularly for units with thermoplastic optical elements that soften at fairly low temperatures. One supplier gives operation and storage as between -20 and 70 C, but he also cautions not to operate above 70 C, or the plastic lens will be damaged.

One key development in LED display technology can be related to the growing demand for alphanumeric readouts in microprocessor products—the integration of more "smarts" on the display itself, to reduce or eliminate the need for discrete interface components when it is being used with a microprocessor.



**Dc gas-discharge displays** can be made in a variety of configurations like these by Pantek. All cathode segments are internally bused and a separate anode connection is provided for each digit position.

Litronix is out in front here with its "intelligent" DL1416 four-character, end-stackable alphanumeric 16-segment display. CMOS circuitry on the substrate includes memory, an ASCII ROM (64 characters) and multiplexing functions. Inputs are TTL and CMOS-compatible as is the power-supply requirement.

Data entry in the Litronix display is asynchronous and random-access. Each 0.160-mil character can be addressed independently and continues to display the last character written until replaced by another. The four-character DL1416 is priced at \$22.50 in 1000 quantities.

A four-character, 5 × 7 dot-matrix alphanumeric package from HP is tailored for use with microprocessor-based instruments and systems. To minimize external hardware costs, the package contains shift registers and externally programmable constant-current generators.

#### Liquid crystals—power misers

When the relatively large amount of power that LED display elements consume becomes objectionable—it can run to 0.5 W or more with all segments lit



—you can turn to other devices like liquid-crystal displays (LCDs) or vacuum-fluorescent readouts. For the lowest power consumption by far, check out LCDs. Standard-size, dynamic-scattering displays, such as clocks, draw on the order of microwatts, whereas field-effect watch displays operate on nanowatts. A major point in the LCDs' favor is that they are compatible with MOS and CMOS driving circuitry.

In the early 1970s, LCDs had their problems. But persistent development efforts have substantially improved fabricating and sealing techniques, and reliability. Lifetimes of 50,000 hours are now commonly quoted. Also, each LCD producer has developed a witch's brew of his own LCD materials that gives features like improved contrast and faster response times than before.

Liquid-crystal displays ranging from watch-sized elements to large-area systems with digits or characters inches high, are being produced by such manufacturers as Ashley-Butler, Beckman, Hamlin, Liquid Crystal Displays, Motorola, Optel, Shelly Associates, Transparent Semiconductors and UCE, Inc.

Costs are now competitive with LEDs. A 3-1/2-digit clock display with 0.5-in. digits goes for \$7.35 per 1000 from UCE, Inc., while a 16-segment, four-digit alphanumeric display with 1-in. characters sells for \$21.42 per 1000 units from the same supplier.

One disadvantage of LCDs is that they require an ac voltage of 3 to 15 V. Applying dc causes an electrolytic action that plates the cell. Typical frequencies for dc/dc converters range from 25 Hz to 1 kHz.

Response time of an LCD cell is temperature-sensitive, and increases as the cell gets colder. Typical turn-on times range from 75 ms at 25 C to double that at 0 C.

Turn-off times spread from 150 ms at 25 C to four times that at 0 C. But this is a dramatic improvement over the early cells that took as long as 3 seconds to turn off. Still, for low-temperature operation, you'll need a heater.

Operating temperature depends upon the type of nematic (liquid crystal) material used, but is generally on the order of -5 to 75 or 80 C.

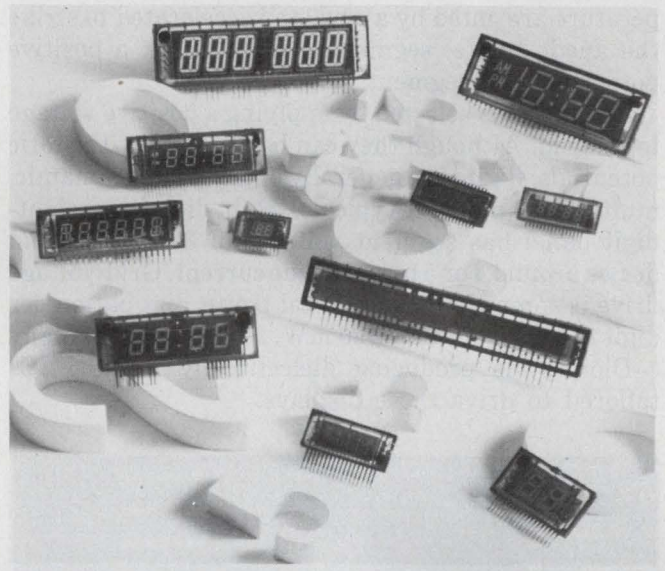
LCDs are low-cost because they're simple. They consist essentially of two glass plates with 0.5 mil of liquid-crystal material sandwiched between. On the inner surface of the rear glass, a continuous electrode is plated. On the inner surface of the front face, a transparent pattern of the display segments is formed, with connections to the outside world.

Depending upon the type of LCD material, either a dynamic scattering or a field-effect display is produced. When a voltage is applied between the front and rear faces, the digits or other desired patterns appear. The cells are either reflective or transmissive. Reflective cells use ambient light from in front of the display, while transmissive cells either use ambient light that passes through the rear or they incorporate some sort of backlighting.

In dynamic-scattering LCDs—the first to be de-

veloped—voltage applied to the cells gives a frosty image. Field-effect devices, developed more recently, operate by rotating the plane of polarization of light that is either reflected from the rear of the cell or transmitted through it. As a result, they require polarizers—a source of trouble. Moisture absorption in highly humid environments rapidly destroys the effectiveness of the polarizing material (usually iodine suspended in a thin, plastic sheet).

To protect against humidity, in some cases, plastic overlays are laminated on top of the polarizer material. But Polaroid has begun pilot production of a new material called the K polarizer, which resists moisture much better. However, it costs more than standard polarizing material.



**Flat-pack, multidigit fluorescent displays** feature a blue-green color and high brightness. The devices by Futaba can be driven from 12 to 24-V sources.

Polarizers are not needed in the latest type of LCD cell, one that uses what is termed a pleochroic dye. The colored dye is mixed with field-effect liquid-crystal material to give a blank field of the dye's color. Applying a voltage causes the digits to lose all color, so that a colorless number appears against the colored background. These devices are potentially less expensive than available LCDs. Operating characteristics are close to that of field-effect devices. The only supplier of these displays right now is Integrated Display Systems, which offers them in red, blue, purple and brown.

Other advanced LCD devices are being developed. Hamlin is offering multiplexed LCDs on a custom basis, and UCE, Inc., has experimental graphic displays of 64 x 64 X-Y lines, forming 4096 dots. Price is \$250 per panel.

#### **Vacuum-fluorescents use less power**

For a display with a power drain of about one-half to two-thirds of a LED, look at the vacuum-fluorescent

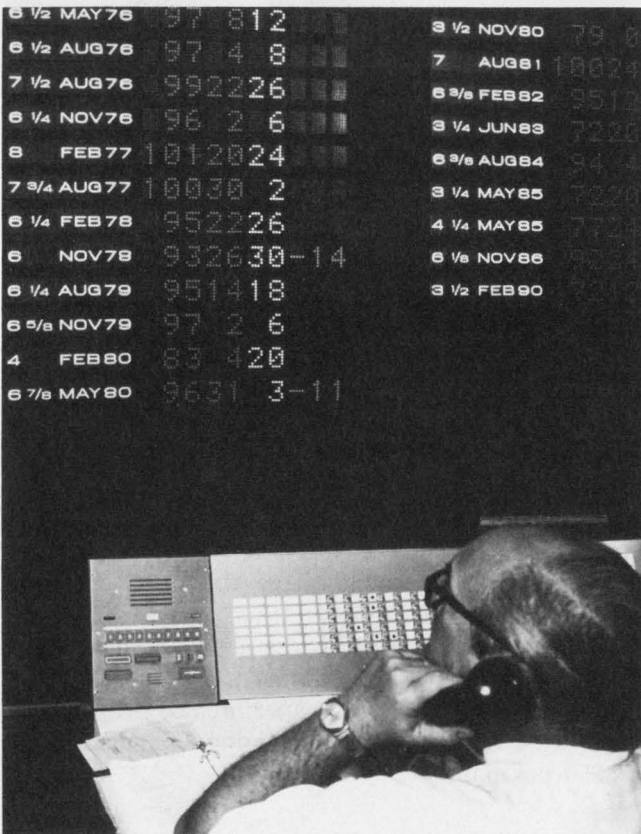


device. Originally developed by Ise Electric of Japan, and first used in desktop calculators in 1969, vacuum-fluorescents have seen considerable activity since then.

Vacuum-fluorescent units are produced in four to 13-digit, seven-segment arrays by Ise, Futaba and NEC, and in 9, 10, 16, 20 and 40-character dot-matrix alphanumeric devices by Ise.

The basic fluorescent device is a modified form of a triode vacuum tube. The digit segments are deposited on a flat substrate and coated with material that fluoresces under electron bombardment. Electrons from a cathode heated to subluminescent temperature are gated by a grid, and accelerated to strike the anode (plate) segments, which are at a positive potential. The segment glows.

Each digit is selected by applying a positive voltage to its grid. Although they can be operated with static potentials, digits are generally operated in a dynamic, multiplexed mode. A typical 0.43-in. digit in an eight-digit panel has segment voltages of 30 to 40 V and draws around 4 or 5 mA of anode current. Grid-voltage drive is somewhat lower. Total power dissipation per digit ranges from 10 to 100 mW. At least one company—Dionics—is producing dielectrically isolated ICs tailored to drive these displays.



**Electromagnetic displays** that use light-reflecting, rotating discs to form characters require no power to maintain a display pattern. Ambient light provides good contrast in this display by Ferranti-Packard.

In 1973, a flat multisegment fluorescent display was produced on a monolithic glass substrate. Further improvements have been made, not only by Ise but also by Futaba Industries and NEC, among others. Present designs are superior in performance, appearance and reliability. And they cost less. Today's eight-digit units sell for about \$3.75 per 1000, while a 13-digit display goes for \$11.20 in 1000s.

**Incandescents are the brightest**

The most power per digit of any type of display is drawn by incandescents. But they are also the brightest. These displays are rated as high as 12,000 or 13,000 ft-L. Light output levels can be easily varied to maintain a strong contrast from very low to high levels of ambient light. And just about any color can be produced by slipping the proper filter over the front of the display.

Incandescent displays are available in several forms. One is a seven-segment readout, like those from Dialight, IEE and Discon Industries, that uses individual 5-V, 20 or 30-mA lamps to illuminate the transparent segments of a digit mask. A variation of this design is produced by Master Specialties in a series of fiber-optic readouts that are rated at 1000 ft-L. Light is transmitted from 5-V, 10,000-h lamps to the face of the display area where it illuminates seven segments for numerics and 16 for alphanumeric devices.

Matrix displays formed of individual incandescent bulbs are available from Chicago Miniature, Info-Lite, IEE, Electrodata Concepts and Inter-Market, Inc. (Intec).

Rear-projection incandescent readouts that use 10 or 12 single bulbs and lens systems send the light from each of the lamps through 10 or 12 different messages on a film to a frosted-front screen. Each of the lamps is usually energized separately but any combination of characters or words can be projected from these photographic film reticles.

To create compound messages, up to six lamps can be energized simultaneously in projection readouts by Shelly. They can be stacked up to eight units wide. Image heights are 0.437, 0.62 and 0.70 in. IEE has 14 different models of similar capability with message areas from 0.34 to 3.375-in. high.

Meanwhile, segmented-filament incandescent devices are growing in use, such as the Numitrons from RCA, the Petites from Readouts, Inc., Pinlites from Refac, the Day series from Day-Light Corp., the KW series from Wamco Technical and the DPD series from Durgin and Browne.

These devices are all TTL-compatible, work on 5 V, and consume 15 or 20 mA per filament segment. Their outputs are rated up to 10,000 ft-L. The filaments are designed for derated operation, and lifetimes of



thousands of hours are possible. They are fabricated as planar filament structures in evacuated glass envelopes of different designs. For example, Numitrons enclose the filaments in a vacuum tube. Pinlites have a flat package with metal back and a glass front. Normally, these designs are susceptible to damage from shock and vibration. But some have been ruggedized, and they can pass vibration tests in accordance with MIL-STD-202.

Filament readouts can be multiplexed, but to avoid flicker you must use a multiplexing rate greater than 50 Hz.

### Gas-discharge displays glow

A version of the granddaddy of the gas-discharge tubes, the Burroughs' Nixie, is available in a line of miniature, standard, super and jumbo readouts designed and sold by National Electronics. But inflation has taken its toll. Just six years ago, prices ranged from \$2 to \$30 apiece in 1000 lots. Now the costs range from \$5.25 to \$50.

The Nixie's sophisticated offspring, multidigit gas-discharge displays, are appearing in a host of new products, including desktop calculators, instruments, point-of-sale terminals and even in automobile dashboard displays.

Gas-discharge readouts are bright and can be read in substantially higher ambient light than LED displays. But a drawback is the relatively high operating voltage, 180 to 240 V, that is required for their operation.

Planar gas-discharge devices are being produced in several formats. Burroughs is still manufacturing its Panaplex series with character heights of 0.25, 0.4 and 0.5 in. and four to 16 numeric-digit readouts. To supply the growing alphanumeric market, Burroughs' Model BA16701 with a 0.7-in.-character panel boasts a lineup of sixteen 14-segment characters along with decimal points and commas.

Cherry Electrical Products offers its Plasma-Lux displays with four character heights (0.25 in. to 1 in.) and 4 to 16 digits.

Two types of gas-discharge displays are being produced by Beckman's Information Displays Operation at Scottsdale, AZ. One uses a raised, rather than flat, cathode for seven-segment planar segments in one to four digits per unit. Leads are provided for directly soldering it into a PC board. Prices range from \$1.50 to \$2.00 per digit in 1000 quantities.

The other type is a 35 to 50-character alphanumeric display that is fabricated by means of a thick-film process. The image displays are screened onto a substrate and alternate layers of conductors and dielectric are superimposed. At present, only custom panels are being turned out with this process. But because it is simple, prices as low as \$12 for a 16-

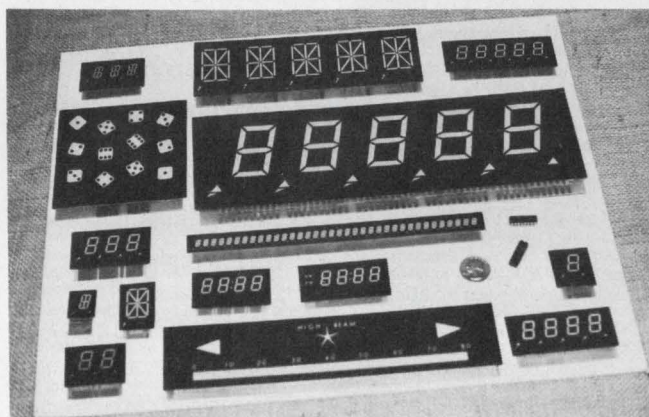
character panel with 14-segment, 0.5-in. readouts are envisioned in the near future.

Canyon Electronics is packaging Beckman's gas-discharge elements into panel-mounted hexadecimal modules having from two to eight seven-segment digits. To display numerals 0 to 9 and letters A to F, decoders and drivers included in the modules operate from TTL/DTL four-line binary-coded data.

Where multiple lines of alphanumeric data must be presented, dot-matrix systems like Burroughs' well-known Self-Scan I and II panels or IEE's Argus plasma-display subsystem are available. Both Burroughs' and IEE's panels are bright orange-red neon. But IEE has also introduced a green as an option, using Xenon gas.

The Self-Scan II panels, second-generation versions, compete with CRT computer terminals. Because of the relatively thin profile of the Self-Scan II panels, which come in 40, 240 and 480-character versions, over 50% savings in terminal depth can be achieved. Because of the basic dot-matrix presentation, a variety of characters and different fonts can be programmed easily into the displays.

IEE's Argus systems come in seven basic types that differ in both screen-character capacities and character sizes. These systems are also distinguished by four formats: two lines of 16 characters; four lines of 16 characters; four lines of 32 characters, and eight lines of 32 characters.



**Electroluminescent displays** emit a pleasant green light. Such displays by T.L. Robinson Co. are packaged in an unbreakable plastic dielectric material. Standard digit sizes are 0.25, 0.375, 0.50, 0.60 and 1.00 in.

A third source for plasma dot-matrix panels, Owens-Illinois, has suspended production of its Digivue system and is phasing itself out of this field. But National Cash Register and Modern Control in this country, and Fujitsu in Japan, are supplying equivalent devices.

There are other displays that aren't widely used. One is a new, \$1-per-digit electroluminescent (EL) display by T.L. Robinson Co. Made on PC-board



substrates, it offers either seven-segment, 0.6-in. digits or nine-segment, 0.5-in. digits. Half-inch, 16-segment alphanumeric readouts are also available. These displays require 120 to 275 V, 60 Hz to 20 kHz ac to drive them. Their light is soft green.

Driving the Robinson displays requires extensive discrete circuitry, but two high-voltage IC drivers, the DI-220 and the DI-802P from Dionics of Westbury, NY, can do the job.

Another display, electromagnetically operated, requires power only when data are being entered or removed. In some cases, such as with Montevideo

Technology's alphanumeric system, a wheel carrying digits or letters is rotated by magnetic pulses.

In other cases, such as Ferranti-Packard's, the displays are made up of rotatable segments or circular magnetic elements that are black on one side and white or colored on the other. Applying current to these elements rotates them 180°. With the black side out, no data are visible. With the white or colored side out, alphanumeric characters are formed. Although Ferranti's display requires ambient light, it is surprisingly effective in applications ranging from gas pumps to stock-exchange boards. ■■

## Need more information?

The products cited in this report have been selected for their illustrative qualities. However, other manufacturers not mentioned in the report may offer similar products. Readers may consult manufacturers listed here and in ELECTRONIC DESIGN'S GOLD BOOK for further details. The type of display produced is indicated by a code after each listing: EL for electroluminescent; EM for electromagnetic; GD for gas-discharge; IN for incandescent; LC for liquid-crystal; LD for LED; NE for neon; PP for plasma-panel; and VF for vacuum fluorescent.

Ackerman Bodnar Corp., 30 Grove Ave., New Rochelle, NY 10801. (914) 636-4664. (A. Franzone) **Circle No. 501**

Aircraft Instruments Co., Commerce Dr., Montgomeryville, PA 18936. (215) 368-0175. (J.C. Rychlak) (EM) **Circle No. 451**

Alco Electronic Prods. Inc., 1551 Osgood St., North Andover, MA 10845. (617) 685-4371. (C. Czapski) (IN) **Circle No. 452**

Ashley-Butler Inc., 208 Rte. 206 S, Somerville, NJ 08876. (201) 359-5911. (R. Klein) (LC) **Circle No. 453**

Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, CA 92634. (714) 871-4848. (C.H. Vessey) (LC) **Circle No. 454**

Beckman Instruments Inc., Info Displays Op. 350 N. Hayden Rd., Scottsdale, AZ 85257. (602) 947-8371. (R.A. Kuntz) (GD) **Circle No. 455**

Burroughs Corp., Electronic Components Div., P.O. Box 1226, Plainfield, NJ 07061. (201) 757-5000. (Robert Gotsch) (GD, PP) **Circle No. 456**

Canyon Electronics, 2001 W. North Lane, Phoenix, AZ 85021. (602) 944-4421. (G.J. Mitlak) (GD, LD) **Circle No. 457**

Cherry Electrical Products Corp., 3600 Sunset, Waukegan, IL 60085. (312) 689-7700. (F.A. Amendola) (PP) **Circle No. 458**

Chicago Miniature/Drake Mfg. Co., 4433 N. Ravenswood Ave., Chicago, IL 60640. (312) 784-1020. (R. Galarneau) (IN, LD, NE) **Circle No. 459**

Dale Electronics, 1376 28 Ave., Columbus, NE 68601. (402) 564-3131. (Herman Person) (GD) **Circle No. 460**

Day-Light Display Corp., 11 Fairfield Pl., West Caldwell, NJ 07006. (201) 575-1045. (Phil Schneider) (IN) **Circle No. 461**

Dialight, 203 Harrison Pl., Brooklyn, NY 11237. (212) 497-7600. (Chet Dambroski) (IN, LD, NE) **Circle No. 462**

Discon Inds. Inc., 1322 NW 14 Ave., Pompano Beach, FL 33060. (305) 782-7424. (M.C. Crockett) (IN) **Circle No. 463**

Durgin & Browne Inc., 82 Allen Rd., South Burlington, VT 05401. (802) 863-6873. (R. Martineau) (IN) **Circle No. 464**

Electrodata Concepts Inc., 21-16 44 Rd., Long Island City, NY 11101. (212) 392-8800. (John Rattinger) (IN) **Circle No. 465**

Electro Mech Components, 1826 N. Floradale, South El Monte, CA 91733. (W.H. Trumbull, Jr.) (EM) **Circle No. 466**

Fairchild Semiconductor OED, 4001 Miranda Ave., Palo Alto, CA 94303. (415) 493-3100. (LD, LC) **Circle No. 467**

Ferranti-Packard Ltd., Electronics Div., 121 Industry St., Toronto Canada (416) 762-3661. (G.L. Jones) (EM) **Circle No. 468**

Fujitsu Ltd., 680 Fifth Ave., New York, NY 10019. (212) 265-5360. (K. Kurahashi) (PP) **Circle No. 502**

Futaba Industries U.S.A., 630 Carob St., Compton, CA 90220. (213) 537-9610. (Ray West) (VF) **Circle No. 469**

Hamilin Inc., Lake & Grove Sts., Lake Mills, WI 53551. (414) 648-2361. (Gerald Gross) (LC) **Circle No. 470**

Hewlett-Packard, 640 Page Mill Rd., Palo Alto, CA 94304. (415) 493-1212. (Rick Kniss) (LD) **Circle No. 471**

Industrial Electronic Engineers Inc., 7740 Lemoona Ave., Van Nuys, CA 91405. (213) 787-0311. (K.J. Luskin) (GD, IN, LC, LD, NE, PP) **Circle No. 472**

Info-Lite Corp., 46-10 104 St., Corona, NY 11368. (212) 476-1287. (J.M. Cartelli) (IN) **Circle No. 473**

Integrated Display Systems, Montgomeryville, PA 18936. (215) 368-8050. (Tom Gates) (LC) **Circle No. 474**

Ise Electronics Corp., Noritake Co., Inc., 22410 Hawthorne Blvd., Suite 6, Torrance, CA 90505. (213) 373-6704. (David Shimizu) (VF) **Circle No. 475**

Litronix Inc., 19000 Homestead Rd., Cupertino, CA 95014. (408) 257-7910. (Jim Futer) (LD) **Circle No. 476**

Master Specialties Co., 1640 Monrovia Ave., Costa Mesa, CA 92627. (714) 642-2427. (J. Carpenter) (IN) **Circle No. 477**

Modern Controls Inc., 19228 Industrial Blvd., Elk River, MN 55330. (612) 441-5610. (Bert Johnson) (PP) **Circle No. 503**

Monsanto Electronics Div., 3400 Hillview Ave., Palo Alto, CA 94304. (415) 493-3300. (G. Breeding) (LD) **Circle No. 478**

Montevideo Technology Inc., 204 N. 4th St., Montevideo, MN 55435. (612) 269-6562. (W.L. Nees) (EM) **Circle No. 479**

Motorola Inc., Semiconductor Group, LIX Displays, 3102 N. 56th St., Phoenix, AZ 85018. (602) 244-3046. (John Von Dohlen) (LC) **Circle No. 480**

National Electronics, P.O. Box 269, Geneva, IL 60134. (312) 232-4300. (R.D. Mackowak) (GD) **Circle No. 481**

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, CA 95051. (408) 732-5000. (Bob Santos) (LD) **Circle No. 482**

NCR Electronic Display Systems Div., 4750 Editon Ave., Colorado Springs, CO 80915. (303) 597-4613. (W.E. Coleman) (PP) **Circle No. 504**

NEC America Inc., 3070 Lawrence Expressway, Santa Clara, CA 95051. (408) 738-2180. (Jason Stewart) (VF) **Circle No. 483**

Nippon Electric Co., World Products Inc., 7625 Bush Lake Rd., Minneapolis, MN 55435. (612) 835-2117. (O. Woller) (PP) **Circle No. 505**

Opcoa Div. of IDS, Inc., 330 Talmadge Rd., Edison, NJ 08817. (201) 287-0355. (Robert C. Kolts) (LD) **Circle No. 484**

Pantek International Corp., P.O. Box 587, Lewistown, PA 17044. (717) 242-1411. (Stewart Harris) (GD) **Circle No. 485**

RCA Distributor & Special Products Div., 2000 Clements Bridge Rd., Deptford, NJ 08096. (609) 963-8000. (E.F. McCaffrey) (IN) **Circle No. 486**

Readouts Inc., P.O. Box 149, Del Mar, CA 92014. (714) 755-2641. (J.D. McKim) (IN) **Circle No. 487**

Refac Electronics Corp., Pinlites Div., P.O. Box 809, W. Hill Rd., Winsted, CT 06098. (W. Gillis) (IN) **Circle No. 488**

TL Robinson Co., Inc., Electronic Div., P.O. Box D, East Aurora, NY 14052. (716) 652-2111. (T.L. Robinson) (EL) **Circle No. 489**

Shelly Associates, 1562 Reynolds Ave., Irvine, CA 92714. (714) 549-3414. (Robert Anderson) (LC) **Circle No. 490**

Staver Co. Inc., 41-51 N. Saxon Ave., Bay Shore, NY 11706. (516) 666-8000. (J.B. Lazarus) (EM) **Circle No. 491**

Tau Electronic Prods., Keystone Park, Emporium, PA 15834. (814) 483-3356. (M.D. Emmett) (EL) **Circle No. 492**

TEC Inc., Components Div., 2727 N. Fairview Ave., Tucson, AZ 85705. (602) 792-2230. (Earl Tatman) (LD) **Circle No. 493**

Texas Instruments Inc., P.O. Box 5012, Mail Station 12, Dallas, TX 75222. (214) 238-3821. (Bill Alexander) (LD) **Circle No. 494**

Transparent Conductors Inc., P.O. Box 549, Goleta, CA 93017. (805) 968-3561. (D. Feldman) (LC) **Circle No. 495**

Tung-Sol Div., Wagner Electric, 630 W. Mt. Pleasant Ave., Livingston, NJ 07039. (201) 992-1100. (J. Emaus) (IN) **Circle No. 496**

UCE Inc., 20 N. Main St., Norwalk, CT 06854. (203) 838-7509. (R. Borstelmann) (LC) **Circle No. 497**

Vari-Light Corp., 9770 Conklin Rd., Cincinnati, OH 45242. (513) 791-6330. (D.H. Baltzer) (IN) **Circle No. 498**

Wamco Technical Sls., 705 W. 16, Costa Mesa, CA 92627. (714) 642-5100. (M.A. Matthews) (IN) **Circle No. 499**

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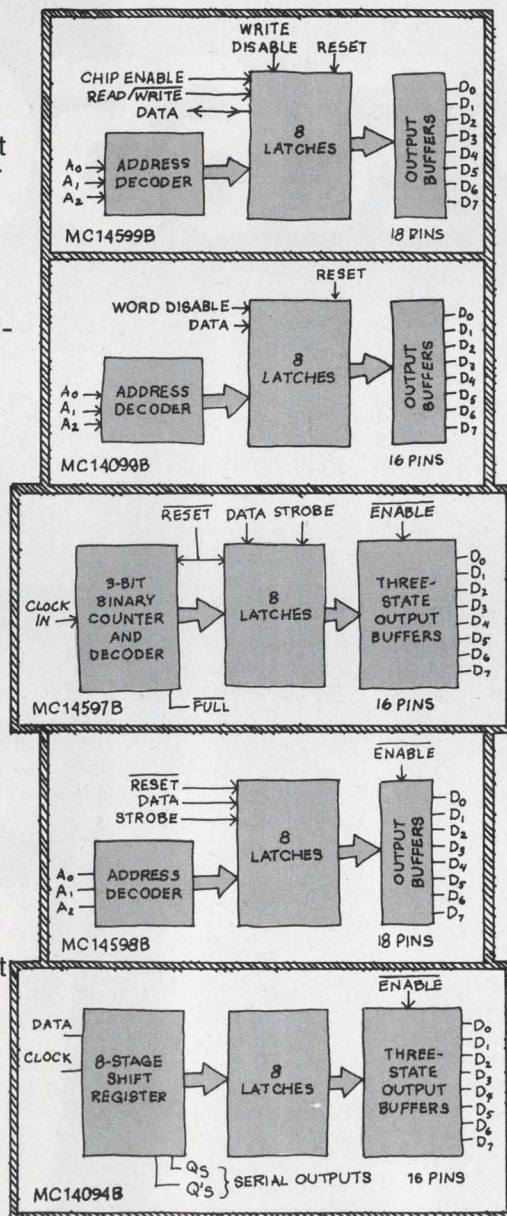
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**MC14599B**, similar in many respects to the MC14099B, has significant difference in the input, a three-state *bidirectional* input which provides communication optimized for bus expansion and readily allows information retrieval. The MC14099B and MC14599B are available now.

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also is similar to the MC14099B, but it has three-state outputs capable of driving bus lines. The output buffers drive either one TTL load or four LSTTL loads. The MC14598B is scheduled for introduction this month.

**MC14597B** is a bus-oriented 8-bit latch and features an on-board counter at the input for stepping data into the latches. Outputs are the same as those of the MC14598B. The MC14597B also is due out this month.

Last to be introduced (December), but by no means least, is the **MC14094B**, second sourcing the CD4094B. This device actually amounts to an eight-stage serial shift register, with a storage latch for each stage which strobes data to parallel B Series three-state outputs.

There it is. Just what you should expect from the CMOS leader. For information on Motorola's CMOS 8-bit latches, write to Motorola Semiconductor Products Inc., P.O. 20912, Phoenix, Arizona 85036, or circle the reader service number.

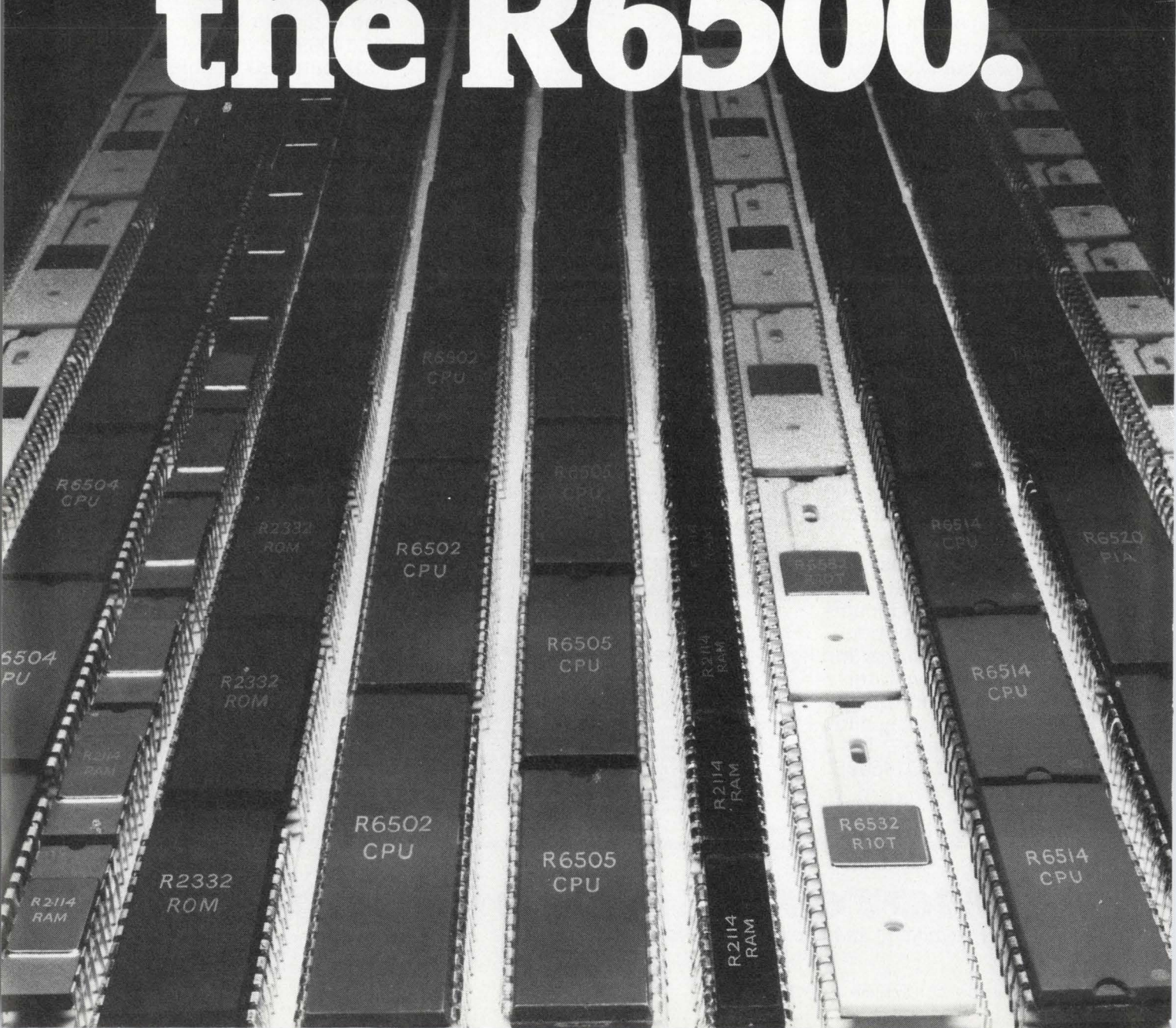


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CIRCLE NUMBER 41



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	40-Pin DIP		28-Pin DIP			
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Memory Address Space	65K	65K	4K	8K	4K	8K
Interrupts—Maskable	Yes	Yes	Yes	Yes	Yes	No
—Non-Maskable	Yes	Yes	Yes	No	No	No
SYNC—Output indicates op code fetch cycle	Yes	Yes	No	No	No	No
RDY—Single step and slow memory synchronization	Yes	Yes	No	No	Yes	Yes
$\Phi_1$ Clock Output	Yes	Yes	No	No	No	No
DBE—Extended Data Bus Hold Time	No	Yes	No	No	No	No

I/O Devices

PART #	NOMENCLATURE	DESCRIPTION
R 6520	Peripheral Interface Adapter	2, 8-bit bidirectional I/O ports; 4 peripheral control/interrupt lines.
R 6522	Versatile Interface Adapter	PIA functions plus 2, 16-bit programmable interval timers/counters.
R 6530	ROM-RAM-I/O-Timer	1024 x 8 ROM, 64 x 8 static RAM; 2, 8-bit bidirectional data I/O ports; 2 programmable data direction registers; 8-bit interval timer.
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## Narrow your choice of displays by counting characters and computing costs. CRTs offer the most flexibility but LEDs can cut small-system costs.

Since CRTs, LEDs and plasma panels all compete for many of the same applications, you may have to make several performance tradeoffs before you can choose which type is best for you (Fig. 1). Factors that must be considered include the type of characters or data you want displayed, size of characters, and the number of characters, among other qualities.

For the most flexible display operation, a CRT-based device would seem a natural choice since the drive electronics determines all the characteristics of the display. LED and plasma panels are not as flexible, especially when they use segments instead of a dot matrix to form the characters. With segmented arrays, only the most basic characters can be formed with the nine to 16 segments commonly used in the arrays.

However, if you're going to use the standard ASCII character set, the three display approaches are competitive at the outset. Character size, the number of characters, appearance and cost become the deciding factors.

Display appearance, of course, depends on external factors such as ambient light, aesthetics and required viewing distance. Similarly, character size depends on viewing distance and aesthetics. Character size, though, does limit your choice of display technology. For characters 0.5 in. high and more, you most probably would choose a CRT-based display, since you can adjust character height to any size you want simply by restructuring the control electronics.

However, when displayed characters are less than 0.5 in. high, the choice of display technology again widens to include CRTs, LEDs or plasma panels.

### Choose according to quantity

Because all three technologies fit the bill with ASCII characters, the next tradeoff that can be used as a deciding factor is cost, which can be determined by first examining the display characteristics you want—how many characters on a line, how many lines of displayed data, etc?

A CRT terminal system that accepts ASCII-charac-

ter inputs and provides at least a  $32 \times 16$  character display would typically cost about \$500 (about \$1/character). And, the cost penalty for adding more characters, say up to 2000, would only be a few hundred dollars. But for less than 100 characters, a CRT-based system is not very economical since a large part of the system cost consists of the monitor and basic control circuits needed regardless of the size of the display.

Although not requiring as large an initial investment for small quantity displays, the LED and plasma technologies cost more per character than a CRT system. However for a display system requiring less than 100 characters they offer economically attractive alternatives (about \$5/character). But, displays by themselves do not make a system.

Many small-scale display systems are used in conjunction with microprocessor-based equipment and are often multiplexed to keep circuitry to a minimum. When microprocessor controlled, the display can present some difficult programming problems for the designer.

If the display has no memory, all displayed data must be refreshed quickly enough to prevent any display flicker. So a frame rate of at least 50 Hz is required—but 100 Hz is preferred. If the display is set to handle, say, 32 characters, at least 3200 data words must be loaded from the memory every second. And, the frame rate must be held fairly constant since any large time gaps caused by system interrupts will show as flicker even if the over-all frame rate is high enough. And later on, maintenance, training and checkout will cost more, since the programs held in the processor's main memory must be modified to alter the display.

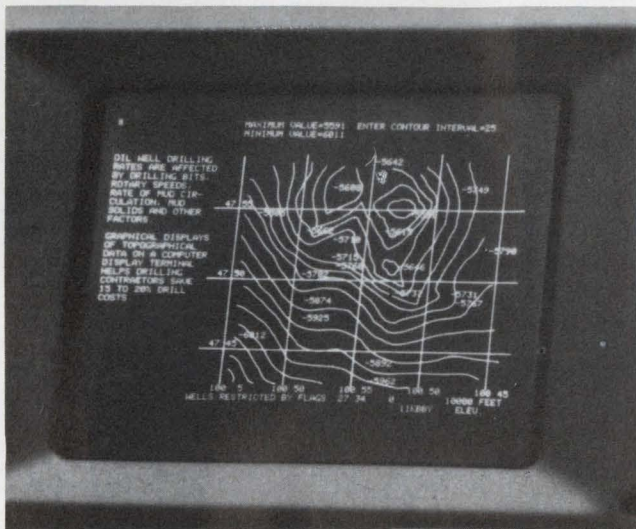
By supplying a separate memory for the display and its operating system, you can circumvent all the programming problems: The display can be treated almost like a memory location or output device. No system interrupts or timing loops are required, and when new data are to be displayed, they are simply written over the old data.

Non-CRT display systems such as the Burroughs SII-0132-0030 Self-Scan array, the Hewlett-Packard HSDP-2000 LED dot-matrix display and the Litronix DL-1416 16-segment array (Figs. 2a, b and c, respectively) can all be used to form low-cost display systems when less than 100 characters are needed. All three

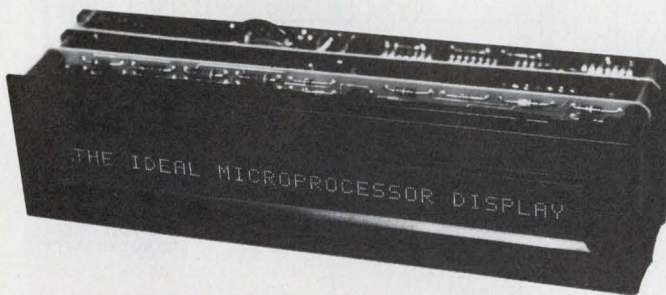
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David M. Barton, Marketing Manager, Intelligent Displays, and David Takagishi, Applications Engineering Manager, Litronix, 19000 Homestead Road, Cupertino, CA 95014.





Tektronix CRT

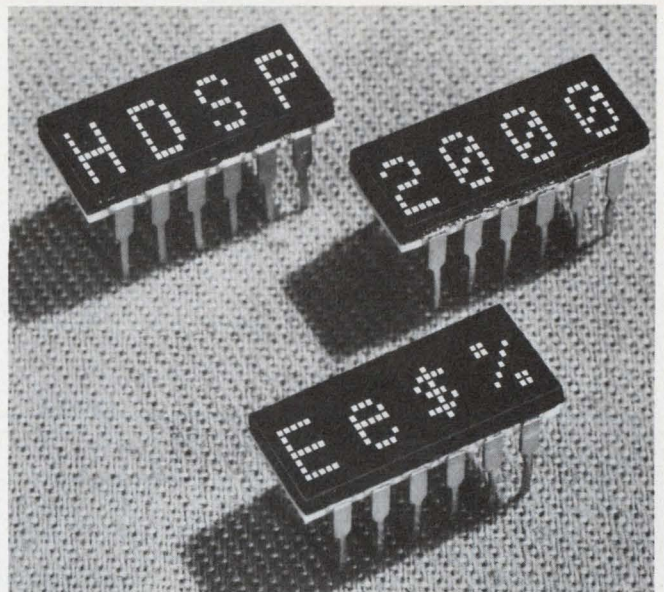


Burroughs Self-Scan

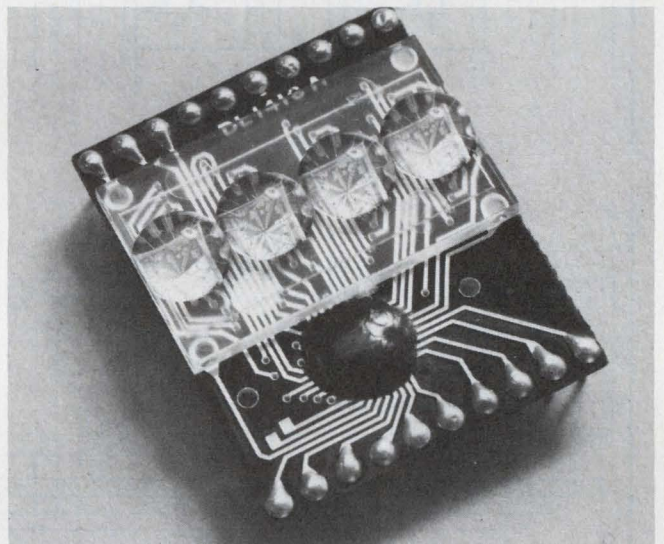
have some or all of the necessary control circuitry built in. Lower cost displays that contain no decoding or drive circuitry such as the old HP 5082-7100 family of dot matrix LED arrays or the newer HSDP-6504 family of 16-segment character arrays. To compare systems, simply examine a design example for a 32-character alphanumeric display using each of the three non-CRT display techniques.

### Compare display techniques

Building a simple  $\mu$ P-controlled display system using one of these three techniques requires a wide assortment of parts, as can be seen from the block diagrams and their accompanying parts lists in Fig. 3. The Burroughs display uses a dot-matrix plasma



Hewlett-Packard dot matrix LED



Litronix 16-segment LED

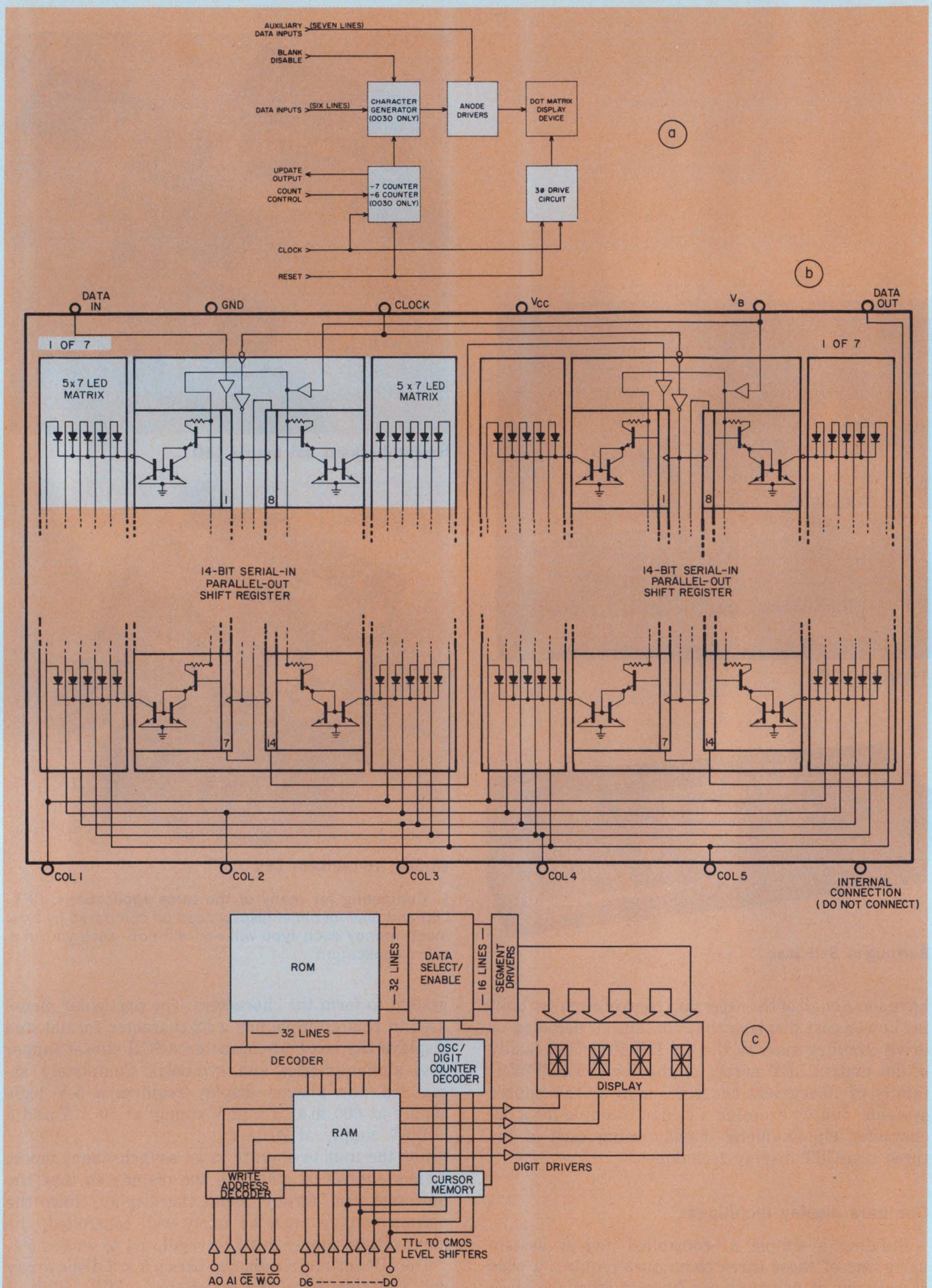
1. **Competing for many of the same applications**, CRT, LED and plasma-panel displays can be compared by how much money each type will—or will not—save you in a given application.

system to form the characters. The particular model used in this example has a 32-character format and displays the basic 64-character ASCII subset (upper case alphanumeric and symbols). Completely assembled, the plasma display requires a 5-V logic supply at 600 mA, a -12 V supply at 50 mA and a -250-V supply at 20 mA.

For the unit to operate in an asynchronous mode, memory must be added to the display so that the processor can "forget" about the display. Since the plasma voltage must be fairly well controlled, the high-voltage supply must be regulated to within 5%.

The HP dot-matrix display uses a  $5 \times 7$  diode array and contains four characters to a DIP. Built-in circuitry includes the drivers for the LEDs and a shift register so that data can be entered serially, which

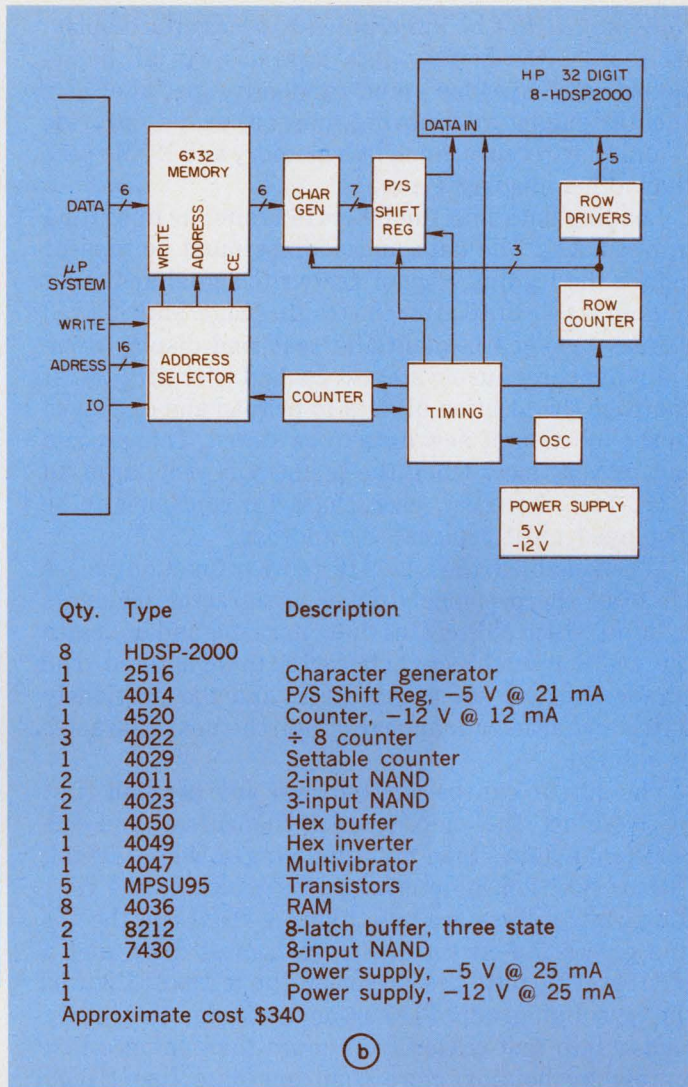
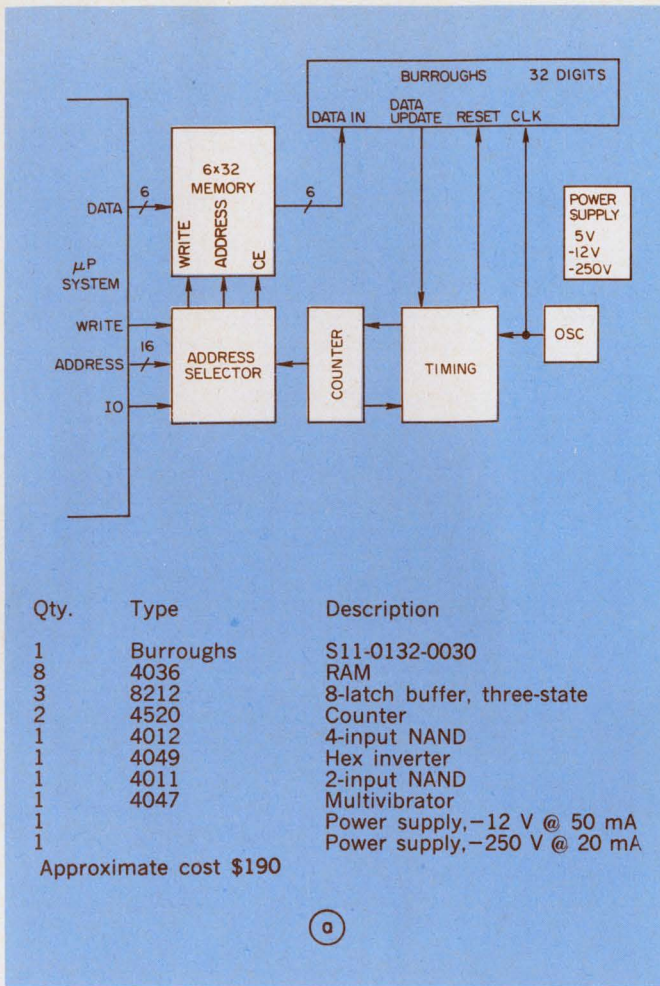




2. Filling various small-display applications, the Burroughs Self-Scan array (a), the Hewlett-Packard LED dot-

matrix array (b) and the Litronix 16-segment array (c) must be closely compared to determine which one to use.





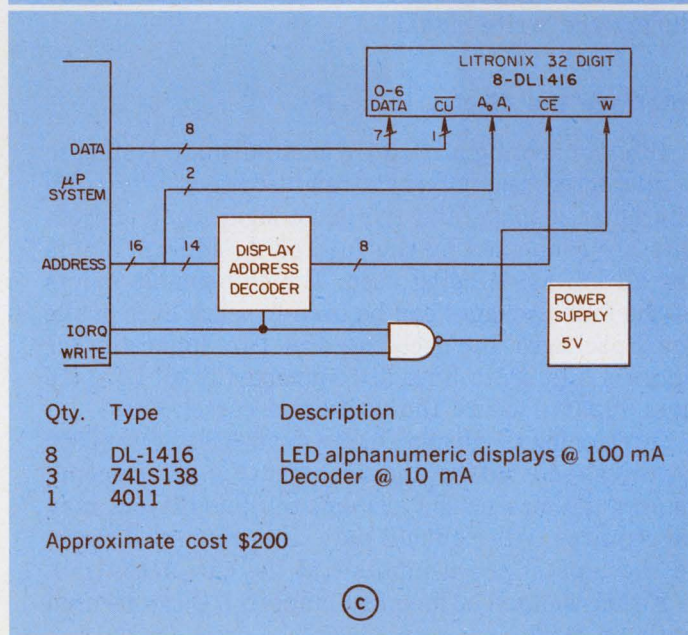
reduces the number of interface pins. No character generator or addressable memory is included on the display. To use external RAM and ROM calls for external row drivers and a counter, as well as timing circuitry for generating memory addresses.

For a 32-character assembly, the HP display typically requires 5 V at 4 A, -5 V at 25 mA, and -12 V at 25 mA. However, most of these supplies are typically included in many large systems and may not have to be specially designed—unlike the Burroughs 250-V supply.

The 16-segment LED display used in the Litronix DL-1416 forms the basic 64-character ASCII subset. Each DL-1416 contains four characters, a character-generator ROM, a RAM, a multiplex oscillator, display drivers and a cursor function. Just 5 V is needed by the display circuit.

Small displays using the DL-1416 require no additional circuitry, since each package has a chip-enable line that can be controlled by the processor. However, to map display locations sequentially, a one-of-N decoder is used to decode all data bits of order two and greater. Address lines  $A_0$  and  $A_1$  drive all the DL-1416s directly. Since only one gate must be added to finish the interface, a special write pulse for "display write" control isn't needed. For 32 characters, the display requires less than an amp.

The small display system shown in Fig. 3c can be treated like a printer port by the programmer. Other



3. By evaluating the displays in equivalent systems, you can get a good picture of the required components and the approximate cost for similar systems. Shown here are three 32-character display circuits using the Burroughs Self-Scan (a), the Hewlett-Packard dot matrix (b) and the Litronix 16-segment (c) displays.



routines needn't be interrupted to access the display. And, since the display-data locations can all be accessed asynchronously and randomly, special effects such as paging and moving lines are easy to provide—and they require much less memory and ROM space than other display types.

Loading data into the DL-1416 is similar to writing into a RAM: The data and address must be present before the leading edge of the write signal and must remain stable until after the trailing edge. Multiplexed display systems sequentially read and display data.

In synchronous systems, control circuitry must compare the location of data to be read and displayed to the location of new data to be stored. This process can be very slow when the memory is very large. In a DL-1416, however, each character continues to be displayed until replaced by another.

When enabled, the DL-1416's cursor function causes all 16 of the previously entered character segments to light, which obliterates that character and indicates the position of the next character to be entered. The cursor itself is not a character, and the previously written character reappears after the next character is entered.

The cursor can be written into any position first by enabling the chip enable, the cursor and the positional data, then by supplying a write signal. Cursor position is determined by which of the first four control lines are held high. A HIGH on the  $D_0$  line places the cursor on the rightmost digit, and a HIGH on  $D_3$  puts the cursor on the leftmost digit of the four-digit group. The cursor can be simultaneously loaded into and erased from more than one position simply by holding more than one data line HIGH during the write signal.

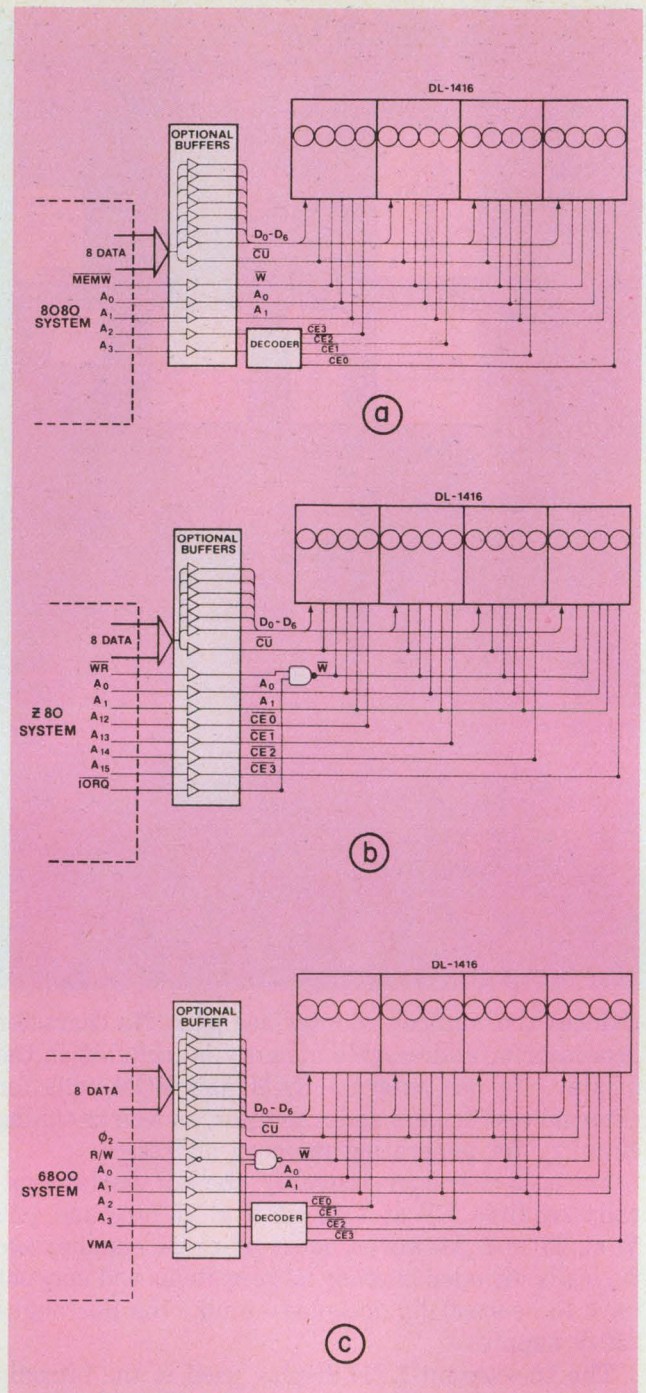
### Interface the display to a $\mu P$

Interconnecting a DL-1416 small-display system to a microprocessor is very straightforward. For a 16-character display, the two least-significant address bits are connected by the  $A_0$  and  $A_1$  address inputs for all DL-1416s being used. The chip-enable inputs of the four packages can be used to select each of the four packages by decoding the two highest-order address bits. Data lines are connected to all DL-1416 data inputs; so are the write and cursor lines.

Interfacing the display array to an 8080, Z80 or 6800 requires some buffers and a decoder (Fig. 4a). Depending on the size of the system, the bus drivers may be required. All eight  $\mu P$  data lines connect directly to the inputs (seven inputs and the cursor control).

Either isolated or memory-mapped I/O can be used with an 8080.

The interface for a Z80  $\mu P$  is very similar to that of the 8080, except that the write pulse is generated differently (Fig. 4b). And the interface for a 6800-based system requires very few modifications (Fig. 4c). However, the 6800 uses memory-mapped I/O techniques only, so take care to select the display RAM



4. Interfacing the Litronix display to a microprocessor requires nothing more than some buffers and gates. Typical interconnects are shown for an 8080 (a), a Z80 (b), and a 6800 (c).

addresses that don't limit processor RAM expansion.

But you don't have to use any RAM locations to access the display. ROM addresses can be used instead since the processor's read/write line will determine whether the ROM is being read or the display is being written to. ■■

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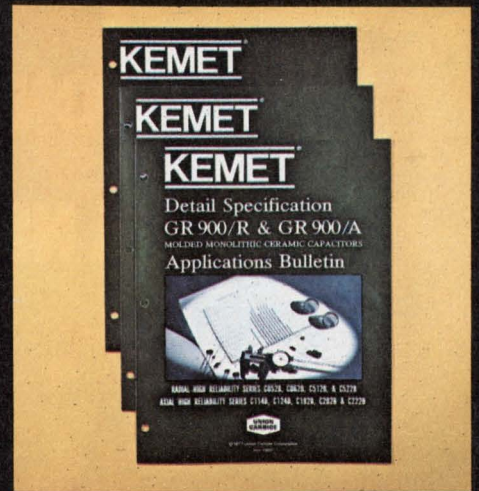
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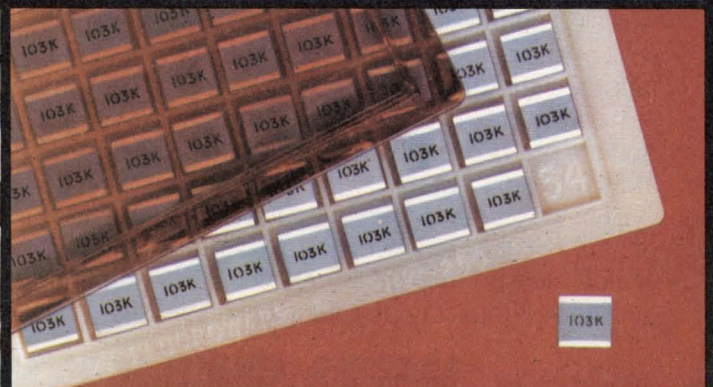
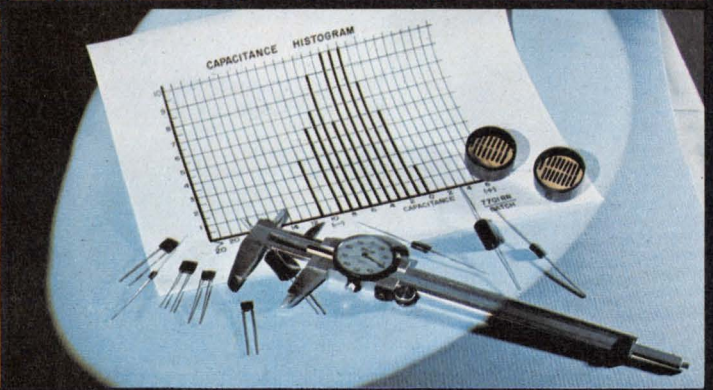
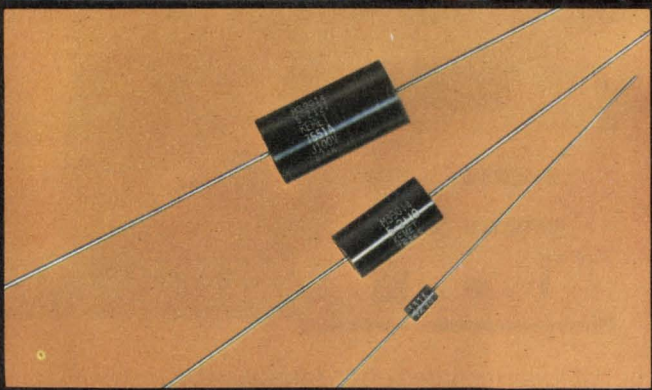
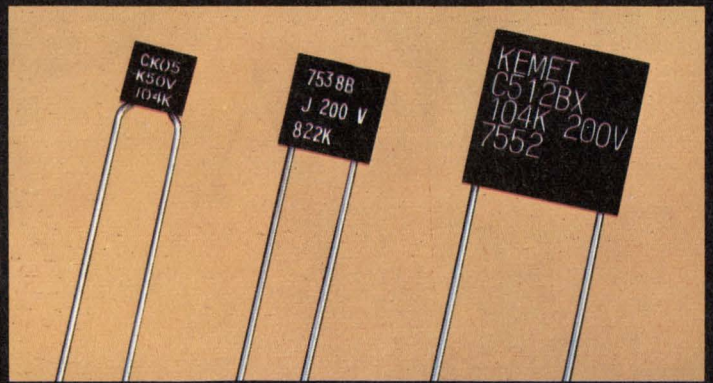
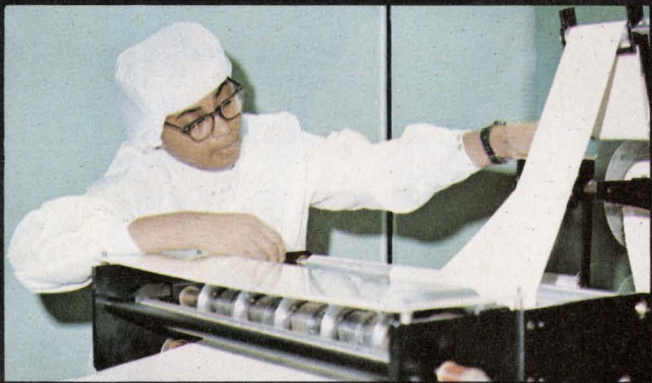
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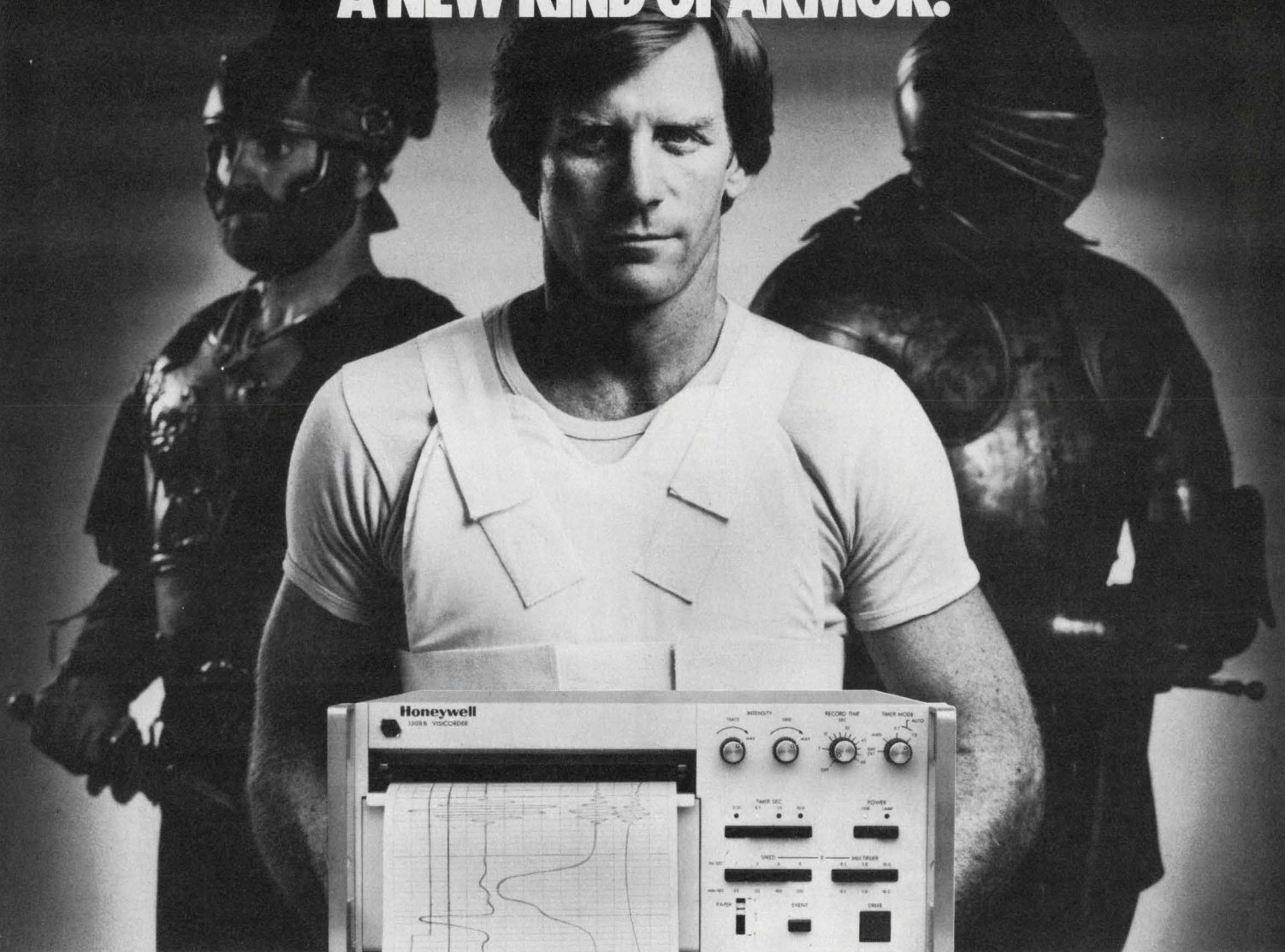
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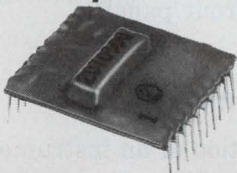
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CIRCLE NUMBER 47



# Electromagnetic-interference specs

may affect your whole design. Minimize their impact by making components serve double-duty for EMI control.

Controlling electromagnetic interference can often be an elusive goal that at first seems incompatible with other specifications, or with your cost objective. But you may be able to sidestep the cost/performance confrontation by making system components do double-duty—e.g. a mounting bracket that also serves as a shield.

Frequently, however, tradeoffs between EMI and other requirements are not at all straightforward. Take, for example, the requirements of a Doppler radar navigation system for a small helicopter. The system consisted of a radar, and a control/display unit. Besides conforming to MIL-STD-461A for EMI (Fig. 1), the system had other requirements to meet:

- Low cost.
- Operation at 71 C.
- Rigid size and shape limits for one to four "boxes."
- Global navigation capability—both latitude/longitude and Universal Transverse Mercator (UTM).
- Compensation for magnetic variation, compass deviation, and antenna signature, including temperature effects.
- Ability to process angular attitude data, convert velocity coordinates, remember way points and targets, and monitor itself.
- Ability to vary the display brightness, to cover a 3:1 contrast ratio.
- Hf, vhf, and umf receivers on board.
- Hf antenna in plastic bubble, only inches from the display.

Because all the other specs were quite rigid, the only "tradeable" requirements were cost and EMI performance. But the final choice in a tradeoff does not always follow the most direct pattern—many factors directly or indirectly affected the trades, as illustrated by Table 1.

### The dimmer connection

If EMI had been the only concern, either a liquid-crystal display or an incandescent display with a resistive dimmer would have been best. But other considerations were more important.

For instance, committing the system to masked-ROM storage was considered too restrictive in the development phase. The use of PROMs, however, added to the heat load, even with a memory utilization of 99%.

Choosing between a single and separate power supplies was also difficult. Similar but separate power supplies for the radar and display boxes added heat and cost to the system, but reduced the aircraft wiring and EMI control costs—which were considered more important.

Having made these choices for program storage and power supplies, only the more efficient, switching-type dimmer (Table 1) could be used. But the high electromagnetic noise of this dimmer had to be contained somehow. Could it be done without the added cost and the light absorption of metal screens or conductive films? Could another equipment component that was needed anyway, also control dimmer EMI—such as the front panel?

### A panel has more than one face

The primary function of an instrument panel is to support instruments. It must provide this support under shock and vibration, so that the individual components will not be excited beyond their design limits—and with as little weight as possible. Sheet metal is usually out of the question for a front panel in a military vibration environment, but a die-cast structure fulfills the required function economically in volume production.

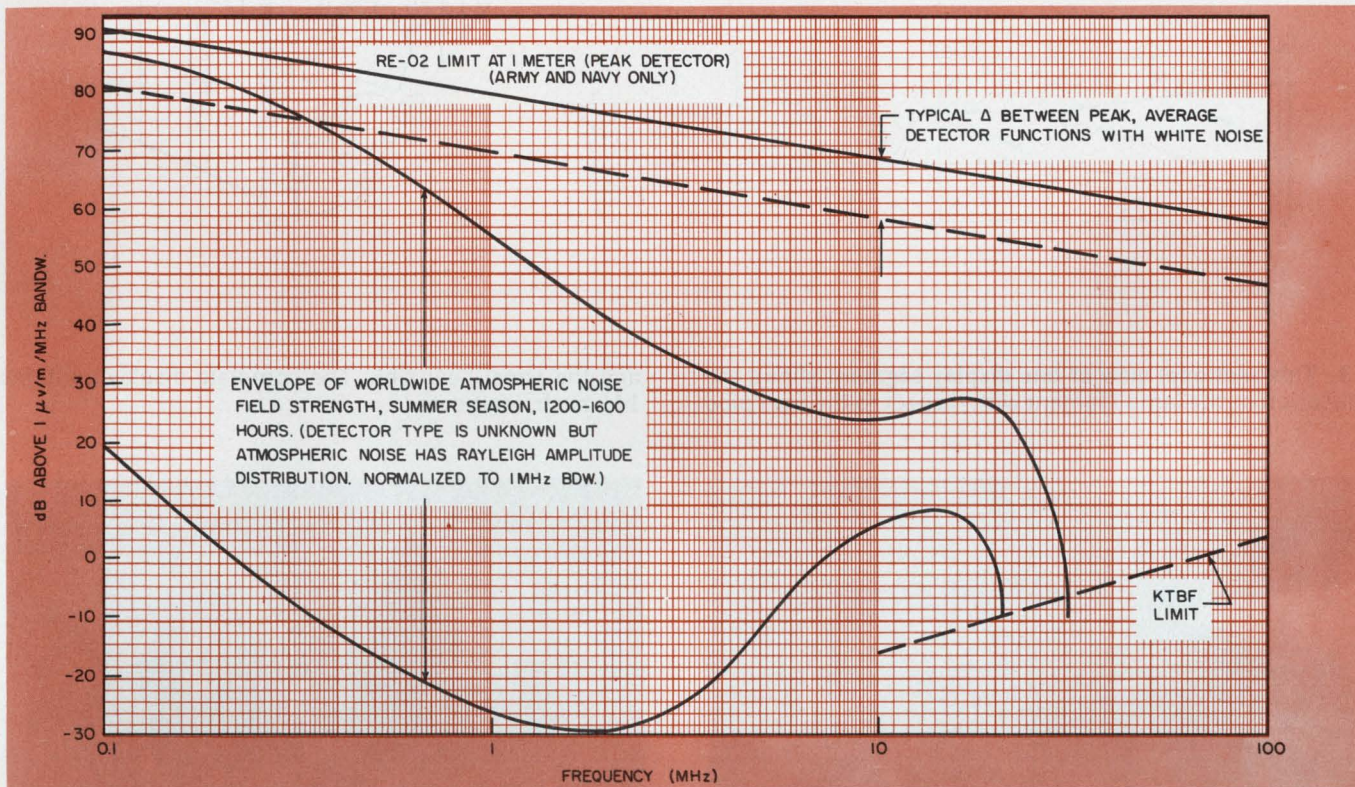
An instrument panel can also dissipate heat. In the case of an incandescent display, full brilliance typically coincides with maximum ambient temperature. When any helicopter is parked in the desert sun with the doors closed, sunlight hits the panel directly, and the plastic bubble creates a greenhouse. That's why a 71-C operational ambient is required for four successive 1/2-hour periods (MIL-STD-5400).

Only an incandescent display was found to be bright enough in full sunlight (Fig. 2). But it also generated additional heat. In the worst case, the display's seven 0.1-W bulbs for each of 11 numeric characters and 16 bulbs for each of 4 alphanumeric characters dissipated 14.1 W, for a statistical average load of 5.6 W. By embedding the bulbs in an aluminum "swiss cheese"

---

Louis A. Messer and Neville J. Sawyer, Group Engineers, Teledyne Ryan Aeronautical, 2701 Harbor Drive, San Diego, CA 92112.





1. MIL-STD-461A defines allowable broad and narrow-band emissions, 1 m from the test sample. Superimposed is the atmospheric noise range, which varies widely with

time and season, and can exceed the EMI limits. (The chart is based on CCIR report 322, Geneva, 1963, and ITT's Reference Data for Radio Engineers, p. 27-2, 5th edition.)



2. Here, the navigational computer's control display unit is placed in its natural habitat. Despite the bright sunlight, the display clearly shows the grid coordinates where the picture was taken, 14.5 km southeast of Oceanside, CA. Light-absorbing filters to protect the windshield-mounted receiving antennas were not needed.

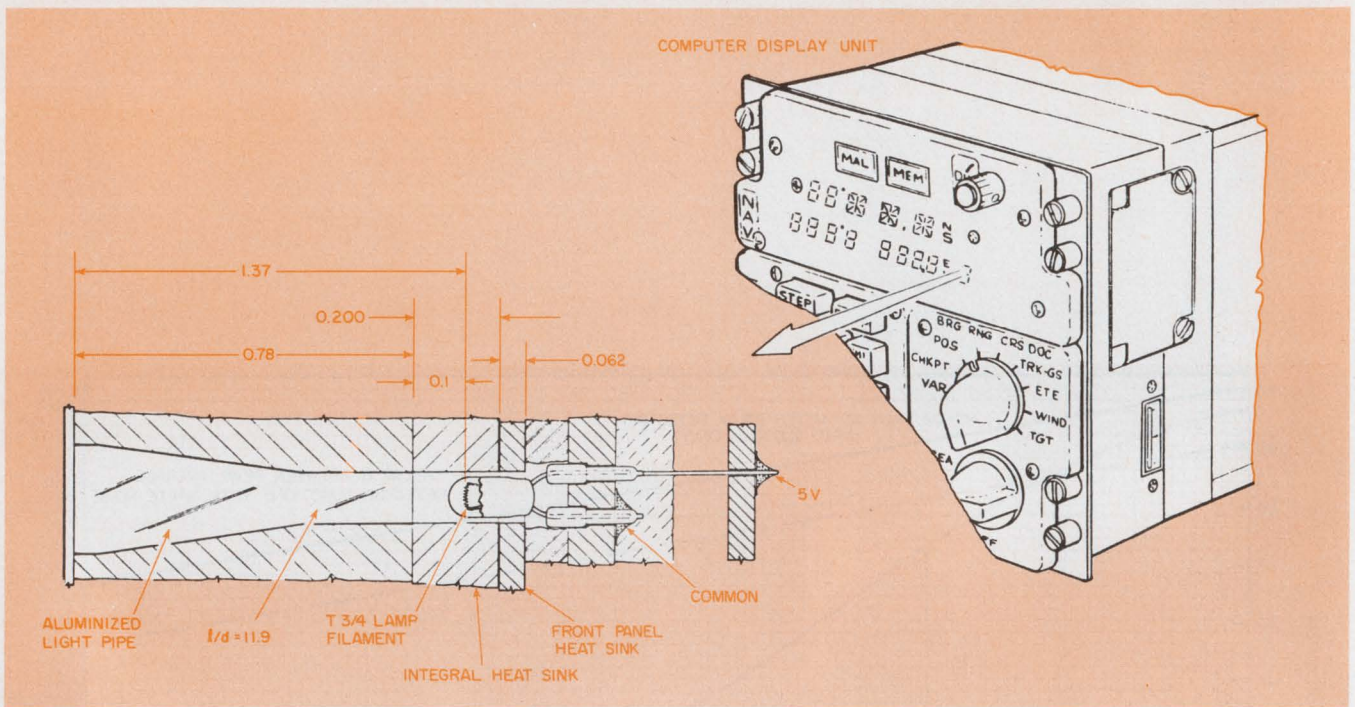
matrix of adequate thickness, a path of low thermal resistance was created (Fig. 3).

Through a removable display insert, the thermal path was continued into the panel. By choosing comparable dimensions for the thickness of both parts and the overlap, adequate structural rigidity was ensured.

But for EMI control, the ability of a panel to create a barrier for electromagnetic energy proved the most crucial feature. So, the frequency range over which the shield had to be effective had a big impact on the panel design. While the visible radiation of the light bulb filaments had to come through unattenuated, the dimmer-pulse frequencies radiated by these filaments had to be kept from the antenna, only a few inches away.

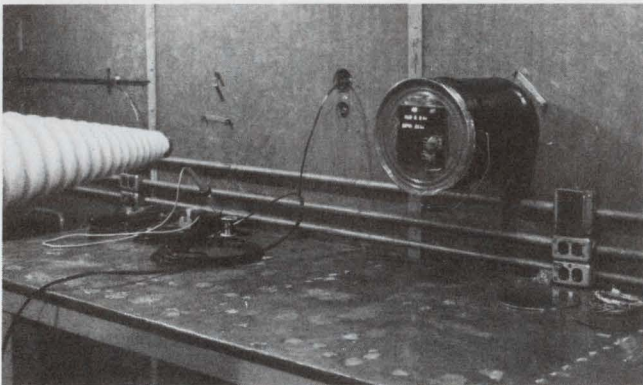
Here, the ratio between the "signal" wavelength (light) and the shortest "noise" wavelength was so large that a cylindrical waveguide below cut-off could serve as a filter. The required panel thickness (for heat



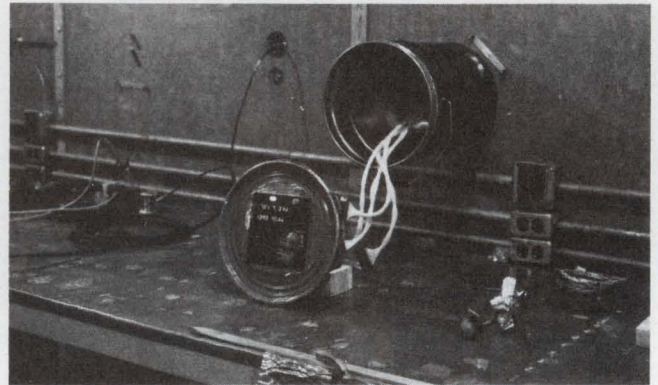


3. This sectional view of one display segment shows the location of the lamp filament with respect to the light pipe

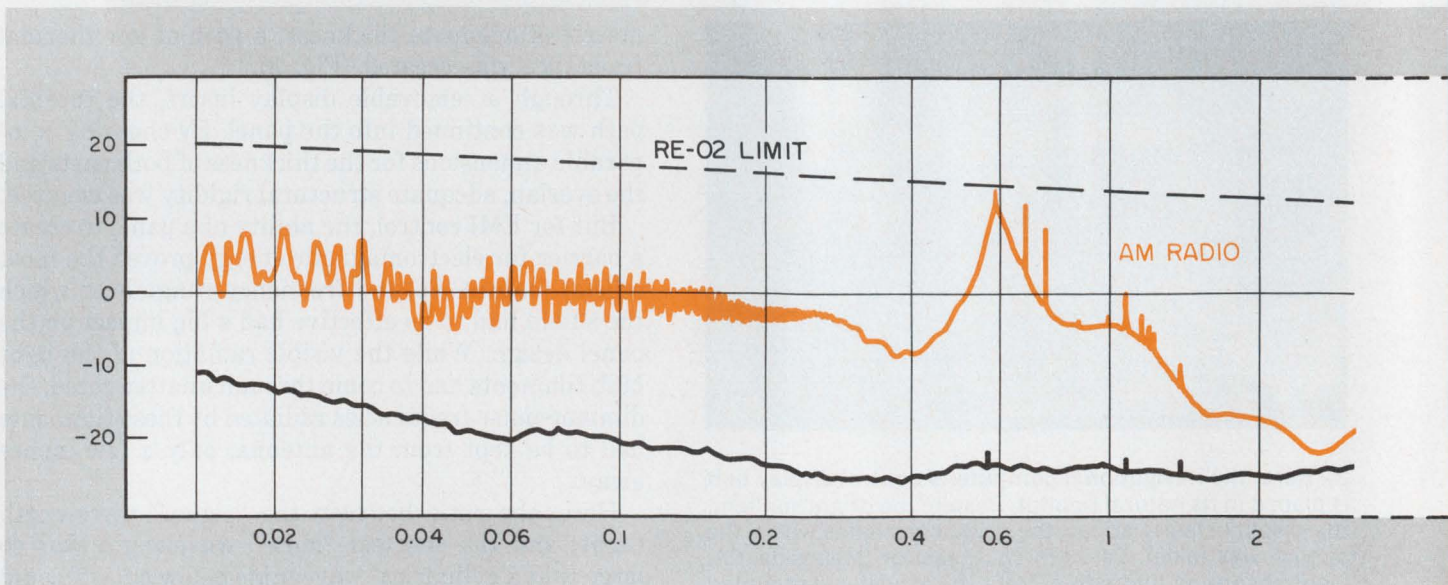
and the panel heat sink. The complete display contains 141 such segments.



4. A 5-gallon paint can makes a good temporary enclosure for evaluating the design's EMI effectiveness.



Tests were run with the display unit mounted in the can (left), and lying on the bench (right).





removal) and the small bulb diameters (Fig. 3) made such a filter practical.

Waveguide cut-off occurs where the major dimension of an aperture of finite depth is smaller than half a wavelength.<sup>1</sup> Attenuation (in dB) rises very steeply and follows the expression

$$A = 0.0046 \ell f [(f_c/f)^2 - 1]^{1/2} \quad (1)$$

where  $\ell$  is the aperture depth in inches (to the filament)

$f$  = the operating frequency in MHz

$f_c = 6920/d$  is the cut-off frequency for a circular aperture, and

$d$  = the aperture diameter in inches.

If  $f_c \gg f$ , Eq. 1 can be simplified for a circular aperture

as follows:

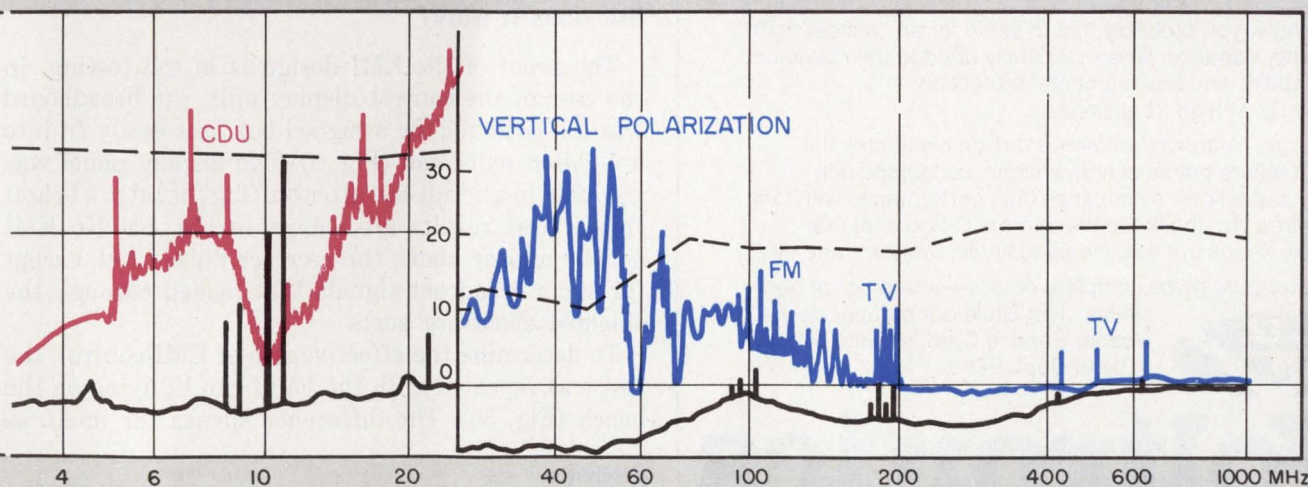
$$A \approx 0.0046 \ell f_c \approx 32 \ell/d$$

Thus, the attenuation is independent of frequency, and with the dimensions from Fig. 3, would be 32 dB. But, the helicopter display itself further enhanced this attenuation. In order to prevent optical cross talk, the fiber-optic segment formers were plated with a metal sheath. This increased the  $\ell/d$  ratio to 12, so that leakage was actually determined by the small cracks between the panel and the display. EMI was undetectable with the lamp dimmer set at 50% duty cycle (maximum ac power).

Such a panel can be die-cast in one piece, which is both economical and desirable. Point contacts in

**Table 1. Design tradeoffs**

Function	Alternative 1	Alternative 2
Display	Incandescent: Bright enough to read in sunlight; reliable; very high heat dissipation; inexpensive.	Liquid crystal: Insufficient track record; limited visibility; very low power consumption, temperature sensitive.
Display location	Directly viewed: Best visibility in full sunlight; low initial cost; segment gaps appear when dimmed; <b>high EMI</b> .	Indirectly viewed: Inexpensive replacement bulbs; wider viewing angle; special characters easily available; <b>less EMI</b> and heat radiation.
Display dimmer	Resistive: <b>Little EMI</b> , simple and inexpensive; inefficient.	Variable duty cycle: less heat dissipated; <b>high EMI</b> .
Display driver	CMOS: Compatible with other digital components; <b>moderate EMI</b> .	TTL: For incandescents the only low-cost driver; <b>EMI radiation extends to 0.4 GHz</b> .
Program storage	Masked ROMs: Need less space and power; revisions costly.	PROMs: Flexibility during design stage; high power consumption.
CDU and radar power supplies	Common supply: Burdensome interconnections; lower cost (not a decisive factor if supply architecture is simple).	Separate supplies: More flexibility, <b>better EMI separation</b> ; more heat dissipation.



5. Radiated emissions measured with the shielding can closed (black), and open (color). The RE-02 limit from the

EMI spec MIL-STD-461A, modified to include equipment calibration, is shown as a broken line.



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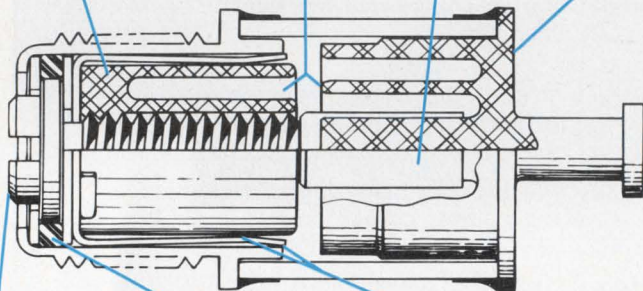
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CIRCLE NUMBER 48

## Help for the needy

Because EMI-control is so tightly interwoven with all electrical and mechanical aspects of the whole equipment, only the system designer himself, and not a consulting specialist, can incorporate EMI-control successfully. But equipment designers often regard EMI-control as a form of black magic because familiar design procedures don't seem to work. The problem is that some circuit elements—often called parasitics—rarely appear on the data sheet.

Unfortunately, many publications are better at explaining theoretical behavior than solving real-world problems. One useful aid, however, is Donald R. White's *EMI Control Methods and Techniques* (Volume 3, EMC Handbook series, Don White Consultants, 14800 Springfield Road, Germantown, MD 20767). The author derives the principal equations, converts them into practical graphs, explains their pitfalls and limitations, and gives numerous quantitative examples. Studying the relevant ones is more effective, and a lot cheaper than attending an intensive crash course.

metallic joints develop discontinuities in the rf surface currents, which act as slot antennas, so a monolithic structure is always preferable. But if any contact points in an EMI shield are anodized, they will again create discontinuities.

This cutoff-attenuator principle was also used in the keyboard. In the helicopter's control/display unit, each key contains a lamp, either for illumination or as an indicator. A small tubing holds the lamp and serves as a guide for the plastic actuator. The metal key separator (escutcheon) increases the  $l/d$  ratio, as do the sleeve bushings.

## But does it work?

The proof of the EMI design is in the testing. In the case of the control/display unit, the breadboard was too large for the assigned box, but easily fit into a 5-gallon paint can (Fig. 4). The display panel was mounted in a lid cut-out after buffing the lid to a bright finish. Test results are shown in Fig. 5a. No EMI signals appear above the receiver noise level, except for some broadcast signals that leaked through the shielded enclosure ports.

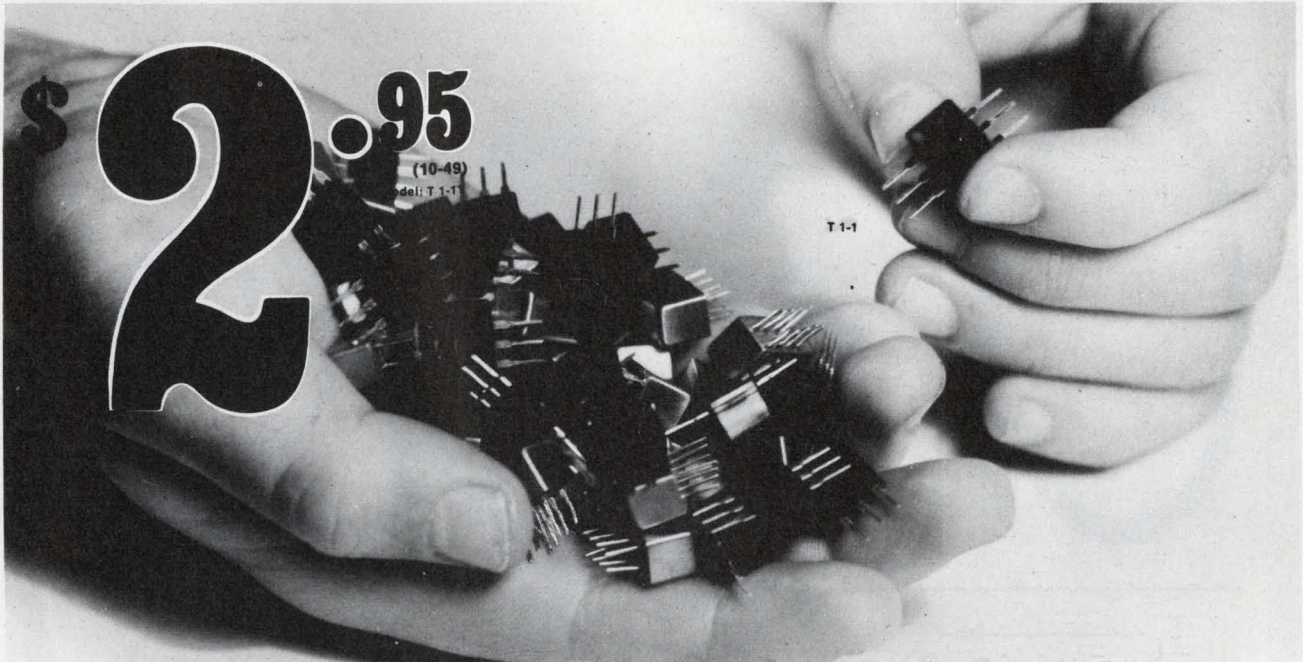
To determine the effectiveness of EMI-control, the test was repeated with the paint can lid lying on the bench (Fig. 5b). The difference speaks for itself. ■■

## Reference

1. White, Donald R. J., "EMI Control Methods and Techniques," Vol. 3, EMC Handbook series, Don White Consultants, Inc., Germantown, MD, p. 11.2.



# RF TRANSFORMERS



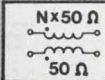
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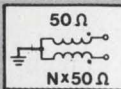
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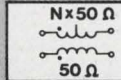
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Plastic Case	T 1-1T	T 1.5-1T	T 2.5-6T	T 4-6T	T 9-1T	T 16-1T
Freq. Range, MHz	.15-400	.1-300	.01-100	.02-200	.15-200	.3-120
Impedance Ratio	1	1.5	2.5	4	9	16
Max. Insertion Loss	MHz	MHz	MHz	MHz	MHz	MHz
3 dB	.15-400	.1-300	.01-100	.02-200	.15-200	.3-120
2 dB	.35-200	.2-150	.02-50	.05-150	.3-150	.7-80
1 dB	2-50	.5-80	.05-20	1-100	2-40	5-20
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Plastic Case	T 2-1T	T 3-1T	T 4-2T	T 8-1T	T 14-1T
Freq. Range, MHz	.015-600	.5-800	.5-600	.15-250	2-150
Impedance Ratio	2	3	4	8	14
Max. Insertion Loss	MHz	MHz	MHz	MHz	MHz
3 dB	.015-600	5-800	2-600	.15-250	2-150
2 dB	.02-400	2-400	5-500	25-200	5-100
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Plastic Case	T 1-1TT	T 2-1TT	T 2.5-6TT	T 3-1TT	T 4-1T	T 5-1TT	T 13-1TT
Freq. Range, MHz	.05-200	.07-200	.01-100	.05-250	.2-350	.3-300	.3-120
Impedance Ratio	1	2	2.5	3	4	5	13
Max. Insertion Loss	MHz	MHz	MHz	MHz	MHz	MHz	MHz
3 dB	.05-200	.07-200	.01-100	.05-250	.2-350	.3-300	.3-120
2 dB	.08-150	.1-100	.02-50	.1-200	.35-300	.6-200	.7-80
1 dB	.2-80	.5-50	.05-20	.5-70	2-100	5-100	5-20
Maximum Amplitude Unbalance MHz							
.1 dB	5-80	1-50	1-20	1-70	5-100	10-100	5-20
.5 dB	.05-200	.07-200	.01-100	.05-250	.2-350	.3-300	.3-120
Maximum Phase Unbalance Degrees MHz							
1°	5-80	1-50	1-20	1-70	5-100	10-100	5-20
5°	.05-200	.07-200	.01-100	.05-250	.2-350	.3-300	.3-120
Price (10-49)							
Model TMO	\$5.95	\$6.25	\$6.25	\$5.95	\$4.95	\$6.25	\$6.25
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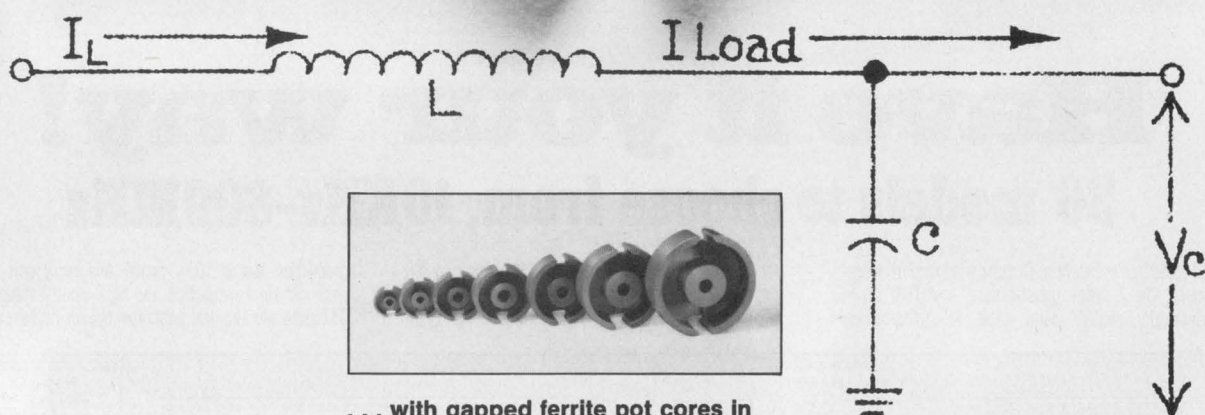
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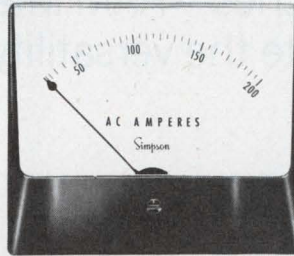
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## Microprocessor-based video games have it all over fixed-logic. Two approaches—RAM intensive and object-oriented—demonstrate the versatility of 'smart' games.

Perhaps no other application of microprocessors fires the imagination more or better demonstrates  $\mu P$  flexibility than electronic video games. Games that contain microprocessors are easier to modify than games controlled by standard logic. They also have a shorter development cycle—it consists mainly of programming. They are more reliable—fewer parts mean fewer repairs. And they are easier to maintain—problems can be fixed simply by changing ROMs or PROMs.

Video games with microprocessors can be RAM-based, display object-oriented or alphanumeric. Whatever the approach, there are five basic components: a processor, a program-memory, a timing generator, input/output accessories and special games-interface logic.

Choosing a processor depends, among other things, on cost. Normally, ultra-high speed isn't required in consumer-oriented games. Suitable processors include the Signetics 2650, Fairchild F-8, Intel 8080 and 8048, and the Zilog Z-80.

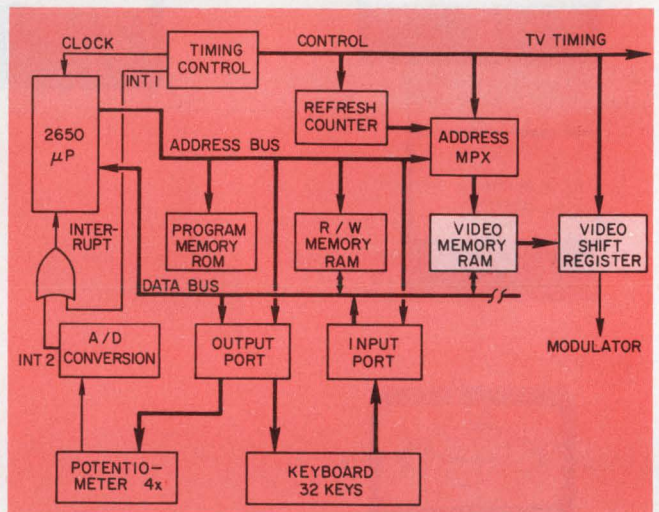
Custom processors are also available. But while their reduced logic tends to keep their cost down, they lack support, can be hard to use, and can be difficult to expand, which is especially important for systems with plug-in cartridges. And custom structures may lock out industry-standard peripherals.

The ROM cartridge holds game programs and can be changed from game to game. Access time need only be as fast as required by the processor. But the ROM has to be large enough to carry the intelligence needed for more complex games.

The  $\mu P$  system is "run" by a timing generator, which also synchronizes it with a TV.

### The memory-mapping method

In a typical RAM-intensive approach, the TV screen is divided into 128 dots horizontally and 96 dots vertically, to give a total field of 12,288 dots (Fig. 1). The hardware for the example of Fig. 1 is built around the 2650 microprocessor and 16 k bits of refresh



1. Keeping picture information in RAM is one way to design  $\mu P$ -based TV games. Here, a 16-k refresh memory loads a video register every 1.6  $\mu s$  with data representing X and Y screen coordinates.

memory, with a full picture of 128 columns and 96 rows.

The refresh memory serves as a memory map for the television picture. Sitting, in effect, between the TV set and the microprocessor system, it can be accessed by both. The refresh memory is organized as 4 k  $\times$  4 for quick access. The dot position is represented horizontally by an X coordinate and vertically by a Y coordinate.

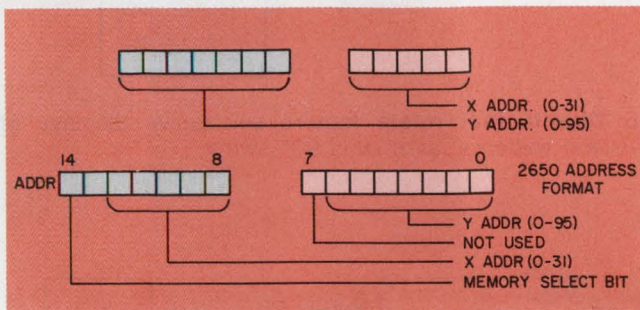
Each horizontal scan line takes 64  $\mu s$ , with a dot width of approximately 400 ns. Vertically, there are 96 dots, with three picture lines per dot. A 4-bit video shift register is loaded with data from the refresh memory every 1.6  $\mu s$  during the active picture period. These data are shifted into the TV with a 2.5-MHz clock. To change the stored picture, the  $\mu P$  can access the refresh memory in between the access required by the shift register.

All the signals necessary to access the refresh memory and form the picture on the TV screen are derived from the timing and control circuit, which also generates the 2650's clock and a program-interrupt signal that synchronizes the game every 16.67 ms.

Input/output accessories consist of a keyboard of 32 keys and four potentiometers, all read by the 2650.

Kam Li, Project Manager,  $\mu P$  TV Games, and Alex Goldberger, MOS  $\mu P$  Application Manager, Signetics Corp., 811 E. Arques Ave., Sunnyvale, CA 94086.



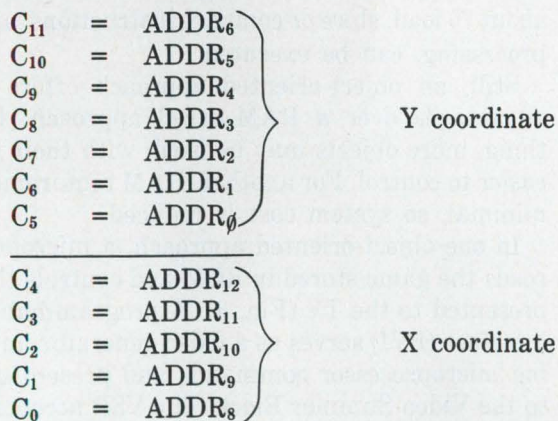


2. The 12 bits needed to address the refresh memory are divided into two ports: one for horizontal and the other for vertical information.

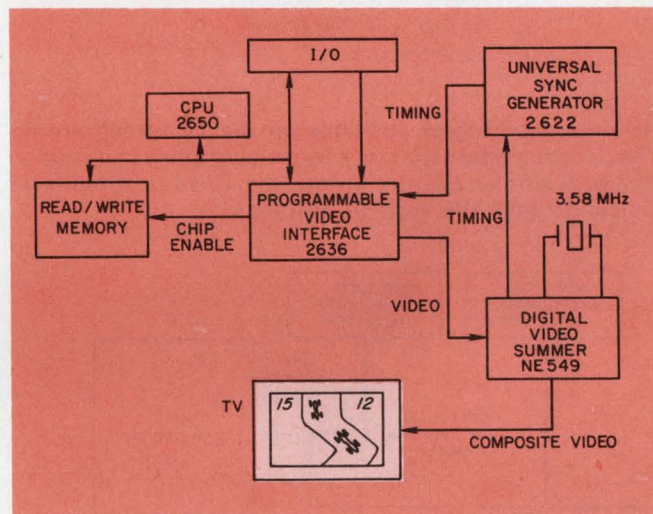
For that purpose, the keyboard is divided into four rows so that eight keys can be read at one time. The read signal also initiates an a/d conversion cycle for one of the four potentiometers. A 4-bit output port selects the potentiometer and keyboard row.

### The address format

To address 4 k of memory calls for 12 address bits, which are generated by the refresh counter ( $C_0$  to  $C_{11}$ ) and the 2650 ( $ADDR_0$  to  $ADDR_6$  and  $ADDR_8$  to  $ADDR_{12}$ ). The refresh counter and the 2650 address the refresh memory alternately through an address multiplexer. The address of the refresh counter is divided into horizontal and vertical (X,Y) addresses, to give the following address format (Fig. 2):



The 2650 uses one address bit,  $ADDR_{14}$ , to distinguish between accesses to the video refresh RAM



3. Another approach to video games can be termed "object-oriented," rather than "dot" oriented. In the former method, the object-shape information is stored in a RAM, rather than the entire screen image, which saves on over-all cost.

and those for the scratchpad RAM used for normal program execution.

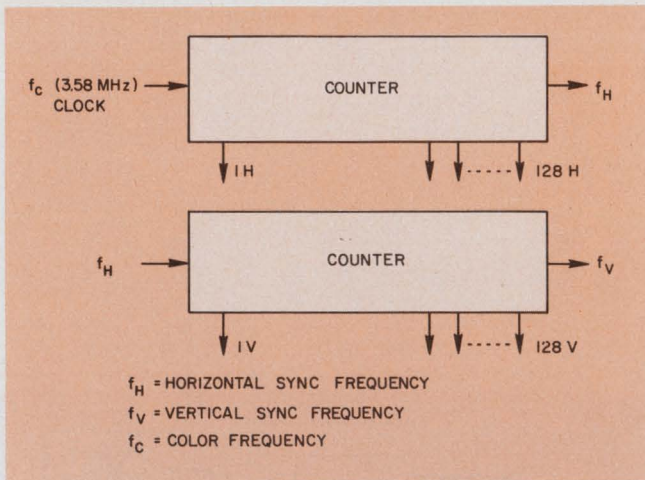
### Timing and control

The most important game-control signal, the game-synchronization pulse, functions as an interrupt,  $INT_1$ , for the 2650  $\mu P$ . Motion can be generated by the software, with this interrupt serving as a time reference. A program sequence starts when an  $INT_1$  is received. All program functions are then carried out.

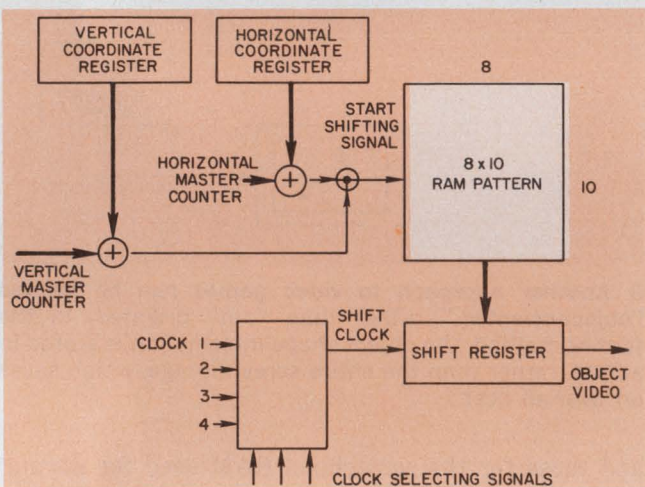
Programming is simplified if all the program functions can be executed between two program-synchronization interrupts, or within 16.67 ms. If exceeded, position changes of moving objects must occur in every other field, and motion can become jerky.

Other program-control signals include those for the 32 keys and four potentiometers. To select one keyboard row and one potentiometer, a 4-bit latch simultaneously enables the keys selected and one of the potentiometers. Port C of the 2650 (WRTC command) latches the vector (four bits of data). At the same time, a one-shot is triggered. The resulting pulse width depends on the value of the potentiometer selected.





4. Horizontal object positions on the TV screen are derived from a 3.58-MHz clock by dividing down in a counter chain. A similar counter divides the TV's horizontal sync pulses to give the vertical positions.

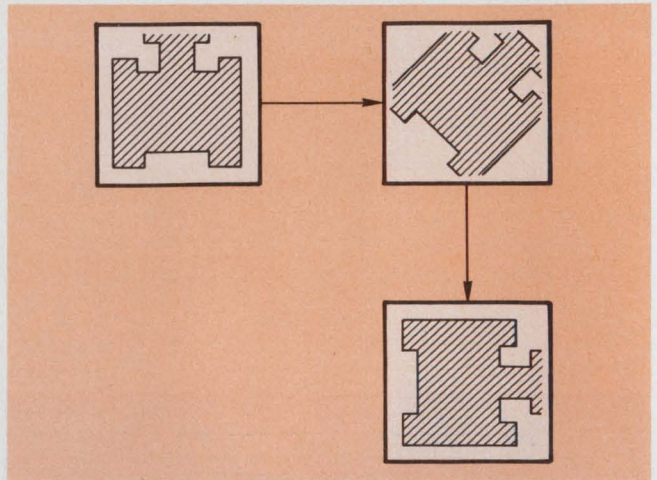


5. Size and location of the picture objects are determined in an object module, four of which make up a programmable video interface. Object descriptions are held in 8 X 10-bit RAM patterns.

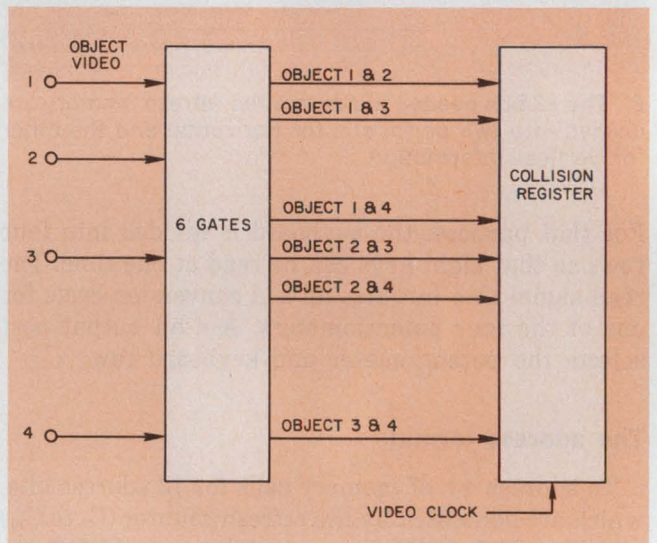
The falling edge of the one-shot pulse generates a second interrupt,  $INT_2$ .

The time between selecting the potentiometer and the falling edge of the one-shot ( $INT_2$ ) is a measure of the potentiometer position, and can be determined under software control, thus performing an a/d conversion. Meanwhile, keyboard rows can be read. To perform various programming sequences or game events, the potentiometer can program analog variations in the game, while the keyboard provides game commands.

The potentiometers and keys are ready every 16.67 ms and take about 3.6 ms max to read and perform a/d conversion. The remaining 13 ms are used for interpreting the keyboard and potentiometer, calculating actions and—as a result—modifying the refresh memory. Only during the 1.6-ms frame-blank period



6. Objects that rotate require successive displays of several patterns, as in this 90° swing.



7. Objects that collide are detected with logic gates. To "combine" any two objects out of four requires six gates. Collision data are stored in a register read by the  $\mu P$ .

is the mapped memory changed. During this interval, about 70 load, store or compare instructions, and their processing, can be executed.

Still, an object-oriented approach offers several advantages over a RAM-based approach. For one thing, more objects may be used, with their motions easier to control. For another, RAM requirements are minimal, so system cost is reduced.

In one object-oriented approach, a microprocessor reads the game stored in ROM and controls the video presented to the TV (Fig. 3). A programmable video interface (PVI) serves as a video generator, interpreting microprocessor commands and presenting video to the Video Summer Block. The VSB accepts digital video signals from the object block and generates either rf for a standard TV receiver or color-composite video for a TV monitor. A master timing generator



controls all four blocks.

The microprocessor communicates with the PVI over address and data buses. Basically, the PVI looks like part of the memory field to the 2650, which writes data into the PVI RAM field. The RAM stores object shapes, screen coordinates, colors and control information.

In turn, the PVI generates video signals that reflect the information stored in its control field. It also presents the 2650 with I/O and status information (e.g., object collisions) by writing the data into internal registers. The  $\mu$ P can then read the I/O and status information data from the registers and make decisions about game actions.

### Setting up the timing

All timing circuits are generated from a 3.58-MHz clock by a Universal Sync Chip, which provides the various timings for the TV's vertical and horizontal oscillators. It also provides sub-multiples of the clock for more complex signals—those bearing a synchronous relationship to the movements of the electron beam.

A horizontal counter chain divides the frequency of the clock into positions 1H, 2H, 4H. . .128H (Fig. 4). A vertical counter chain is identical except that it counts horizontal sync pulses rather than 3.58-MHz clock pulses. A divider chain gives sub-multiples of vertical positions—1V, 2V, 4V. . .128V.

Four object modules comprise the PVI (Fig. 5), with each object module consisting of a pair of coordinate registers that specify where a particular object is to be shifted out. In addition, each object is described by a RAM pattern of  $8 \times 10$  bits. A set of master counters and vertical and horizontal counters is available from the sync block to locate the electron beam at a given instant. When the coordinate registers match the master counters, the object pattern is shifted out.

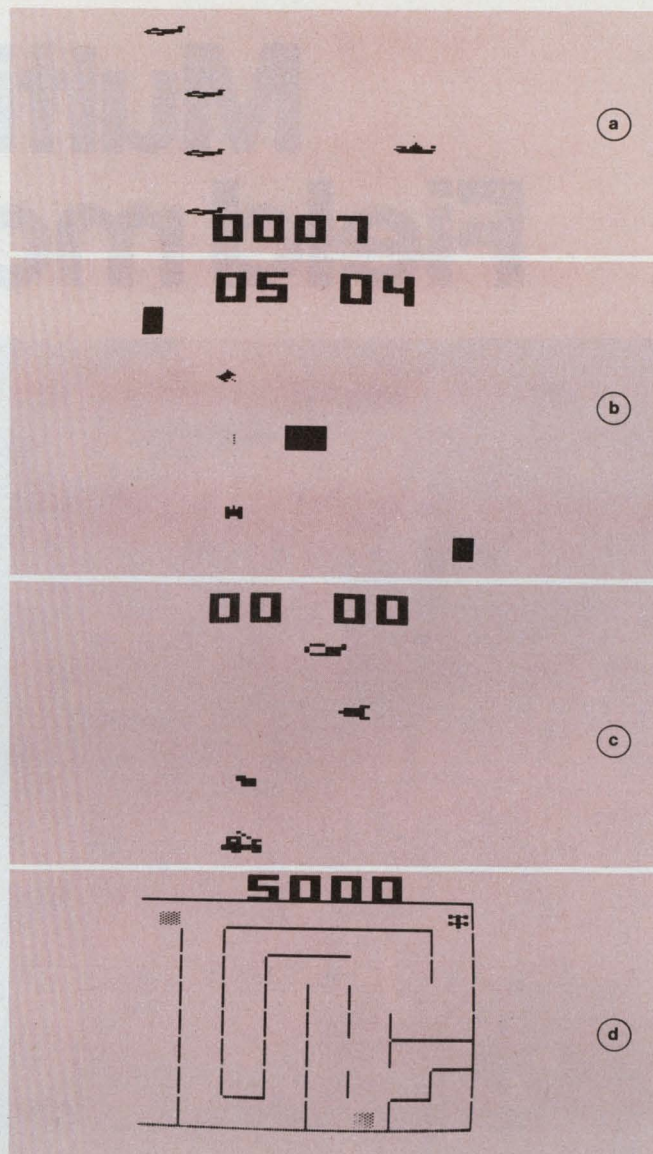
Object size depends on the program-controlled shift rate. Resolution depends on pattern size. Better resolution can be "painted" by a smaller pattern.

Objects are made to move by programming the microprocessor to change the object coordinate-register pair. Vertical motion occurs by incrementing or decrementing the vertical-coordinate register, and horizontal motion by incrementing or decrementing the horizontal-coordinate. In this way, two degrees of freedom are available for each object.

### More complex games

Other motions, such as rotation, require more complex programming. For example, a rotating automobile will require several object patterns at different angles. A  $90^\circ$  rotation will need successive displays of several patterns (Fig. 6).

Colliding objects can be detected by hardware (Fig.



8. The versatility of object-oriented games is demonstrated by the variety at the designer's disposal—from jet planes strafing warships (a) to tank battles (b), bombing games (c), and road races (d).

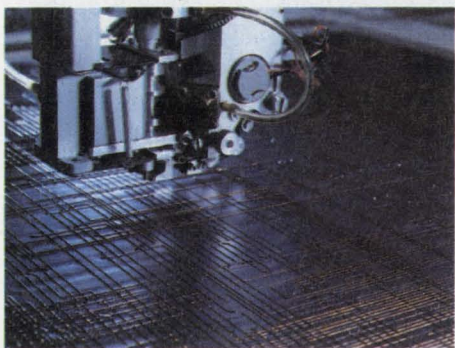
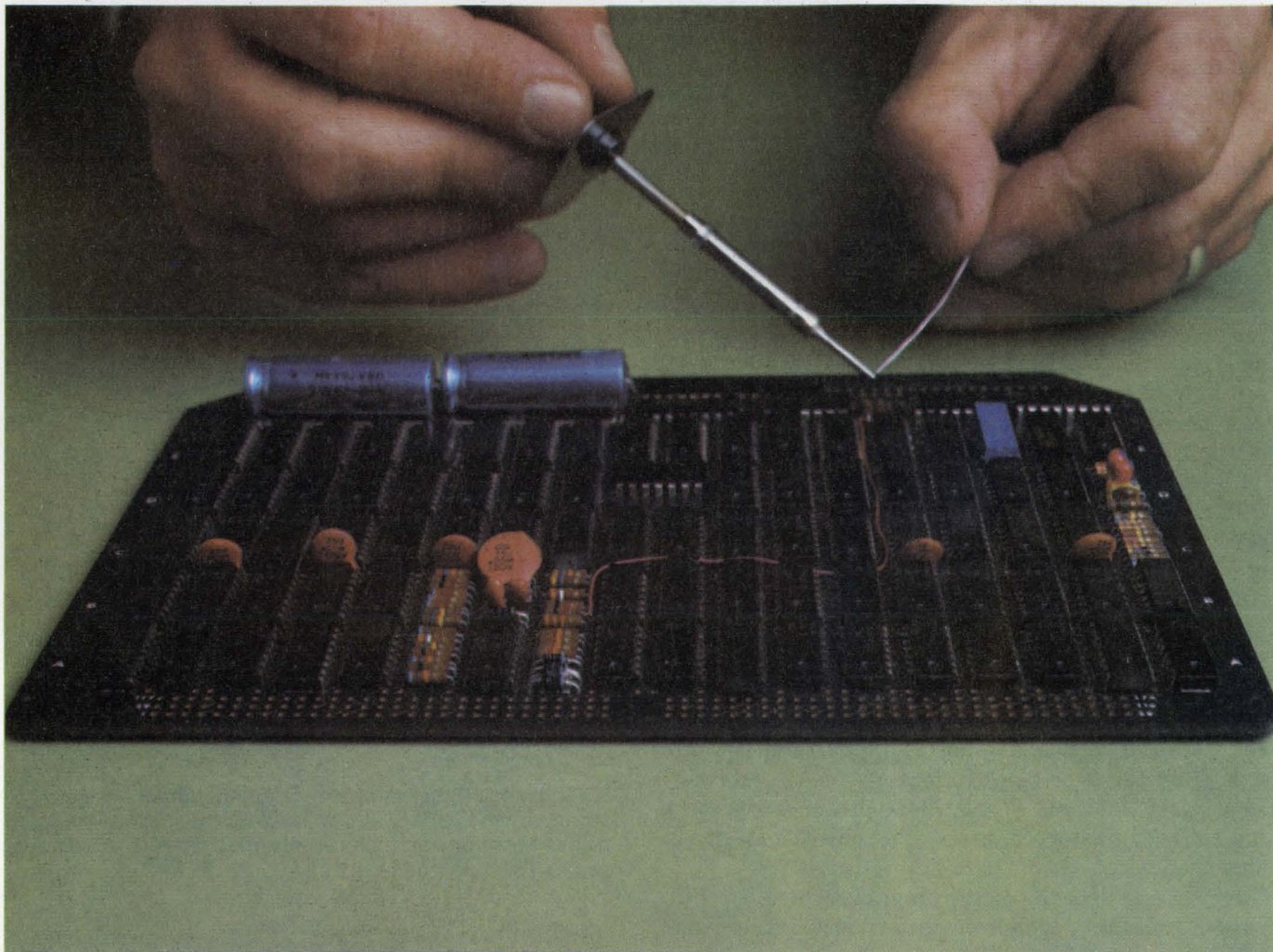
7). Four object video signals indicate the presence of each object. To detect all collisions takes 6 gates.

The PVI's digital output is interfaced with a TV receiver by the Video Summer, a single chip. The 16-pin device accepts a binary code (color), along with sync, blanking, and burst information from the PVI and universal synchronizing chip. The IC then provides a 16-color composite video signal (including black and white) that interfaces directly with the rf modulator and is connected into the terminals of a standard TV receiver. (Sound is external to the TV.) Examples of video pictures of games using the object-oriented approach are shown in Fig. 8.

PVIs can also be concatenated in parallel to show more objects. This approach is particularly useful in coin-operated games, where turnaround time must be faster than for home games. ■■



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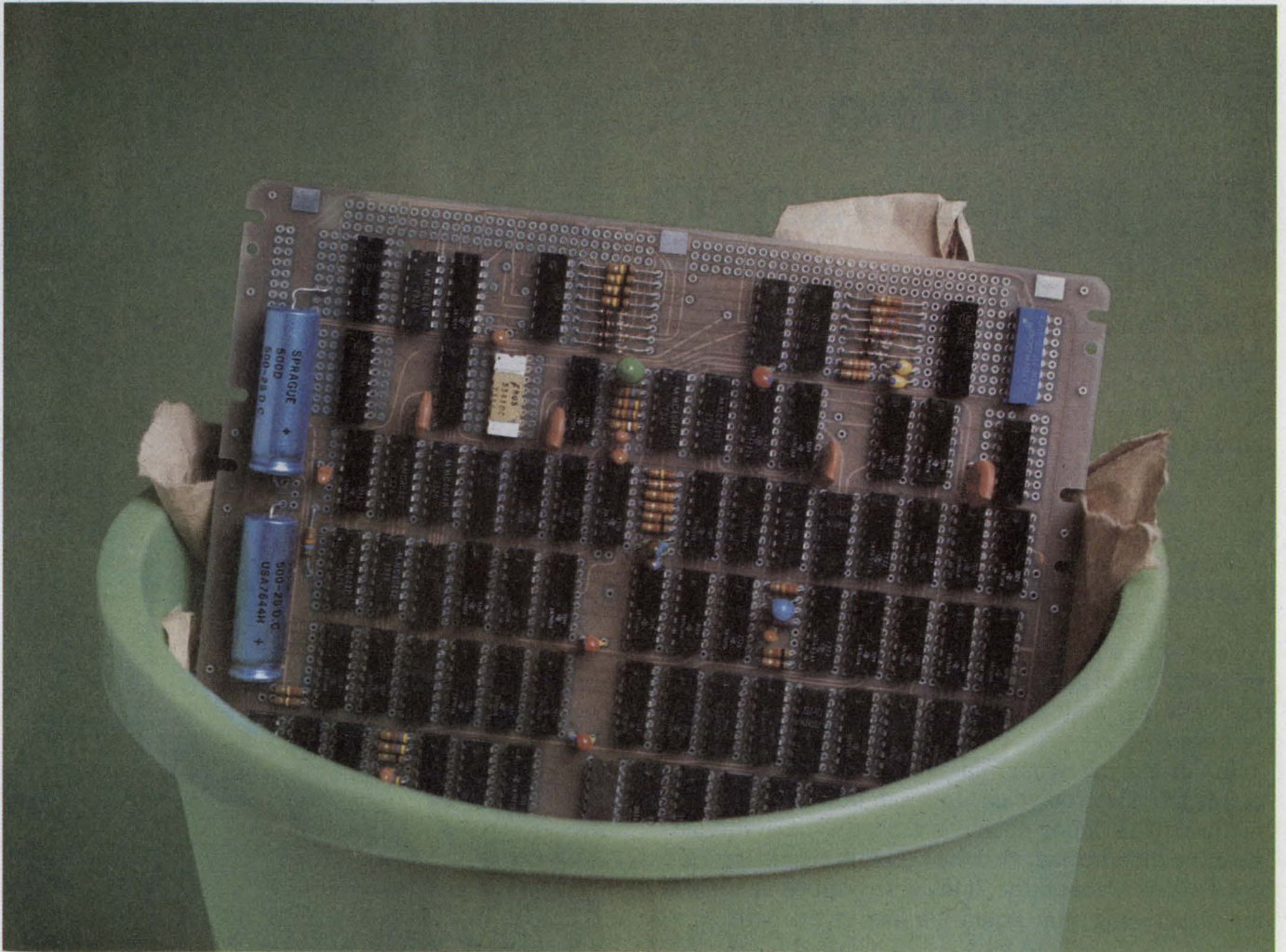
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CIRCLE NUMBER 52



# Mal Northrup of Rockwell

## Speaks On Building Program Managers

Good program managers aren't born, they're trained. And one of the best sources of these managers are your own engineers. Their background and experience enables them to segment problems into manageable tasks. So they can put together individual solutions that represent the larger solution. And in any program you have to solve a series of problems before a program can be successfully concluded.

What are the main differences between a project engineer and a program manager?

For one thing, the project engineer is more concerned with a specific element of a system, while the program manager is more involved with the total business as well as technical portions of a large program.

In preparing your engineer for the program manager's slot you've got to teach him to see the big picture. He's going to have a vastly different perspective than he had when he was a line engineer. He's got to know about the total cost requirements and manufacturing limitations he has to live with.

**He's got to be taught to take an active interest in all phases of design, not just that little subsystem he's been working on for a year and a half.**

You've got to get him to understand the cost restraints on his design. He should know that there's no sense in designing a box too big for the market requirements or, as in our case, a chip that is larger than our competitors offer. That's certainly another key responsibility of your future program manager—to understand what the competition is doing.

Your future program manager should know that a unique product with some technical leverage and a 10 to 20% cost advantage might have a market life of three years. However, two months later a com-



petitor may be on-line with a product that is 25% under your cost. It doesn't matter whether it's a component or a large system, whether it's a capacitor or telephone switching computer. The same competitive pressures are there.

Cost estimating a project is one of the key responsibilities of your program manager. He must see that his projects don't overrun. This is one area for which he is best qualified, since he has had to be cost-conscious since he started working in industry. As an



engineer he had to determine how much time and expense it was going to involve doing the whole job or just a portion. As program manager, he no longer will have hands-on relationship to the project; he's not going to select the individual components that make up the product. Instead, he's going to have to rely on the estimates of others for the total project cost.

Your engineer needs to know that as program manager he's going to have to interface with a variety of customers who in many cases may be technically naive. A customer may be a neophyte in a particular area of electronics. His engineering requirements may be conveyed on the back of an envelope. He may draw a picture and scribble a few words of what it is he'd like done. In fact, you might remind your budding program manager that that's just the way the early calculators were designed: "I want a 4-function machine that adds, subtracts, multiplies and divides, and I'd like it to have batteries that last a certain amount of time. And it should look nice." Bidding on a project like that is far different from receiving a finished specification from a customer.

**Your program manager has to be able to recognize what he needs to do the job. He has to be able to say to the customer: "I don't have enough information. Tell me what you need."**

As a program manager, your engineer has got to remain objectively analytical in looking at the customer's needs. That doesn't mean that he cannot stand up and say, "Wait! I must have a better definition of what you want, what your environmental specs are, what your output requirements are." But he has to do this in an objective way. Not as an adversary.

Finally, he must make his customer aware of any problems that might delay his project or might affect the final design. His customer must be made aware of progress and delays. It's not always going to make him happy, but it's better than a surprise.

In preparing your engineer for a program management slot, teach him to avoid confrontation techniques. In getting his message across, he must have a story, a plan, facts and figures. If he recommends a product change, he has got to have backup data available. What will the impact be on scheduling? Frequently he'll be frustrated because the program will not change direction.

In all my years as an engineer manager, I found that one of the best tools I had was the ability to present complex data in graphical or pictorial form.

Your program manager can't waste time trying to explain or manipulate data. Teach him to find a way to graphically plot the data so that it's visible and readily understandable to everyone, whether it's to the customer, head of engineering operations or vice president of sales. An exploded pictorial drawing, for

example, may show labor times and dollars associated with each of the various product elements—assemblies, subassemblies, packaging, wirebonding, and so on. Because of his training and analytical approach, your engineer has a natural ability to break down these program factors into meaningful chunks that people can understand. By teaching your engineer properly to employ the graphical-presentation method, when he gets to be a program manager he can use it to recognize trend data immediately. It's going to be the key to his success.

**A key point to impress upon your engineer is that while he may have been completely at home in the development phase of a project—as program manager he just won't have direct technical and management control.**

Frequently, nobody is going to report to him directly, yet he will have ultimate responsibility for the outcome of the program. He may have to figure out how to redirect a program that isn't meeting requirements.

Your program manager will often have full accountability for the profit-and-loss performance of the program. To achieve this he will interface with different departments within the company.

He's got responsibility, but only indirect authority. What this means is that your program manager must be able to achieve results through others—the real key to professional management.

The quickest way to assure a product failure is to stick your engineer into a cubby hole where he simply passes his work across the transom to someone in manufacturing. Get your prospective program manager involved in the total manufacturing process.

It's okay to design a component or system, say, in the privacy of an office, but it's another thing to get it on the production line and get working products of hundreds and thousands or more. It may be simple to build one prototype but it's far different building even ten by people who don't have the gut-care level that your engineers have in that design.

Get him to spend some time in production control and industrial engineering. You can be sure they will explain to him that his "perfect" design is not necessarily built in the way he intended. Make him aware of what the limitations of the factory are.

If your manager is lucky enough to have a high dollar impact on shipments, he may get favored treatment. If not, he has to be aware of this and be able to tell what the scheduling requirements are in the factory. He has to be able to know quickly when he needs additional support from engineering to solve problems in the factory.

As program manager he cannot simply pass off a project to production but must insure that what he gives production is fully characterized and will meet all the test requirements with margin to spare. He



## Who is Mal Northrup?

When discussing his education, Malcolm Northrup points out that he was something of a prodigy. "It took me nine years to get a four-year physics degree."

Northrup's educational time-machine started in 1958 when he quit school during his first year at California's San Jose State and joined Ampex in Redwood City as a draftsman. "Working looked like more fun than college at the time," he reminisces. He quickly found out that he had made his first career mistake and began taking night classes at Santa Monica City College. Meanwhile, he moved ahead at Ampex as designer of magnetic tape peripherals and in 1962 was recruited by Collins Radio in Cedar Rapids, IA to design magnetic-tape equipment. During the next four years, he attended Coe College in Cedar Rapids, concentrating on physics while working full time for Collins. He had completed all the technical requirements for his degree when he was transferred to Collins' Computer Systems Division in Dallas in 1966. Working full-time as a mechanical engineer on the company's disc-file project and on the DC-10 flight-data storage project, Northrup also took on a full load at Southern Methodist University in Dallas. He finally won his B.S. in Physics with honors the following year, when he was 31.

"It's a tough way to get your degree," Northrup says, "but it did have the advantage of keeping me current in technology, something that is often difficult for a working engineer to achieve."

In 1970, Northrup became mechanical engineering group manager—Disc and Tape. In 1971, two years before Collins became part of Rockwell International—a company that grossed about \$5 billion in 1976—Northrup moved to the Microwave Division in Dallas, serving first as mechanical group manager and later as department manager, Mechanical Design and Product Documentation. In February of this year, Northrup was appointed vice president, Micro-electronic Devices in Rockwell's newly formed Electronic Devices Division.

Northrup lives in Mission Viejo, CA with his wife, Jan, and two of his five children; Amy, 6, and Christian, 8. He enjoys building his own furniture. "It's so malleable, not like metal. And it's a tremendous frustration release." He's currently refinishing an old wooden icebox which he bought in Dallas for about \$100. "It would cost about \$800 unrestored around here," he says.

For Northrup, on-going education is still a preoccupation. His own interests are now in advanced-management courses and seminars. He also works to encourage his people constantly to update their education through night or company courses. "Three days after joining Ampex, I knew a lot about the importance of education and during the years I worked on my degree, I learned that new ideas and thinking—as well as knowledge—were what make work fun," he says.

must be trusted in the factory. If a problem comes up they know they can go back to him and work on the problem until it's solved.

### **Your engineer as a program manager must demand more in the area of product testing.**

Looking back to when I was a design-engineer, I remember the most satisfying part of my work was to create the raw design. This said I've got a way to solve a particular problem. And probably one of the least palatable parts of the job was to sit down and wring out the design model and figure out whether it had margin in all the areas in which it's supposed to have margin—a tough job. In-depth product testing is a prime responsibility of the program manager, as well as the engineer.

A man who had a great deal to do with influencing my thoughts on engineering once told me that you have two responsibilities as an engineer. One is that you must first prove that your product or idea can work. Then you have to prove that it can't fail.

In today's world of product liability this philosophy becomes a burning issue in every business. Teach your

program manager to make darn sure that what comes out of the factory isn't going to be sent back by the customer. Or worse, that it will need to be serviced on the customer's facility or in his system.

The engineer who understands the total perspective of what his job is—which is to bring a product out of the factory and have it delivered to his customers with a minimum number of problems and maximum reliability—is the guy who, when he's program manager, is going to be able to deal with those problems very quickly. He's going to understand where the holdups are; he'll be able to read the signs very early.

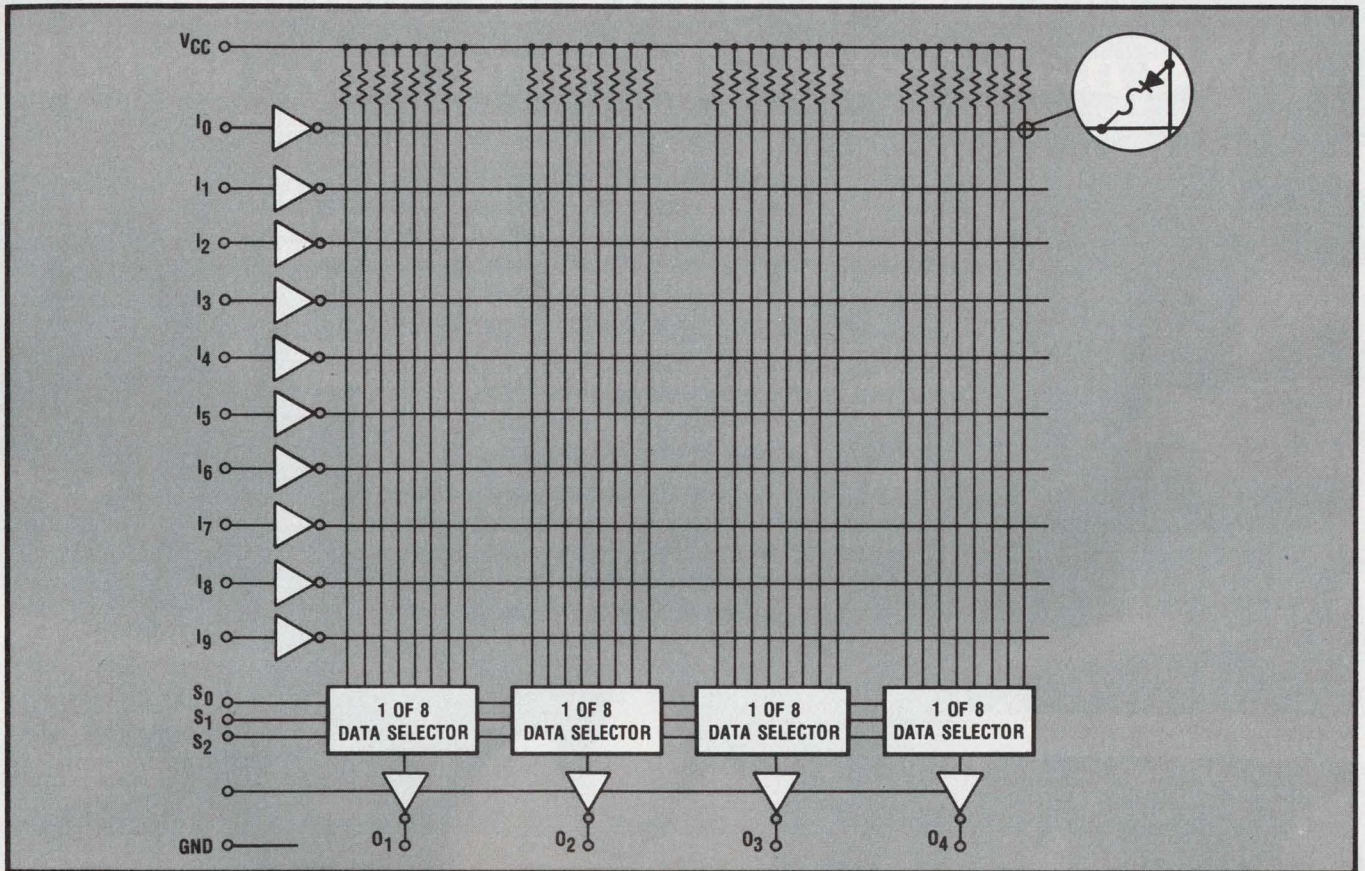
Finally, get your engineer more involved in the marketing aspects of your company's business. Engineering says what can be made and is concerned about the product performance. Marketing on the other hand, is concerned as to whether or not the product can be sold. These views aren't necessarily compatible.

The isolation between marketing and engineering these days is far less than what it was 10 years ago. Today, marketing people don't feel any compulsion to stay away from engineering when they feel they have a customer input relating to an aspect of product design. The program manager avoids these inputs only at his own peril. ■■



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# Ideas for design

## Game timer generates coasting pulses positively clamped to prevent a glitch

The Idea for Design, "Timer Pulses Coasting to a Stop Heighten Electronic Game Realism" (ED No. 5, March 1, 1977, p. 78), has proved useful to many readers. But the circuit has one operational handicap that may prove annoying—and costly. Just when you think the oscillator has finally stopped, the timer pulses once more. However, a second 555 (or the second half of a 556) can provide a positive fix (see figure).

Pressing and releasing switch  $S_1$  charges a low-leakage capacitor,  $C$ , which in turn supplies charge to another smaller low-leakage capacitor,  $C_1$ , at an ever-decreasing rate. Thus, the frequency of  $IC_1$ 's output diminishes gradually. When  $C$  can no longer supply enough charge to recharge  $C_1$  to  $\frac{2}{3} V_{CC}$ , the trip level of the 555's internal comparator, oscillations cease with the output of  $IC_1$  remaining HIGH.

When  $S_1$  is released, timer  $IC_2$ , which is configured

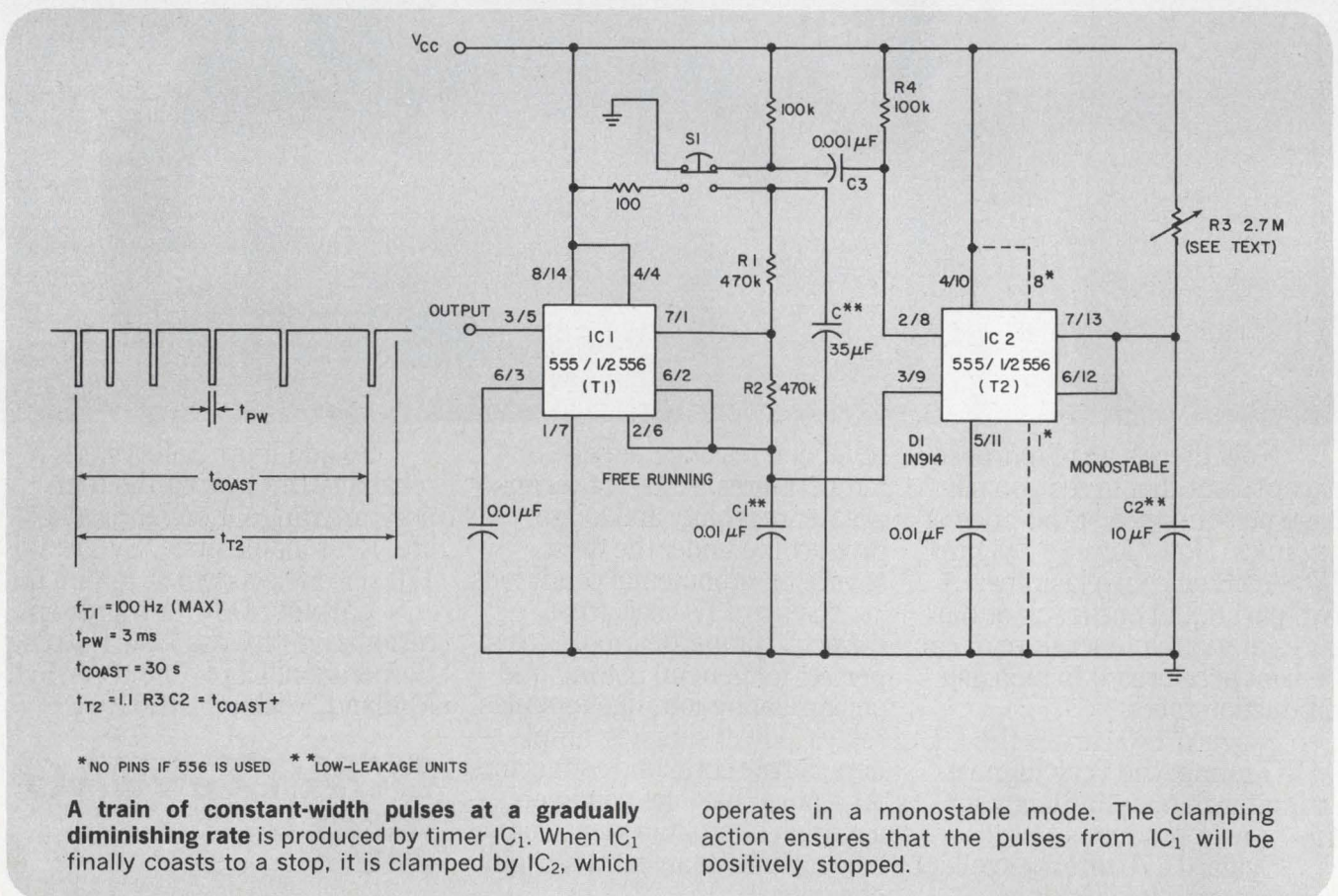
as a monostable, is triggered through differentiator  $R_4C_3$ . Its output remains HIGH for time  $t_{T2}$ , which is slightly greater than the desired coast time,  $t_{COAST}$ , of  $IC_1$ . The output of  $IC_2$  (pin 3/9) couples via  $D_1$  to timing capacitor  $C_1$ .

When  $IC_2$  times out, its output goes LOW and clamps  $C_1$  to a value less than  $\frac{2}{3} V_{CC}$ . This clamping action positively inhibits timer  $IC_1$ , whose output remains HIGH until it is again triggered by  $S_1$ .

With capacitor  $C_2$  equal to  $10 \mu F$ ,  $R_3$  should be set to about  $2.7 M\Omega$  for  $t_{T2}$  to slightly exceed a  $t_{COAST}$  of 30 s. Timer  $IC_1$  supplies 3-ms pulses over the entire 30-s coast period with the values shown in the figure.

*William D. Kraengel, Jr., Electrical Engineer, Ground Systems Equipment Corp., 65 Sunset Rd., Valley Stream, NY 11580.*

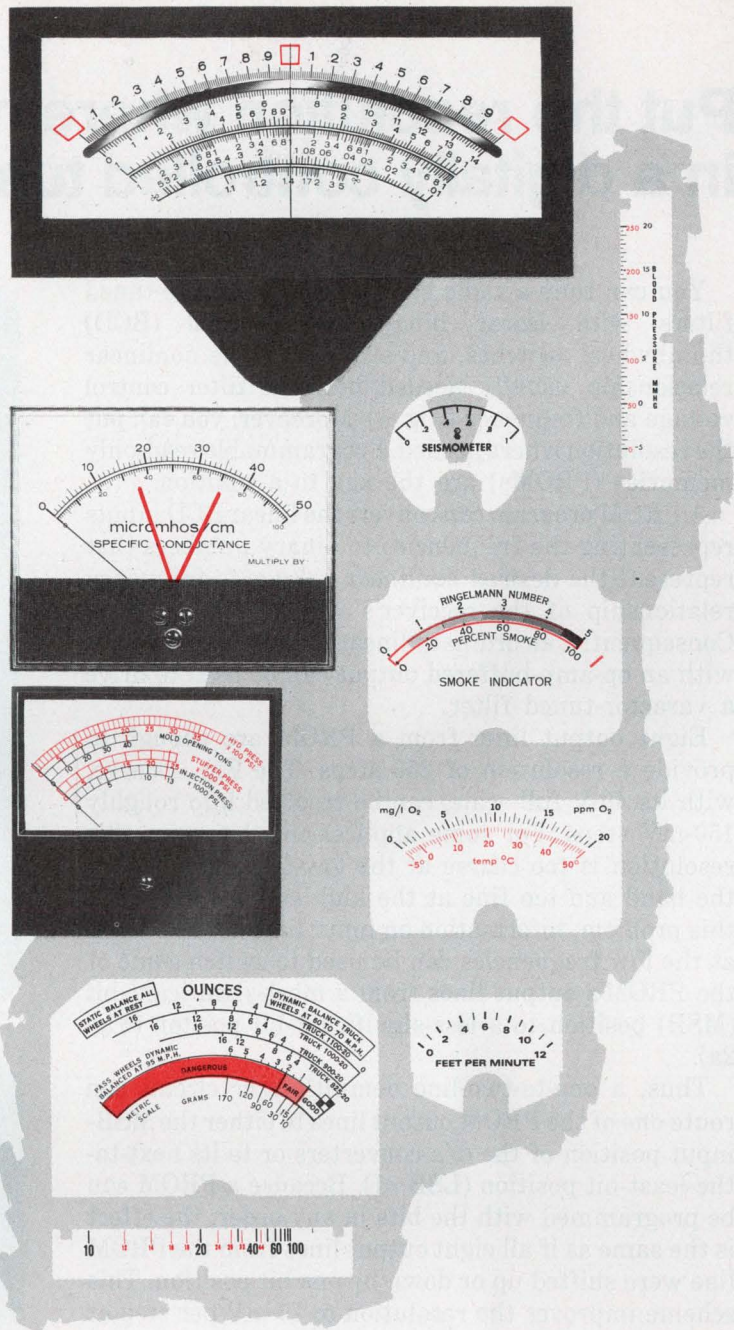
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# Put the resolution where needed in a digitally controlled tuning system

You can tune a radio receiver using voltage-tuned filters with linear binary-coded-decimal (BCD) thumbwheel switches, and still obtain the nonlinear relationship usually needed between filter control voltage and frequency (Fig. 1). Moreover, you can put the resolution where needed. Programmable read-only memories (PROMs) are the key to a solution.

A PROM program can convert the linear BCD inputs representing the frequencies to binary numbers that represent the desired nonlinear voltage-to-frequency relationship of the receiver's voltage-tuned filters. Consequently, an ordinary linear binary d/a converter with an op-amp-buffered output can be used to drive a varactor-tuned filter.

Eight output lines from a PROM are enough to provide a resolution of 256 steps. The Fig. 1 curve, with its 40-V full scale, can be resolved into roughly 150-mV steps. For some applications, however, this resolution is too coarse at the low-frequency end of the band and too fine at the high end. To overcome this problem, information on input lines to the PROM at the low frequencies can be used to switch some of the PROM's output lines from a most-significant-bit (MSB) position to a less-significant-bit position (Fig. 2a).

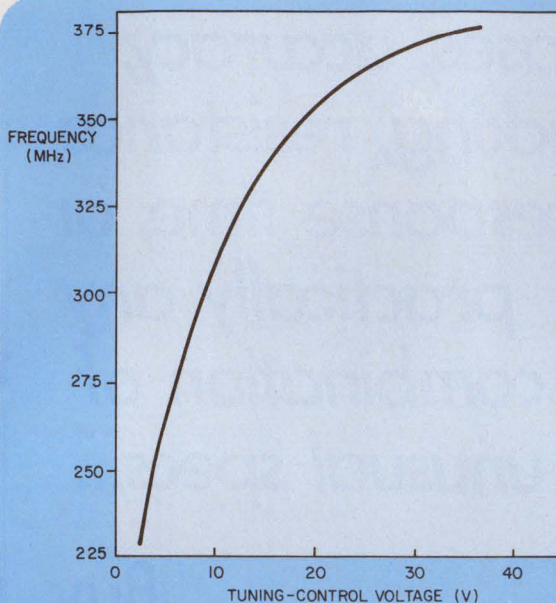
Thus, a one-to-two-line demultiplexer circuit can route one of the PROM output lines to either the MSB-input position of the d/a converters or to its next-to-the-least-bit position (LSB+1). Because a PROM can be programmed with the bits in any order, the effect is the same as if all eight output lines from the PROM line were shifted up or down by one bit position. This scheme improves the resolution to 75 mV per step at the low-frequency end (from 225 to 299 MHz in Fig. 1), but leaves the resolution unaffected at the high-frequency end (above 300 MHz).

Fig. 2b extends the technique by rerouting two PROM output lines, A and B. Since neither the MSB nor the MSB-1 bits in the example of Fig. 1 are used from 225 to 299 MHz, both PROM lines are switched to the LSB+1 and LSB positions, respectively, of the d/a converter in this frequency range. In addition, since the MSB is not used between 300 and 339 MHz, only the MSB-1 is switched to the LSB position.

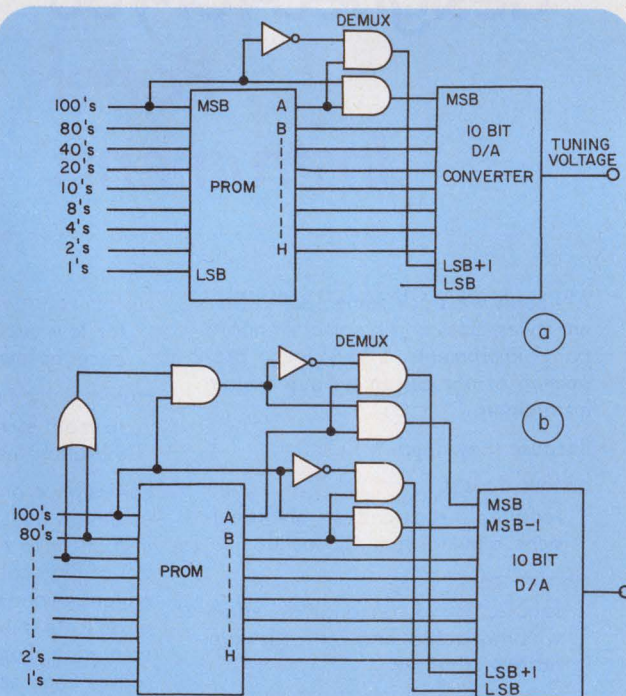
Thus this two-bit demultiplexing scheme provides a resolution of 37 mV from 225 to 299 MHz, 75 mV from 300 to 339 MHz and 150 mV from 340 to 399 MHz.

Carl Andren, Senior Principal Engineer, E-Systems, Inc., 1501 72 St. N., P.O. Box 12248, St. Petersburg, FL 33733.

CIRCLE NO. 312



1. Most voltage-tuned receivers have a nonlinear relationship between the control voltage and tuning filter's frequency.



2. Unused low-order (LSB) input bits to the d/a converter are used at the low frequency end of the range, where they are needed to improve the resolution. Either one bit (a) or two bits (b) are multiplexed in this way to enhance resolution.



# The Complete Solution to your F3870 and F8 Design-In Problems

## The Formulator Development System

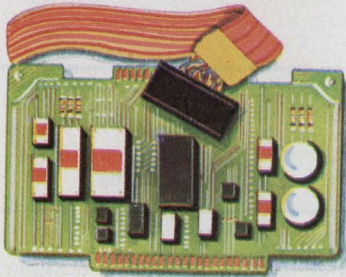


The Formulator family is designed to allow easy, efficient software development and real time hardware simulation of F8 or F3870 based systems. It is supported by a complete line of functional modules including memory, I/O and simulation cards that plug directly into the Formulator cardframe.

The Formulator can, itself, be used as the system breadboard. It provides microprocessor hardware, plus card slots for breadboarding your system. Thus the entire system may reside within the Formulator or in a combination of external and internal configurations.

## In-Circuit Emulation

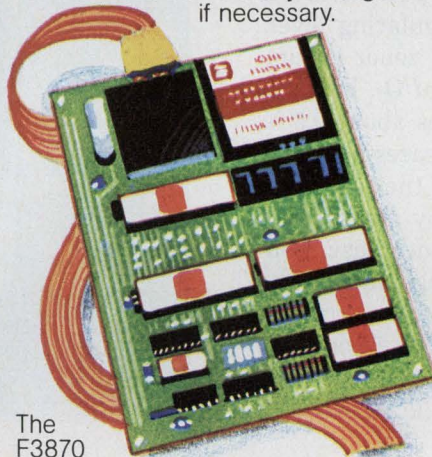
To develop, test and debug F8 and F3870 based products, Fairchild offers simulation options that extend the functional features of the micro-



processor from the Formulator to the 40-pin socket on your breadboard. This allows complete ROM firmware development, real-time symbolic debugging of your breadboard and freezing of ROM codes during the breadboard stage.

## PROM Prototypes

The 3870 Emulator is a PROM-based substitute for the F3870 microprocessor. The Emulator measures 5" x 7" and contains two 2708 or 2716 EROMs in place of the F3870 so ROM codes can be verified and easily changed if necessary.



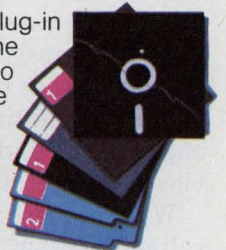
The F3870 Emulator plugs directly into the F3870 40-pin socket in the production prototype via a short cable.

## Powerful and Complete Software

The software consists of an operating system, utility programs and diagnostic routines; a monitor, text editor, assembler and debug package. It includes linking loader and relocating assembler and will operate in interactive or batch mode. The result is an easy to use, reliable, fast and extremely efficient capability for microprocessor based system development.

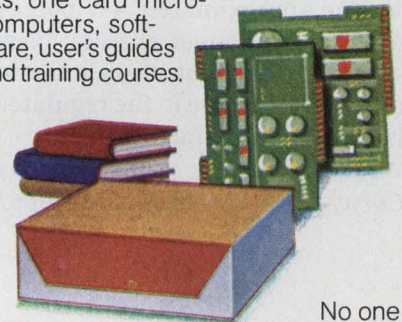
## The Formulator-Floppy Disk Marriage

An inexpensive plug-in module interfaces the Formulator with up to four plug-compatible ICOM Floppy Disc Drives, providing over one megabyte of storage. If you prefer other Floppies an application note provides the information necessary to modify Drivers for your system.



## And That Isn't All

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## Ideas for design

# Electronic car-alternator regulator built with low-cost discrete components

Unlike the car-alternator regulator described in the Idea for Design, ED No. 15, July 19, 1977, p. 100, here's one that uses just three discrete transistors and a few other low-cost parts—much less than the \$30 you'd have to shell out for a commercial unit. The circuit may be assembled on a small bracket with the power transistor's case directly grounded (see figure).

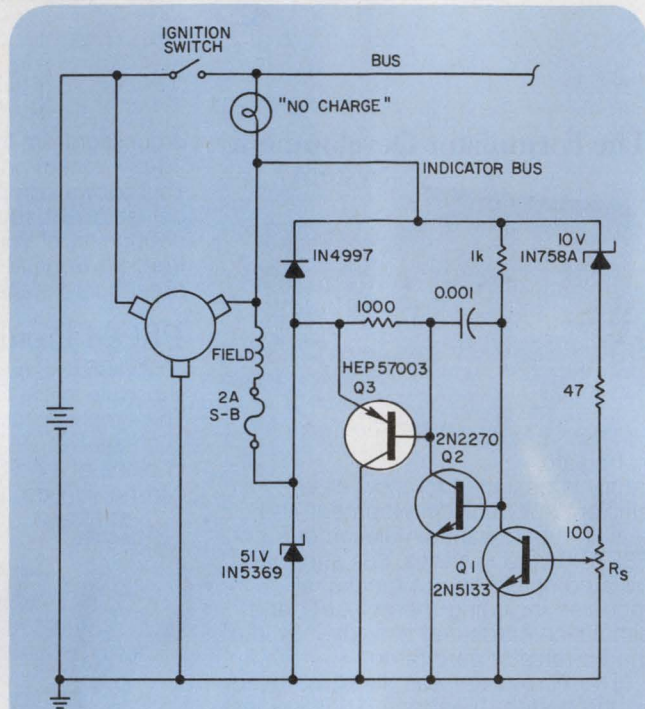
Power transistor  $Q_3$  is in an emitter-follower configuration that drives the alternator's field. Both  $Q_3$  and  $Q_2$  are initially on when the key is on and the engine isn't running. Field current at this time flows via the "idiot" light from the battery.

When the engine is running and the indicator-bus voltage rises sufficiently to cause the 10-V zener diode to conduct,  $Q_1$  turns on, which turns  $Q_2$  and  $Q_3$  off. Transistor  $Q_1$ 's on threshold is set by potentiometer  $R_s$ , which determines the circuit's regulating level.

Temperature sensitivity of the 10-V zener is compensated by the base-to-emitter drop of  $Q_1$ . From 23 to  $-40$  C, the zener's voltage decreases about 0.5 V, while  $Q_1$ 's base-to-emitter voltage increases about 0.1 V. The approximately 4-V potential at the top of the 47- $\Omega$  resistor must thereby increase by about 0.6 V—which more than cancels the zener's decrease. Usually, the 0.1-V rise in the regulated voltage that results is entirely satisfactory.

*K. C. Herrick, Chief Engineer, ESI Electronics Corp., 1258 Fitzgerald Ave., San Francisco, CA 94124.*

CIRCLE NO. 313



The power-transistor case can be directly grounded in this simple car-alternator regulator circuit.

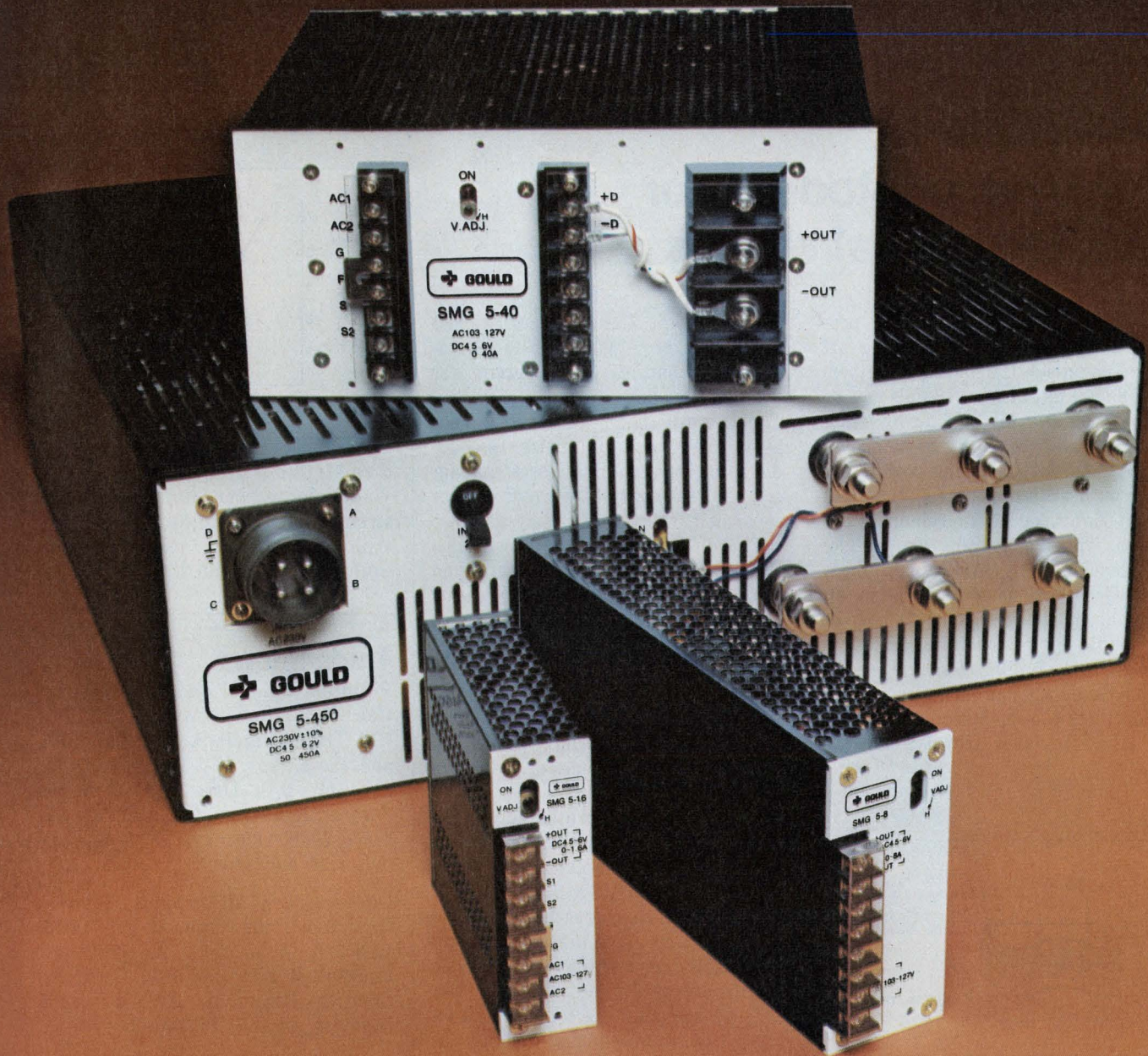
### IFD Winner of August 2, 1977

**Durward Priebe**, Principal Engineer, R&D Laboratory, Hewlett-Packard, 5301 Stevens Creek Blvd., Santa Clara, CA 95050. His idea "Reduce Ground-Loop Problems in Safety-grounded Instruments" has been voted the Most Valuable of Issue Award.

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## Epitaxial photodetector catches optical signals

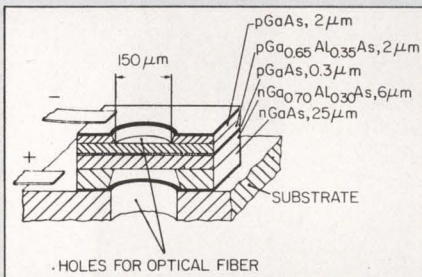
A transparent photodetector provides a simple means of picking off optical signals in the middle of a fiber-optic data link. In fact, signals can be picked off more easily than by using an optical branching unit or by breaking a fiber and inserting a detector along with an amplifier for driving a second light source to relaunch the signals. The transparent photodetector, developed by AEG-Telefunken, West Germany, is a diode with an epitaxial structure similar to that of the double-heterostructure configuration used for gallium-arsenide lasers.

The GaAs absorption layer is only  $0.3 \mu\text{m}$  thick to keep attenuation below 1.5 dB. This layer (third from the

bottom in the figure) is sandwiched between layers of gallium-aluminum-arsenide that are transparent for wavelengths down to about 650 nm. The over-all diode thickness is kept below  $10 \mu\text{m}$  to minimize fiber-to-diode-to-fiber coupling losses that increase as the ends of the two fibers are separated.

The diode's layers are grown on a (100) gallium-arsenide substrate, and gold-germanium-nickel and gold-zinc contacts are added to the n and p sides, respectively, of the wafer. Chemical etching produces  $150 \mu\text{m}$  diameter holes that are transparent. To minimize reflection losses, one-quarter-wave layers of silicon dioxide are evaporated on both sides of the detector.

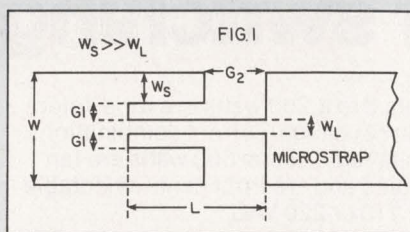
So sharp is the absorption edge of the diode at 860 nm that the diode works well with gallium-arsenide lasers, which limit from 820 to 840 nm. In this range, transmission reaches 70%. Prototype devices have a 2-ns pulse rise time at 9-V reverse bias, but this rise time is expected to be made less than 1 ns by reducing the contact area on the p side, thus reducing junction capacitance.



## Radiation and losses cut with bandstop filter

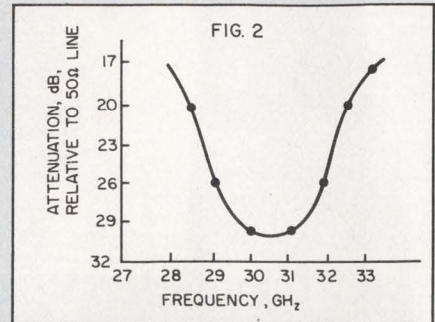
A novel bandstop microwave filter overcomes the undesired radiation and losses produced by conventional microstrip filters formed from open-circuit stubs. These losses can be severe above X-band—the new filter can be used up to 40 GHz.

Developed at the Philips Research Laboratories in Surrey, England, the filter is constructed by forming the pattern shown on the microstrip in Fig. 1. The bandstop filter is one-quarter wavelength long, and has an optimum bandwidth for  $W_L = 40 \mu\text{m}$  and  $G_1 = 60 \mu\text{m}$ —parameters important for obtaining tight coupling and high isolation.



For a 30-GHz center frequency,  $L$  is  $800 \mu\text{m}$  and  $G_2$  is  $100 \mu\text{m}$ . The width of  $W_S$  is not critical, but should be much greater than  $W_L$ .

Peak attenuation can be made to exceed 30 dB (Fig. 2) with a greater



than 17-dB loss over a 10% bandwidth. What's more, bandstop filters constructed for the 26 to 40-GHz range all exhibit much less radiation than equivalent open-stub filters.

## Trade Shows

**Pollution Control and Instrumentation Exhibition (Envirotrol '78)**—U.S. Trade Centers, London, Apr. 3-6, and Paris, Apr. 11-14.

**Sponsor:** U.S. Dept. of Commerce. Contact: R. Connan, Office of International Marketing, U.S. Dept. of Commerce, Washington DC 20230.

**International Electronics Show**—Grosvenor House, London, Feb. 14-16, 1978.

**Contact:** M. Seligman or H. Buchholz, Creative Resources, 2000 S. Dixie Highway, Miami, FL 33133.

**Instruments, Electronics and Automation Exhibition (IEA-ELECTREX '78)**—National Exhibition Center, Birmingham, England, Mar. 13-17, 1978.

**Sponsor:** Industrial and Trade Fairs Ltd. Contact: P. Lowndes, publicity manager, IEA-Electrex '78, The International Electrical, Electronic & Instrument Exhibition, National Exhibition Center, Birmingham, England.

## Energy sources sought

The Swedish Energy and Research Development Commission has proposed a three-year program of research and development on new energy sources, including the sun, wind and biomass (conversion of waste materials).

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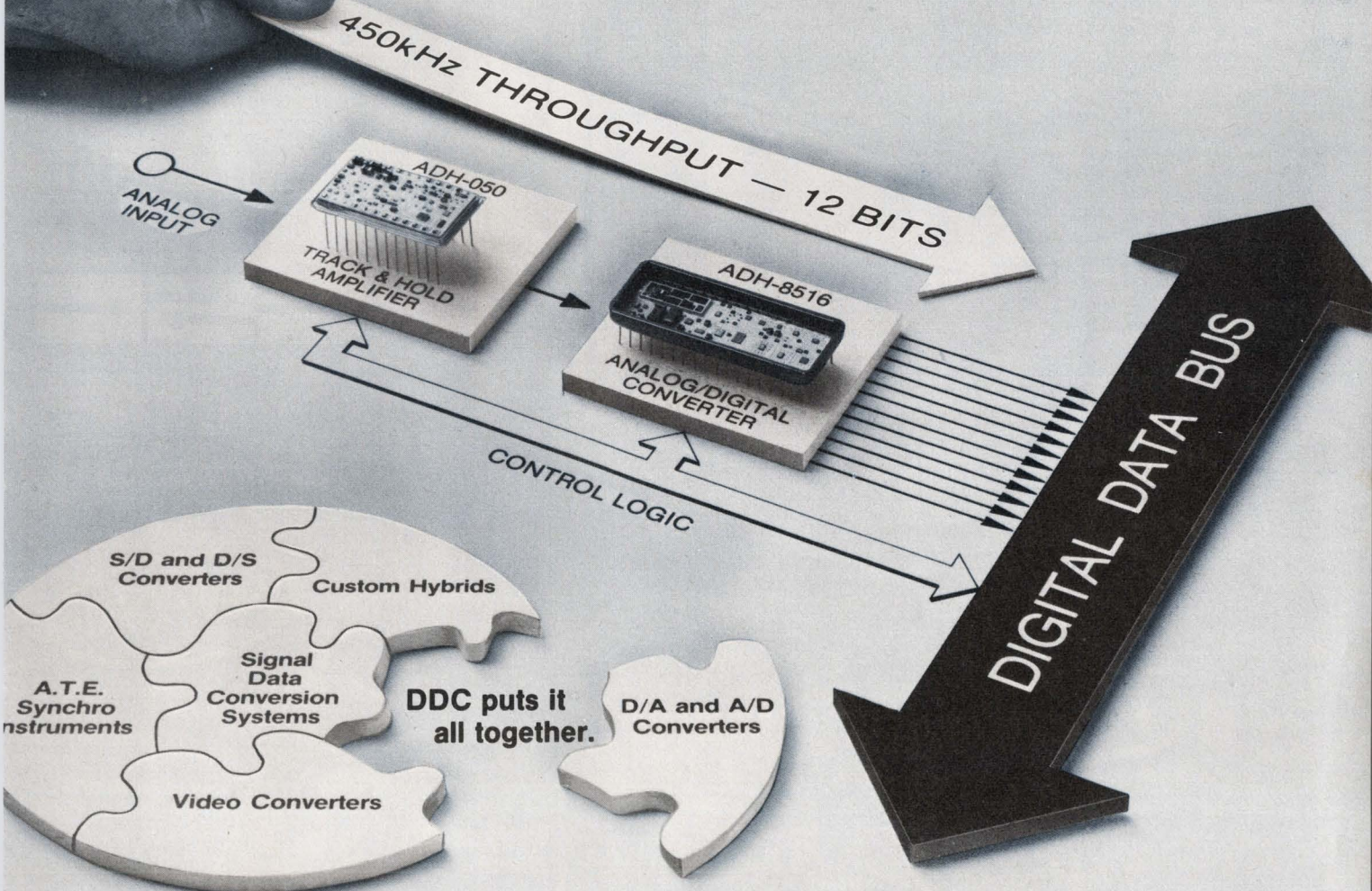
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**Interchangeable probe tips**—For greater versatility. Straight tip supplied; optional alligator clip and insulated quick-connecting clip available.

**Plug-in leads**—24" supplied, with non-corrosive nickel-silver alligator clips.

**Tri-state-output**—DP-1 is isolated from circuit under test:  $Z \geq 300K$

**Auto-polarity pulse sensing**—DP-1 automatically produces proper polarity pulse for circuit under test: logic "0" level produces a "1" pulse; logic "1" level produces a "0" pulse

**LED indicator**—flashes once for single pulse; stays lit to indicate pulse train

**Short-circuit protection**—can pulse into short circuit continuously

**Power**—overvoltage protected to 25V, reverse-voltage protected to 50V; voltage range 4-18V, 30mA max.

**Pulse modes**—Single pulse; press pushbutton for one sec. or less. Pulse train (100pps): hold pushbutton down

**Pulse specs**

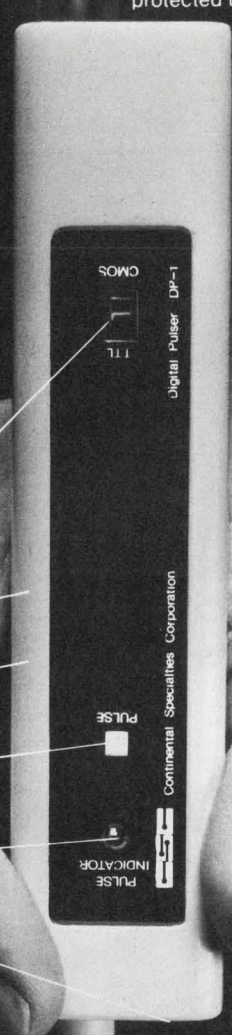
	TTL	CMOS
Pulse width	1.5usec $\pm$ 30%	10usec $\pm$ 30%
Fan out	60 loads	
Sink and Source	100mA source to 3.5V; sink to .6V	50mA source to logic 1; sink to logic 0
$T_r$	100nsec	100rsec
$T_f^*$	one TTL load, 500nsec	100K load, 8nsec

\* $T_r$  is directly proportional to load resistance

**Dimensions** (l x w x d) 5.8 x 1.0 x 0.7" (147 x 25.4 x 17.8mm)

**Weight** 3 oz. (.085kg)

**Power Leads** plug-in 24" (610mm); color coded insulated clips; others available



ACTION	MOMENTARY PRESS OF PUSH-BUTTON	RELEASE PUSH-BUTTON	CONTINUOUS PRESS OF PUSHBUTTON (OVER 1 SEC.)
LED	FLASHES	OFF	ON
OUTPUT	DP-1 SENSES LOGIC "0" PULSE OR 100 PPS PULSE TRAIN	LOGIC "1" (HIGH) PRODUCES "0" PULSE	DP-1 SENSES LOGIC "1" PULSE OR 100 PPS PULSE TRAIN
	LOGIC 1	LOGIC 0	LOGIC 1
	LOGIC 0	LOGIC 1	LOGIC 0

NOTE: SEE SPECIFICATIONS FOR DUTY CYCLE

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**NEW DP-1!**

\*Manufacturer's Recommended Resale

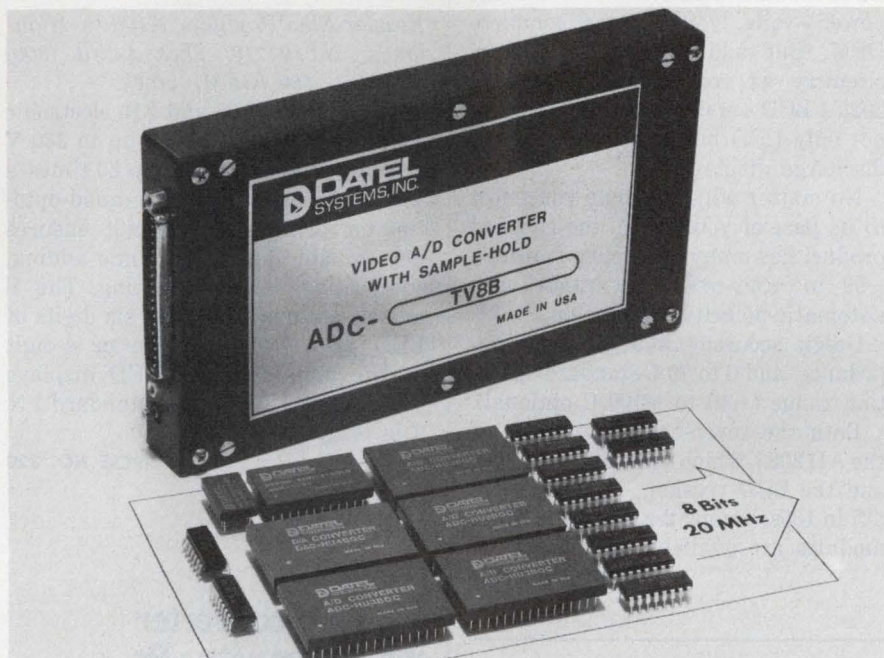
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CIRCLE NUMBER 61



# New products

## A/d converter delivers 8-bit words at 20-MHz data rates



Datel, 1020 Turnpike St., Canton, MA 02021. Gene Zuch (617) 828-8000. P&A: See text.

A built-in track-and-hold circuit enables the ADC-TV8B a/d converter to supply 8-bit data words at 20 MHz. Intended for video applications, the converter is built on a single card and housed in a 7.5 × 4.25 × 0.875-in. (191 × 108 × 22 mm) aluminum case. Its conversion technique is based on four basic hybrid building blocks—a 3-bit parallel decoded a/d converter, a 15-line (4-bit) d/a converter, a fast sample/hold amplifier and an inverting op amp.

Two 3-bit a/d converters combine to make a 4-bit a/d converter that provides the four MSBs. The 4-bit output is fed into the 4-bit d/a converter, whose output is then subtracted from the input. The remainder is converted by a second 4-bit a/d converter.

User-supplied start-convert pulses permit the throughput to be adjusted for any conversion rate up to 20 MHz. Thus, the rate can easily be set to 14.3 MHz or 17.72 MHz for the U.S. or PAL video requirements, respectively, to obtain four times the TV-color subcar-

rier frequency. The full-power signal bandwidth reaches 10 MHz and rolls off at 6 dB per octave past that point. Analog-input ranges of 0 to 1 (composite video standard), 0 to 2, 0 to 5, ±1, ±2 or ±5 V are available along with input impedances of 50, 75 or 93 Ω.

The converter is accurate to within 0.4%, and its linearity error is less than ±0.5 LSB, maximum. Acquisition for the track/hold amplifier takes 25 ns with the aperture uncertainty held to less than 30 ps. The operating temperature coefficient is ±60 ppm/°C over the full-scale range. ECL outputs can handle up to 20 ECL loads and the data skew is less than 2 ns between output bits.

Output coding is either straight binary for unipolar operation or offset binary for bipolar operation. Analog inputs come via a 3-mm rf connector, and digital outputs and power connections pass through a subminiature "D" connector.

The Datel converter comes in two basic models—the ADC-TV8B1 for ECL interfaces and the ADC-TV8B2 for TTL interfacing. The ECL version interfaces with the Motorola 10,000

family of circuits.

Basic power requirements for the converters are ±15 V at 200 mA, +5 V at 0.5 A (200 mA more for the TTL version) and -5 V at 1.5 A. Operation is guaranteed over 0 to 70 C, although extended range versions with -25 to +85 C or -55 to +85 C are also available.

The high-speed converter doesn't have many competitors. Several modular converters in the MATV Series from Computer Labs (Greensboro, NC) deliver 8-bit outputs at 8, 11 or 16 MHz and cost \$995, \$1150 and \$1300, respectively. The modules measure just 5.5 × 4.38 × 0.85 in. Also available from Computer Labs is a two-card 8-bit a/d system with an 18-MHz data rate and a cost of \$1895.

A multicard converter from ILC Data Device Corp. (Bohemia, NY) provides eight bits at up to 17 MHz, and costs over \$3000. Another ILC converter is expected to be available in early 1978—it will come in a 4 × 6 × 1 in. package, cost less than \$1500, and convert at 20 MHz.

The Datel ADC-TV8B converters cost \$1995 and \$2095, for the ECL and TTL versions, respectively, in quantities of 1 to 9. Delivery takes six to eight weeks.

Datel	CIRCLE NO. 302
Computer Labs	CIRCLE NO. 303
ILC Data Devices	CIRCLE NO. 304

## Mini printer head has 100-megacharacter life

C. Itoh Electronics, 280 Park Ave., New York, NY 10017. Floyd Makstein (212) 682-0420. \$210.

Series 500, 40-column dot-matrix impact printers, features reliability, small size, high speed and low cost. Guaranteed are: continuous-duty head life of 100-million characters and MCBF of 5-million lines per mechanism. Printing speed is 2.5 lines/s. Drive is by dc motor. Size is 175 × 146.5 × 112.5 mm.

CIRCLE NO. 308



## Module simplifies DPM recipe —you can choose the display



Analog Devices, Route 1 Industrial Park, Box 280, Norwood, MA 02062. Steve Castilli (617) 329-4700.

Should you want to drive a three-digit LED display, just add a gain pot and the seven-segment version of

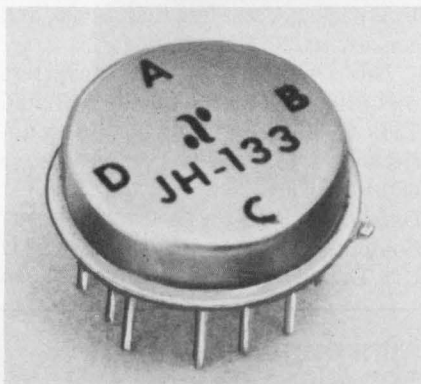
Analog Devices' AD 2023 Displayless DPM module, plus 0.1 W of 5-V input power—voila, you've got a complete DPM. But add decoder and driver circuitry as required, and the AD 2023's BCD version can accommodate not only LED but also LCD and gas-discharge displays.

No matter which module you select to be part of your DPM, the finished product has many appetizing features: -99 to +999-mV input range with automatic-polarity indication, 0.1% ±1-digit accuracy, 100-MΩ input impedance, and 0 to 70 C standard operation range (-40 to +100 C optional).

Both the seven-segment version of the AD 2023, which sells for \$28 in 100s, and the BCD version, which sells for \$27 in 100s, occupy 2 × 2 × 0.4 in. Both modules are available from stock.

CIRCLE NO. 301

## Quad coupler gives 30-dB port isolation

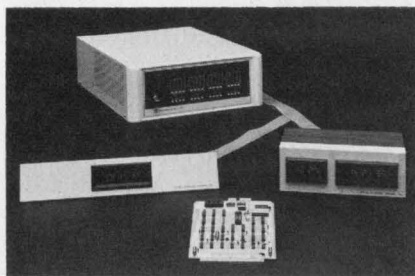


Anzac Electronics, 39 Green St., Waltham, MA 02154. Jim Leonard (617) 899-1900. \$45; stock.

A four-port hybrid coupler, Model JH-133, operates from 20 to 40 MHz and provides isolated quadrature outputs of an input signal with isolation between ports of 30 dB at midband. Phase deviation from 90° is typically 1° with a guaranteed maximum deviation of 3°. Amplitude balance is 0.75 dB max and VSWR is 1.2:1. Insertion loss of the TO-8 unit is 0.5-dB max.

CIRCLE NO. 309

## Real-time clocks provide μC time and date support

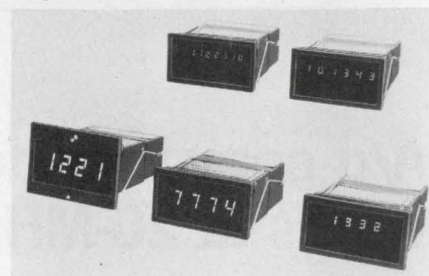


Digital Interface Systems, P.O. Box 1446, Benton Harbor, MI 49022. (616) 926-2148. \$375 to \$750; 8 to 12 wks.

Models 960-030 and 990-030 real-time clocks are compatible with TI 960 and 990 lines of mini/microcomputers and provide hardware time and date support. Battery backup maintains time and date information during power loss. A 10-digit version displays the date and time. A six-digit version alternates between date and time or displays only time. The 960-030 is compatible with the TI 960 A/B CRU bus. The 990-030 is a half-slot board compatible with the TI 990 CRU bus.

CIRCLE NO. 310

## Line-operated counter replaces mechanicals

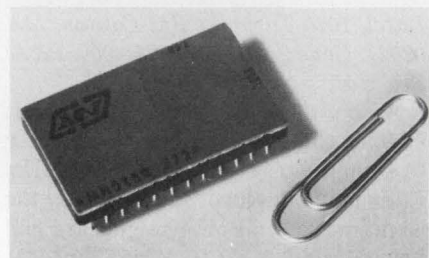


Kessler-Ellis Products, Atlantic Highlands, NJ 07716. Dick Laird (800) 631-2165. \$50 (OEM); stock.

The V Model L06 and L16 electronic counters accept pulses of up to 230 V ac directly and count up to 80 times/s with no moving parts. A quad-optoisolator demodulator circuit ensures long reliable operation while adding, subtracting and or resetting. The V models are available with six digits of LED display 0.2-in. high or 4-digit orange high-efficiency LED displays 0.4-in. high. Units are in standard 1 × 2 in. size.

CIRCLE NO. 320

## 8-bit a/d converter interfaces with μPs



Micro Networks, 324 Clark St., Worcester, MA 01606. John Munn (617) 852-5400. \$75 (0 to 70 C), \$149 (-55 to +125 C); stock to 4 wks.

Designed to interface with popular 8-bit μPs, the MN5150 is complete with internal reference and three-state outputs. It has a 2.5-μs conversion time, 7 user-selectable input ranges including unipolar and bipolar configurations, and hermetic DIP packaging. The converter is monotonic, operates from 0 to 70 C (-55 to +125 C for MN5150H), requires 680 mW and has TTL-compatible control inputs and digital outputs. Both serial and parallel data outputs are available and it can be short cycled for uses needing faster conversion times with lower resolutions.

CIRCLE NO. 321



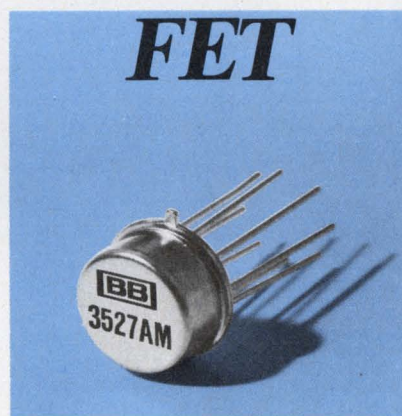
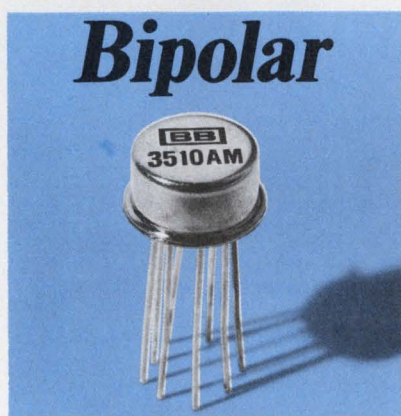
# *Choice Op Amps from Burr-Brown...*

## *Low Cost*

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*The choice bipolar op amp is Burr-Brown's new 3510. The 3510's low  $0.5 \mu\text{V}/^\circ\text{C}$  voltage drift and less than  $\pm 15 \text{ nA}$  bias current provides the performance you need for high-accuracy systems at low cost.*

The 3510's total performance over the  $-25^\circ\text{C}$  to  $+85^\circ\text{C}$  temperature range surpasses many competitive units rated for only  $0^\circ\text{C}$  to  $+70^\circ\text{C}$ . It's ideal for high-accuracy analog circuits and instrumentation designs. Three grades give you voltage offset from 60 to  $150 \mu\text{V}$  and voltage drift from  $0.5$  to  $2 \mu\text{V}/^\circ\text{C}$ . Maximum open-loop gain and CMR specs are 120 dB and 110 dB respectively. Prices (in 100's) are only \$4.95 (3510AM), \$5.95 (3510BM) and \$10.00 (3510CM).

*The choice FET-input op amp is Burr-Brown's 3527. With bias current of less than  $5 \text{ pA}$  and low voltage drift of  $2 \mu\text{V}/^\circ\text{C}$ , the 3527 is your best buy.*

Burr-Brown's 3527 comes out a winner when you compare the three most important FET op amp features—input bias current, offset voltage drift and price. And low laser-trimmed offset voltage means no further adjustment in most applications. Here's a cost-effective answer for current-to-voltage converters and general analog computation circuits. Available in three grades with offset voltage ranging from 250 to  $500 \mu\text{V}$  and voltage drift from 2 to  $10 \mu\text{V}/^\circ\text{C}$ , the prices (in 100's) are \$7.95 (3527AM), \$10.35 (3527BM) and \$19.40 (3527CM).

To get details on these price/performance leaders, contact Burr-Brown, International Airport Industrial Park, Tucson, Arizona 85734. Phone (602) 294-1431.



*Performance,  
Reliability, Economy*

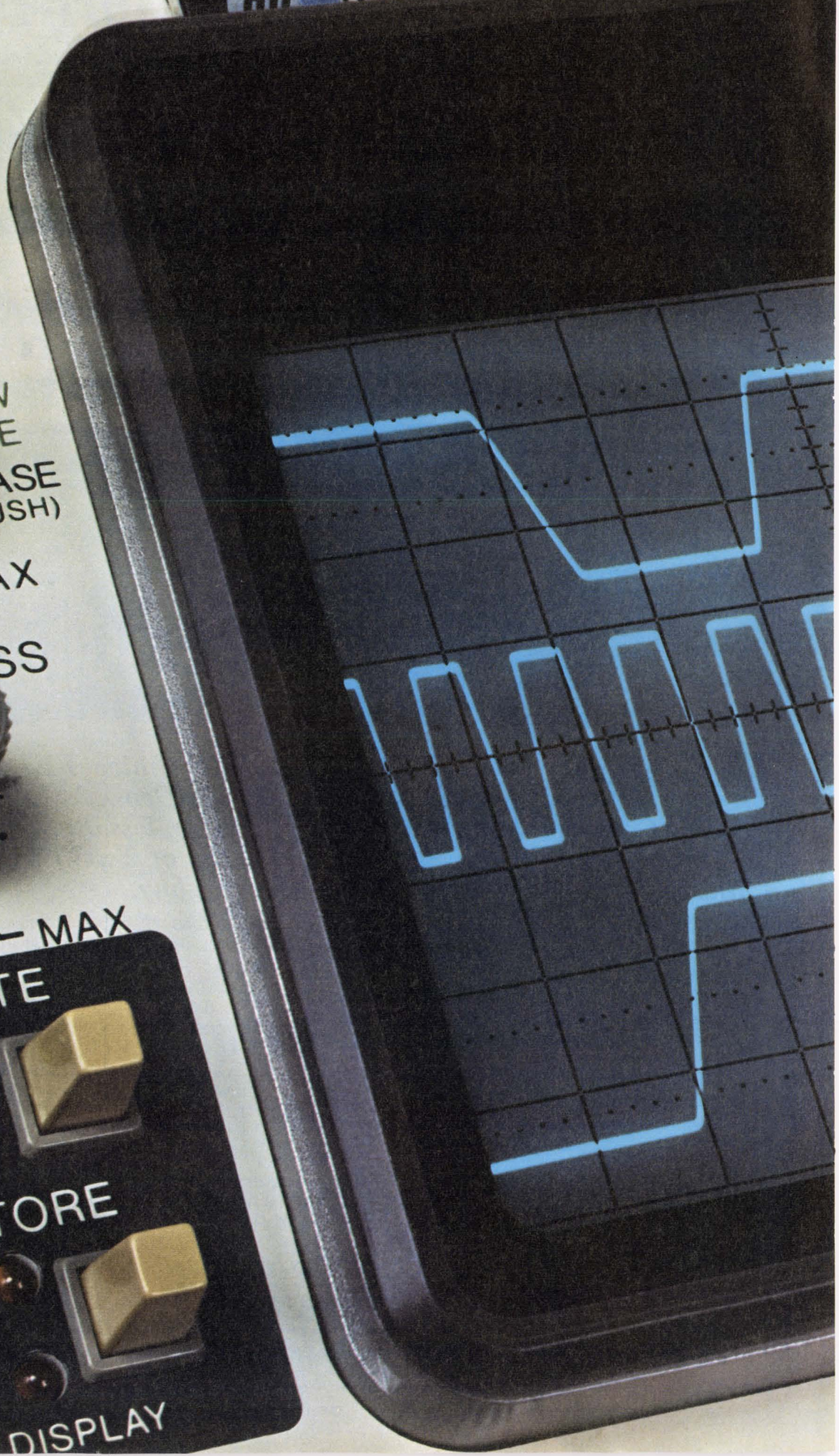


STORE  
ERASE

OR  
VIEW  
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ERASE  
(PUSH)  
MAX

BRIGHTNESS  
MAX

WRITE  
STORE  
DISPLAY





# For one easy-to-use scope that: Captures single-shot events... Displays low-duty-cycle signals clearly... Provides three channels for the price of two...

## HP's the Answer.

And the new 1741A is your scope. It gives you a unique combination of features for a moderately priced 100 MHz storage scope: Variable persistence for clear viewing of glitches and low-duty-cycle traces; storage for studying single-shot events; and third-channel trigger view for convenience in making simultaneous three-channel timing measurements.

**Excellent variable persistence** means a bright, sharp trace you'd expect only on a nonstorage scope. The result is an easy-to-read display of fast, low-duty-cycle repetitive signals. And the ability to see leading edges and glitches you'd otherwise miss.

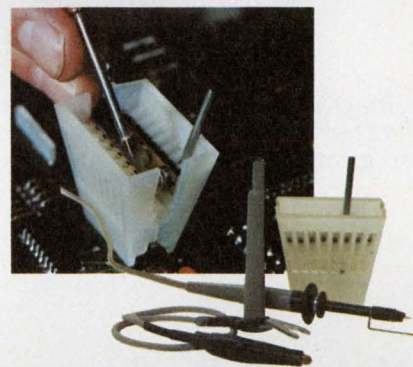
**Auto erase/Auto store.** In Auto erase you adjust the display rate up to 2.5 per second. After that, it's all automatic, which means you simplify set-ups and eliminate smeared displays of digital data. It's a powerful tool for capturing those elusive glitches in data streams. In Auto store, your 1741A is armed, and as long as the instrument is fully operational and powered, will wait indefinitely, ready to store a random, single-shot event when it occurs.

**Third-channel trigger view,** selected at the push-of-a-button, lets you observe an external trigger signal along with channel A and B—three traces in all—so you can easily make timing measurements between all three channels. In most applications, that means three-channel capability for the cost of a two-channel variable persistence/storage scope.

For measurement convenience, the

1741A has a selectable 50 ohm input in addition to the standard 1 megohm input. A 5X magnifier permits two-channel measurements as low as 1 mV/div to 30 MHz, without cascading. You can even select a special modification (TV Sync) to tailor this scope for TV broadcast and R&D applications. Priced at \$3950\*, the 1741A is an exceptional storage scope value.

Call your local HP field engineer today for all details. And for low-cost variable persistence/storage in a 15 MHz scope, ask him about HP's new 1223A.



And here's something NEW for scopes. HP's EASY-IC PROBES. A new idea for probing high-density IC circuits that eliminates shorting hazards, simplifies probe connection to DIP's and generally speeds IC troubleshooting. Ask your HP field engineer about them.

\*Domestic U.S.A. price only.



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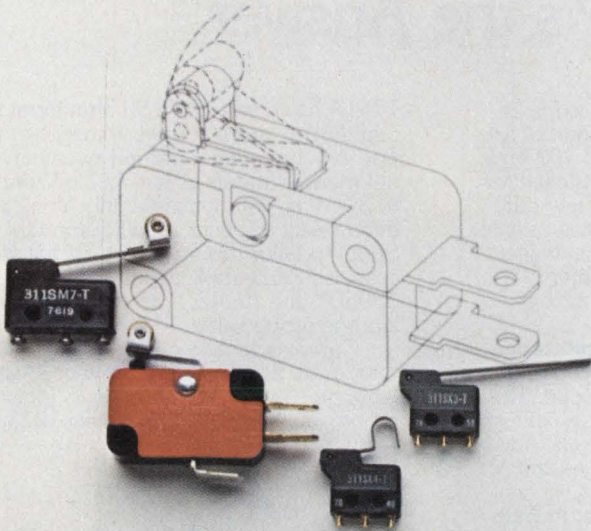
For assistance call: Washington (301) 948-6370, Chicago (312) 255-9800, Atlanta (404) 955-1500, Los Angeles (213) 877-1282

CIRCLE NUMBER 63

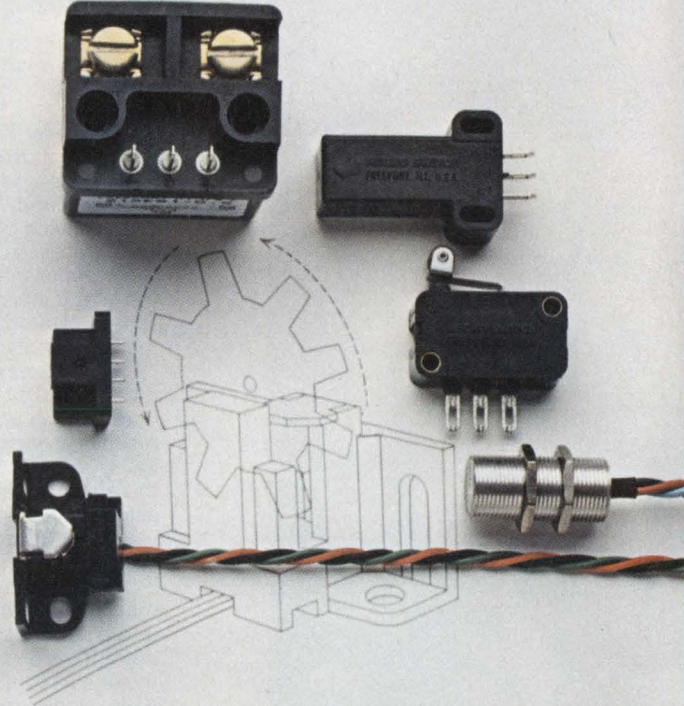


# Some of these components will probably never The others will just come close.

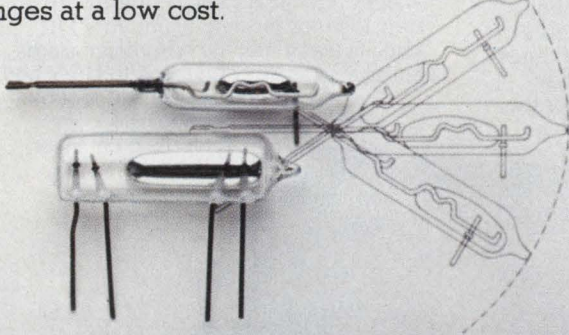
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Snap-action V3, SM and SX switches offer wide variety of actuators, electrical capacity and termination.



Mercury switches offer hermetic sealing, a variety of electrical capacity and broad temperature ranges at a low cost.



AML manual devices for low installed cost, electrical flexibility and attractive panel appearance. Series 8 miniature manual switches provide small size and wide variety of operators. DM offers inexpensive snap-in panel mount design.



Solid state keyboards provide high reliability no mechanical keyboard can offer. Panel sealed versions also available.





**wear out.**

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Each is based on a Hall-effect integrated circuit. A circuit that's been tested through billions of operations without failing. And proven by performance in thousands of applications.

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Like the long-life versions of our snap-action V3, SM and SX precision switches. Available in a wide variety of sizes, electrical ratings, terminals, actuators, contact forms and operating characteristics—some tested to a mechanical life of over 10,000,000 operations.

MICRO SWITCH will provide you with field engineers for application assistance and a network of authorized distributors for local availability. Write us for details or call 815/235-6600.

And find out how you can get a component that goes on forever. Or at least comes very, very close.

**MICRO SWITCH**

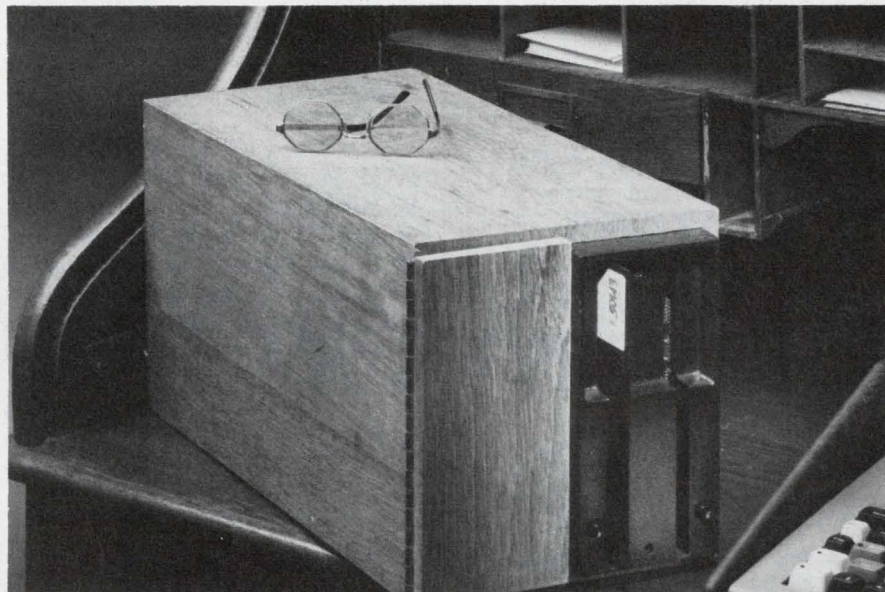
FREEPORT, ILLINOIS 61032

A DIVISION OF HONEYWELL

MICRO SWITCH products are available worldwide through Honeywell International.

## MICRO/MINI COMPUTING

# Control up to four drives with processor-based system



*Extensys, 592 Weddell Dr., Sunnyvale, CA 94086. Ed Hartnett (408) 734-1525. P & A: See text.*

The FOS100 disc system from Extensys can handle up to four floppy-disc drives and comes in either a dual drive or quad drive version. Furthermore, by using an optional memory controller board, multiple 64-kbyte banks of semiconductor memory can be connected to an 8080A-based host system. Because the FOS100 has its own control processor and buffer memory, it minimizes the loading of the host system.

Boards in the disc system permit the host computer to control up to four PerSci 277 drives via a "personality" module (a dedicated controller board). The system can interface to the S-100 microcomputer bus. The memory management controller board permits up to 16 disc drive systems to operate on the host computer, thus allowing access to up to 64 drives. Or, multiple 64-kbyte RAM banks can be accessed via a bank-switching scheme controlled by software.

Software for the FOS100, a diskette-based program called EMOS, contains

an assembler, editor, disc copy, file copy, basic bank-switching routines and an extended Basic high-level language developed by Microsoft. The operating system contains software executed by both the host and I/O processors as well as a file privacy feature to protect data held on disc.

The essence of the FOS100 system is the File I/O board, which contains its own 8080A processor, a bootstrap PROM, 8192 bytes of RAM and all interface logic necessary for the personality module and S-100 bus. The board can act as a buffer between the disc and the host processor and eliminate the need for the host unit to stop operation to handle an I/O routine.

Two versions of the FOS100 are available, the FOS100-2 with one dual drive (\$2880), and the FOS100-4, with two dual drives (\$4680). Both versions are housed in 9.5 x 9.5 x 19-in. wood-grain cabinets, suitable for desktop use. The memory-management feature that permits multiple 64-kbyte banks to be used costs an additional \$295. Delivery is 30 days.

CIRCLE NO. 307



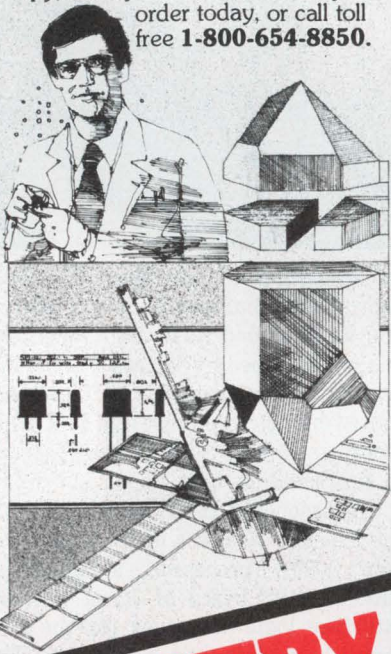
# Comprehensive

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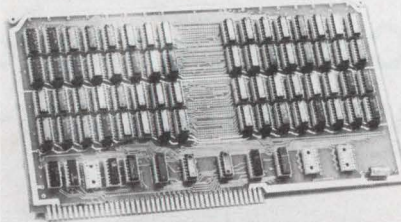
Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

CIRCLE NUMBER 65

## MICRO/MINI COMPUTING

### Static RAM boards are SBC 80/10 compatible



*Electronic Solutions, 8070 Engineer Rd., San Diego, CA 92111. Richard Van Antwerp (714) 292-0242. \$295 (4 k), \$395 (8 k).*

RAM-4 and RAM-8 are 4-k and 8-k RAM boards using low-power static RAMs. The boards are compatible with Intel's SBC 80/10 and National's BLC 80/10  $\mu$ Cs. Memory cycle time is 630 ns and power consumption on an 8-k board is 9.5 W. Address selection is done via jumpers. All ICs on the board are socketed.

CIRCLE NO. 322

### ROM tester permits manual or auto stepping

*Tetrahedron Associates, 7605 Convoy Ct., San Diego, CA 92111. (714) 277-2820. \$495; 2 wks.*

The RC-102 ROM, PROM and EPROM checker compares the code in a programmed ROM with a known good listing. Accepting ROMs with capacities of up to 4096  $\times$  8 bits, the tester displays both the data and the address of the accessed location. Operation is possible in either octal or hex modes, via switch selection, and there are two basic test modes. The RC-102 can perform a compare test against a reference and automatically cycle through all address locations or it can perform a step-by-step output to the display under manual control or automatically step through the addresses at an adjustable rate. Address stepping can be done either forward or reverse. Error indicators in the compare mode include a Hold light that remains on if an error has been detected and a Flash light that goes on momentarily when passing through an error. The memory tester is housed in a 10  $\times$  12  $\times$  2.5 in. cabinet and requires 115 V ac.

CIRCLE NO. 323

### CPU board mates with general-purpose modules

*Control Logic, 9 Tech Circle, Natick, MA 01760. Hiram French (617) 655-1170. \$350; 4 wks.*

A Z-80 based applications system, the MM1-ZCPU, is compatible with the MM1 modular support boards developed for the Intel 8080A. Using a bus-structured system, either a Z-80 or 8080A CPU board can be used with the same memory and I/O support boards. The device has a capacity for 4 k of EPROM plus 1 k of RAM and operates at a clock rate of 2 MHz.

CIRCLE NO. 324

### Desktop $\mu$ C is turnkey system



*Mohr Labs, Route 4 Fish Hatchery Rd., Madison, WI 53711. Bob Herbst (608) 271-5380. \$3449.*

A desktop microcomputer turnkey system, based on the MOS Technology 6502 processor incorporates a 20  $\times$  64 character CRT and an ANSI keyboard with a numeric keypad. It also includes a 4-k RAM (expandable to 16 k), a 3-k system monitor EROM, a 16-level priority interrupt system, a modem and a TTY interface.

CIRCLE NO. 325

### Transmit/receive module mates $\mu$ P to phone line

*Wintek, 902 N. 9th St., Lafayette, IN 47904. (317) 742-6802. \$1499.*

Bidirectional communications between a  $\mu$ P and the telephone system are possible with the telephone-tone transmit/receive module. It contains a central office quality tone transmitter and receiver based on the 6800  $\mu$ P modules. It is available on industry standard 4.5  $\times$  6.5 in. PC boards with dual 22-pin edge contacts.

CIRCLE NO. 326





# Relax

**It's amazing how an easy mind cements relationships.**

We're the easy mind people. TRW Capacitors.

We can solve your problems connected with reliability in ultra-miniature capacitors. Our X463UW metallized polycarbonates are designed to do just that.

The X463UW gives you "Space Age" performance in circuits demanding the smallest possible size. Capacitances range from .001 to 10 mfd, at 50, 100, 200 and 400 vdc—with less than 1.5% capacitance change from  $-55^{\circ}\text{C}$  through  $125^{\circ}\text{C}$ . IR is 60,000 megohm x mfd minimum at  $25^{\circ}\text{C}$ . DF is less than 0.3% at  $25^{\circ}\text{C}$  and 1 KHz. And stability? In humidity and shelf life tests the stability of the X463UW is actually two to three times better than polysulfone.

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We also put the same kind of effort into our engineering services and our field support. Try us. We can help reduce the tension. Give us a call, or write: TRW capacitors, An Electronic Components Division of TRW, Inc., 301 West "O" St., Ogallala, Nebraska 69153. Tel: (308) 284-3611.

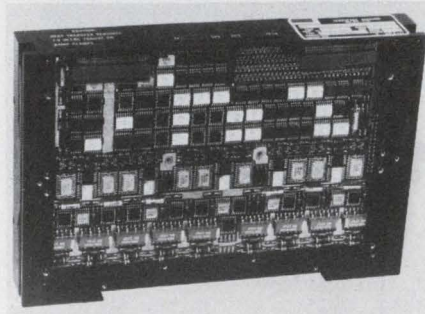


**TRW** CAPACITORS  
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 CIRCLE NUMBER 66



## MICRO/MINI COMPUTING

### Core memory permits use in severe environments

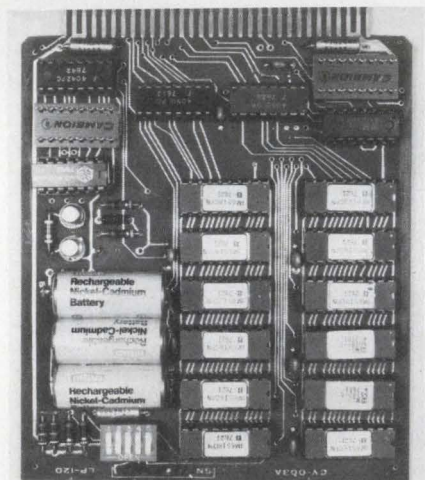


Electronic Memories & Magnetics, 20630 Plummer St., Chatsworth, CA 91311. Ted Lutz (213) 998-9090.

SEMS-16 core memory system meets the environmental requirements of aerospace, shipboard and severe industrial use. The memory has a 32 k × 18 capacity with an access time of 350 ns and cycle time of 900 ns. Size is 6 × 9 × 1.4 in.

CIRCLE NO. 327

### CMOS RAM simulates 6312 ROM for protos



Cybertek, 222 150th Ave., Madeira Beach, FL 33708. (813) 392-3467. \$280; 4 wks.

A 1 k × 12 CMOS RAM module has been added to the LP-12 family of low-power OEM  $\mu$ C boards. In addition to being a general-purpose RAM board in the LP-12 family, the LP-12D RAM module can be strapped for address block recognition and RSEL signal generation. This enables it to simulate the 6312 ROM for prototyping purposes. It includes write-protect capability and optional on-board batteries for non-volatility.

CIRCLE NO. 328

### Cartridge drive handles data at 9.6 Mbits/s



Control Data, Box O, Minneapolis, MN 55440. Kent Nichols (612) 853-4656. \$3900 to \$6000.

Model 9448 cartridge-module disc drive (CMD) transfers data at 9.6 Mbits/s. The module is interface-compatible with the company's storage-module drive (SMD) and mini-module drive (MMD) families of OEM disc products. The drive is available in three basic models, with storage capacities of 32, 64 or 96 Mbytes. Storage is divided between a 16-Mbyte front-loading cartridge and up to 80 Mbytes of fixed-disc capacity. Specs include an average random-data access time of 30 ms at a rotational speed of 3600 rpm, and average latency time of 8.33 ms. Each data recording surface has a track density of 384 tracks/in., and data are recorded at densities of 6038 bits/in. The drive includes  $\mu$ P-based control logic, and comes in a pedestal cabinet or 19-in. rack-mount case.

CIRCLE NO. 329

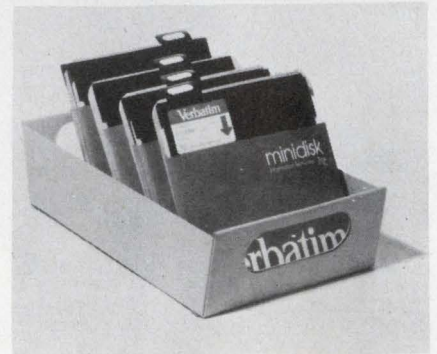
### Add-in memory improves operating margins

Ampex, 200 N. Nash St., El Segundo, CA 90245. Clyde Cornwell (213) 640-0150. \$1725; stock.

An add-in memory, ARM-1280, reduces memory costs while improving operating margins for a broad range of computers. The device provides 16 kwords of add-in memory that is pin-compatible and totally transparent to all models of Nova 800, Nova 1200, D116H and D116S computers. Memory cycle speed is switch-selectable to match the requirements for each model. For the Nova 800, cycle time is 800 ns; Nova 1200, 1200 ns; D116H, 960 ns; and for the D116S, 1200 ns. The 16 kwords are available on a single board and can be plugged into any memory slot. The unit operates in any address field up to the maximum addressable in any of the computer models.

CIRCLE NO. 330

### Bin allows fast diskette storage and retrieval



Printcraft Systems, 11-17 Beach St., New York, NY 10013. Don Hubbinett (212) 966-0001. \$22.50 to \$25.50; stock.

Bins for the fast retrieval and storage of the new mini diskette are available in 50-diskette capacity units. Each has five support plates and five titled dividers. A 100 diskette capacity unit with 10 plates and dividers is also available. Color is tan with padded base for desktop protection. Highly portable, the unit can easily be stored on a cabinet shelf, or any standard file drawer.

CIRCLE NO. 331

### Small data terminal doesn't cost a bundle



Micon Industries, 252 Oak St., Oakland, CA 94607. Bill Northfield (415) 763-6033. \$400.

The Miget, a data-communications terminal, provides keyboard entry and display output for all  $\mu$ C and  $\mu$ Ps using RS-232C interface and ASCII code. It is light weight (4 lb), small (8 × 10 × 3 in.), and has a built-in power supply. Basic operation of the unit is via a simplified typewriter keyboard that provides a simultaneous 32-character display. Features include eight selectable baud rates from 110 to 9600, TTY compatibility, an optional memory system and acoustical coupler, and a choice of eight colors.

CIRCLE NO. 332

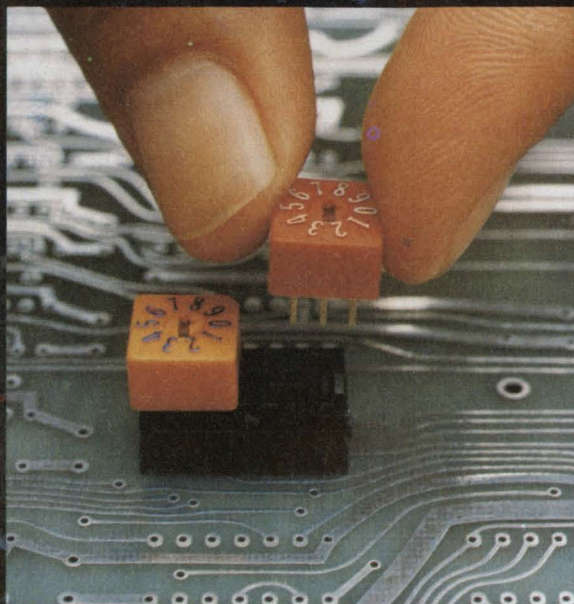


# MICRO

DIP SWITCH

# MINI

DIP SWITCH



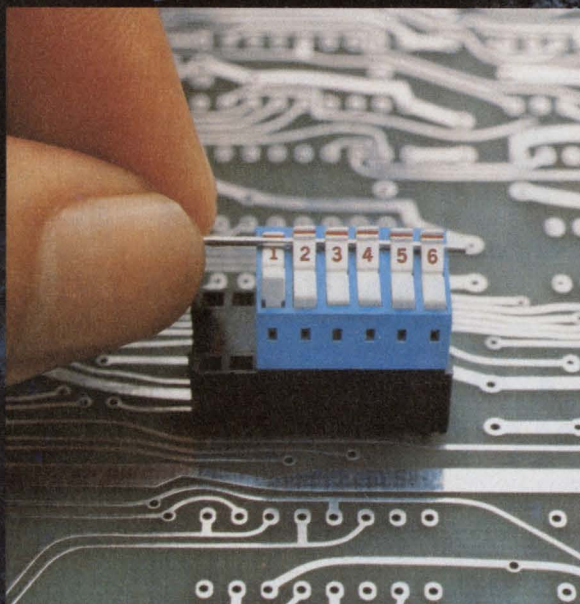
**MICRO-DIP**...10 and 16 position miniature binary coded DIP switch designed to be mounted directly to PC Boards. Ideal for address encoding, pre-setting, PCB programming...every area of digital electronics.

Packaged in a color coded, glass-filled nylon housing with terminals on .100 x .300 centers. It occupies only one half of a standard 14-pin DIP socket.

Screwdriver slot is rotated in either direction to desired setting. Gold contacts protected by dust-seal design.

Positive detenting 10 position BCD, 16 position binary with separate common to not true bits, repeating 1 and 2 pole codes. Guaranteed life of 10,000 detent operations. Operating temperature range of  $-10^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ , contact resistance of 25 milliohms max. initial.

One year warranty.



**MINI-DIP**...new from EECO. Form A and C contact arrangements ideal for positive on/off switching and programming.

Easily actuated, positive wiping, gold contacts are packaged in a dust free glass-filled nylon housing.

Interference-fit of terminal pins and one piece housing prevent contamination. Larger cross section pins allow positive insertion into sockets and P.C. Boards.

New locking design in which .035 diameter locking rod is inserted through rockers, insures against accidental actuations.

Guaranteed life of 50,000 cycles. Operating temperature range  $-10^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ , contact resistance 25 milliohms max. initial.

Standard .100 x .300 centers allows retrofitting of other major brands of DIP switches. Available in 2-10 station Form A, 1-5 station Form C contacts.

One year warranty.

# EECO

1441 East Chestnut Avenue, Santa Ana, California 92701 - Phone 714-835-6000. Distributed in U.S. by Marshall Industries, Hall-Mark, and Schweber. In Canada by R.A.E. and Penryn. Agents Throughout the world.



## MICRO/MINI COMPUTING

### Graphic display system delivers 262,144 points

Matrox Electronic Systems, P.O. Box 56, Ahuntsic Stn., Montreal, Quebec H3L 3N5. Lorne Trottier (514) 481-6838. From \$895 (unit qty); 4 to 6 wks.

Capable of providing a variable resolution graphics display, the MTX-512 can be user programmed to produce 256 × 256 × 512, 512 × 512 or 256 × 1024

point displays. American or European TV compatibility is also field programmable. Changing the resolution is as simple as changing the size of the RAM used to hold data, starting with 4-k dynamics for the 256 × 256 display, increasing to 8-k dynamics and then to 16-k dynamics. The display system comes on a 7.75 × 10.5-in. circuit card and requires 5 V at 800 mA and 15/12 V at 200 mA. Boards are available that mate with the PDP-11 and LSI-11 buses. Write time for the display is 1.4 μs/dot and the full screen erase time is 48 ms.

CIRCLE NO. 431

# LIMIT ONLY ONE PYROSCAN SYSTEM FOR EACH CUSTOMER



Pyroscan 100 system

Whether you have one or one hundred temperature sensors to monitor, the Newport Pyroscan System will do your job... and only one System is all you should need.

Pyroscan systems provide the flexibility and expandability to meet your present and future needs.

A Pyroscan 30 System is wired to accept three

10-channel cards while Pyroscan 100 is wired for ten cards. Just plug in the cards as your requirement changes, attach your sensors, and that's all there is to it.

Newport's building block approach allows you to start with a Scan Programmer and one 10 channel switch card (without cabling) for only \$380. Go to a full logging system and pay \$1480 for the first ten channels. A 30 channel system is only \$1810.

How about a ten channel switching card that is addressed by BCD code for only \$145?

A module change allows you to switch to a different thermocouple type.

Ask about Newport's Custom mod centers for your special application convenience. Send for the Pyroscan 8 page brochure. U.S. Prices only.

## NEWPORT

#### FEATURES:

- 20 thermocouple and 7 Platinum RTD ranges available
- First and last channel programming
- Resolution 1.0 or 0.1 degree C or F
- Manual/single/continuous scan
- System expansion made easy
- Variable dwell and scan rate
- Internal clock option
- Printed paper tape record
- Highly stable cold reference junction
- Linearized over sensor range
- Screw terminals for TC inputs
- Single or dual limit alarm options
- Easy to order
- Easy to obtain
- Easy to operate

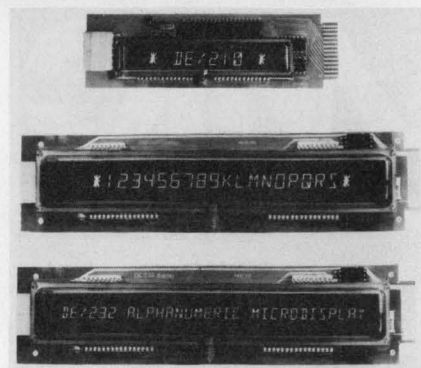
Corporate Office  
630 East Young St.  
Santa Ana, CA 92705  
Telephone: (714) 540-4914  
TWX: 910-595-1787  
Cable: Newlab, Santa Ana  
CA 92705

Newport BV  
P.O. Box 7759  
Schiphol East  
The Netherlands  
Telephone: (20) 45-20-52  
Telex: 844-16347

Newport Laboratories GmbH  
6072 Dreieich  
Max-Planck-Strasse 13  
Postfach 102163  
German Federal Republic  
Phone: (06103) 64041/63042  
Telex: 417908 (NEWPT D)

CIRCLE NUMBER 121

### Single-line displays have 10 to 32 characters

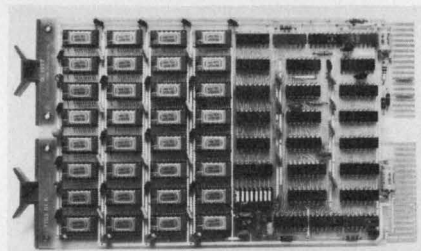


Digital Electronics, 415 Peterson St., Oakland, CA 94601. (415) 532-2920. \$99 to \$199 (100 qty).

Alphanumeric, single-line display modules using vacuum fluorescent technology and 14-segment character design are available. The models are DE/210 (10-character positions), DE/220 (20 characters), and DE/232 (32 characters). They feature an on-board μP that has a character generator, display buffer and refresh logic. The displays have both parallel and serial interfaces and they represent as few as one output address to the host system.

CIRCLE NO. 432

### DEC-compatible RAM has 32 k on single board



Cyberchron, 5768 Mosholu Ave., Riverdale, NY 10471. Chris Fadden (212) 548-0503. \$1995 (user), \$1795 (OEM); stock.

A 32-kword single width memory board for the DEC LSI-11 and PDP-11/03 computers, CDM-77/03, uses 16 k dynamic RAMs to achieve maximum memory density. The memory is addressable as a contiguous block from 0 through 30 k with the address selection accomplished via an on-board DIP switch. It is completely LSI-11 hardware and software compatible and will function with either burst (CPU) and refresh or distributed (DMA) refresh.

CIRCLE NO. 433



# Dialight is your second source to C&K for miniature rockers and toggles...



Come to the people who've always been specialists in having more good ways to solve problems: Dialight. What we've done in indicator lights, illuminated switches, readouts and LEDs, we're doing now in miniature rockers and toggles.

This new Dialight family of switches, which comes in a full range of sizes is, we're proud to point out, all-American made.

When you consider all the configurations of styles, sizes, life and safety ratings, colors and mountings, you'll find there are literally hundreds of thousands of design combinations. Such a number of possibilities

can in itself be a problem, except that the new Dialight catalog is specifically designed to prevent confusion and help you quickly and easily find the most advantageous combination of features for your applications.

If you'd like to see what Dialight quality rockers and toggles can do for the looks, durability and economics of your products, contact us today for the Dialight "Meets Your Need" Book. Your free copy will include a list of stocking distributors in the U.S. and Canada.

**DIALIGHT**  
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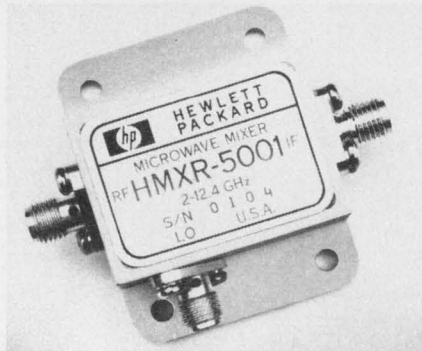
## Dialight meets your needs.

Dialight, 203 Harrison Place, Brooklyn, N.Y. 11237 (212) 497-7600

CIRCLE NUMBER 150



### Low-loss broadband mixer has high isolation



Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. John Kane (415) 493-1501. \$325; stock.

A double-balanced mixer for broadband-microwave use, the HMXR-5001, has low conversion loss and high isolation across the 2 to 12.4-GHz band, while retaining a wideband i-f of 0.01 to 1 GHz. Conversion loss is typically 7.5 dB from 2 to 8 GHz and 8.5 dB from 8 to 12.4 GHz. LO-to-rf isolation is typically 30 dB. With a slight sacrifice in performance, the device can be used up to 18 GHz.

CIRCLE NO. 333

### Image rejection mixer covers 2 to 12.4 GHz



Varian, Salem Rd., Beverly, MA 01915. (617) 922-6000. 4-8 wk.

Compact packaging is featured in the 9753 series of low-noise image-rejection mixers covering the 2.0 to 12.4-GHz range in bands up to an octave wide. Each model consists of two mixers, a 90° hybrid, and a power divider combined in a single microwave IC. Minimum image rejection is 18 dB and i-f is dc to 300 MHz with any 20% bandwidth. 4.4 oz and 1 × 2.5 × 1.5 in.

CIRCLE NO. 334

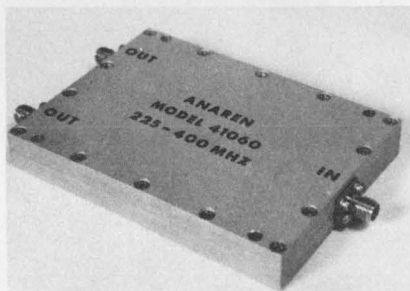
### Mini step attenuator meets MIL specs

Micronetics, 36 Oak St., Norwood, NJ 07648. A. Steinhauer (201) 767-1320. \$375; 6 to 8 wks.

Model 8986 broadband step attenuator meets all applicable military specifications and covers the range of dc to 12.4 GHz. Attenuation is 0 to 90 dB with 50-Ω impedance. Power rating is 0.5 W to 2 kW over the temperature range of -25 to +125 C. Connector types are SMA, BNC or TNC.

CIRCLE NO. 335

### Power dividers offer 100-W cw dissipation



Anaren Microwave, 185 Ainsley Dr., Syracuse, NY 13205. J.R. McVicker (315) 476-7901. \$150 to \$390.

Two in-phase, high-power dividers with stripline construction dissipate 100-W cw with an 85-C heat sink. Model 41060 is 2-way; Model 41070, 4-way. Typical VSWRs are 1.15 and 1.20 and max amplitude balance is ±0.2 dB and ±0.3 dB. Min isolation is 20 dB. Case sizes are 0.5 × 0.75 × 3.75 and 5.0 × 6.0 in.

CIRCLE NO. 336

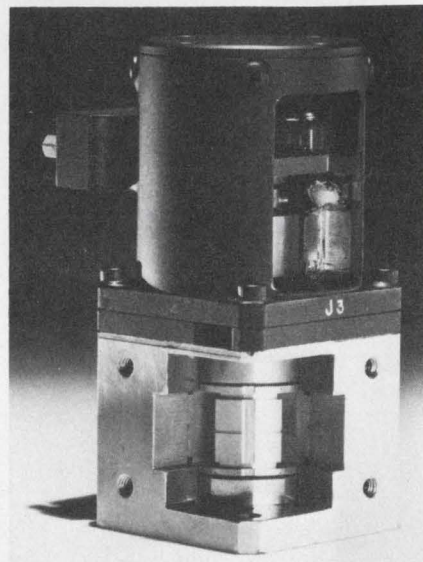
### Cover 1.7 to 40 GHz with motorized latch-switch

Waveline, P.O. Box 718, West Caldwell, NJ 07006. (201) 226-9100.

The 79 series of motorized, latching-type waveguide switches feature a removable drive head with rotor-locking capability. The switches cover the range from 1.7 to 40 GHz. The standard rf section is available as a dpdt (transfer) type with paths of the continuous-arc design. No lossy material is used in the rf section. The rotor is supported on low-friction ball bearings. Rotor clearance in the housing is such that a temperature rise due to high-power loading will not cause binding.

CIRCLE NO. 337

### Waveguide switch covers 10 to 15 GHz



Transco Products, 4241 Glencoe Ave., Venice, CA 90291. Evert Kjellberg (213) 822-0800.

WR-75 is a waveguide switch for the 10 to 15-GHz range and is qualified for space or commercial use. It uses a "transactor" actuator that combines the actuator rotor and switch rf rotor in a single assembly. Typical performance within specified bands is 1.06 VSWR, 0.05-dB insertion loss and 70-dB isolation.

CIRCLE NO. 338

### Small-diameter laser offered for OEM use

Hughes Laser Products, 6155 El Camino Real, Carlsbad, CA 92008. (714) 438-9191. \$115 to \$245; 4 wks.

Helium-neon lasers, using a 1.375-in. diameter unit (LC series), offer high efficiency with low operating-current demand and are aimed at the high-volume OEMs. The lasers are available in three basic formats: plasma tube alone, mounted in a cylindrical aluminum housing, or in a cylindrical aluminum housing with precision mounting grooves. Power output is 1 or 2 mW min. Beam diameter is 0.49 mm and beam divergence is 1.7 mrad. Random (better than 500:1) polarization is offered and the lasers can be provided with alternative beam divergence, noise and other characteristics to meet specific OEM requirements. The housed laser is 1.375 diameter and 11 in. long.

CIRCLE NO. 339



# now there is one... in signal processing

## IF and Microwave Components From One Source.

At Merrimac we have over 750 standard catalog items from DC to 18GHz with lumped elements, stripline or ferrites. If these standard units don't meet your requirements we pride ourselves in designing and producing custom or special components. . . in fact specials are over 50% of our business.

Additionally, we can design and manufacture Sub-Systems and Integrated Packages of active and passive IF, RF and Microwave components within an IF Processing Chain, Microwave sub-system or the combination of both. NOW THERE IS ONE IN SIGNAL PROCESSING. . . MERRIMAC with over 750 standard units, Custom components and Sub-system capability.

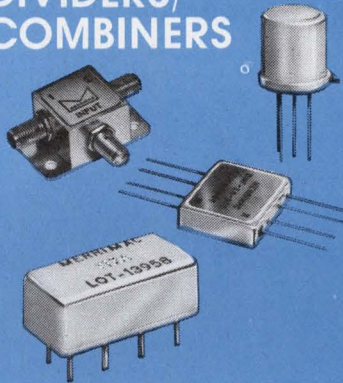
### SPORTS ILLUSTRATIONS SUITABLE FOR FRAMING.



Football, Basketball, Soccer and Hockey.  
Two Color reproductions FREE on request.

CIRCLE NUMBER 68

## AUDIO, VHF AND UHF IN-PHASE, REACTIVE LUMPED ELEMENT POWER DIVIDERS/ COMBINERS



### 50 kHz to 2 GHz

The winning combination is 83 different standard catalog 2, 3, 4, 6, 8, 12 and 16 way Power Dividers in TO-5, FLAT PACK, RELAY HEADER, LOW PROFILE PC PLUG-IN, SMA, BNC, TNC AND "N" CONNECTOR PACKAGES. Newest models feature ultra-broadband, multi-decade frequency ranges within the range of 50 kHz to over 1 GHz, at low costs.

Following are 4 standard low cost, ultra broadband, 2-way Dividers which demonstrate Merrimac's variety of different packages available off the shelf.

Frequency range (all models) 5 (or 10) to 500 MHz

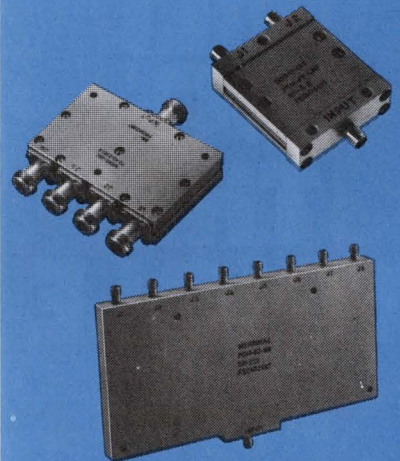
PACKAGE	MODEL NO.	PRICE	ISOLATION dB	PHASE BALANCE
TO-5 (0.3" high)	P-110	\$12.00	25 TYP. 20 MIN.	2°
RELAY HEADER	113-C	\$9.00	30TYP. 25 MIN.	1° TYP. 2° MAX.
FLAT PACK	PDF-2A-250	\$17.00	30TYP. 25 MIN.	1°
WITH SMA CONNECTORS	PDM-20-250	\$35.00	30 MIN.	1°

For complete detailed specifications on the above 4 models as well as our other 79 standard IF power dividers:

**Send for our  
NEW '77 CATALOG  
OF IF SIGNAL PROCESSING  
COMPONENTS.**

CIRCLE NUMBER 69

## MICROWAVE IN-PHASE, STRIPLINE BINARY POWER DIVIDERS/ COMBINERS



### .5 to 18.0 GHz

The winning combination is 58 different standard catalog 2, 4, and 8 way Power Dividers with SMA and TYPE N, in octave, multi-octave and straddle bands from 500 MHz to 18 GHz with in-line and angled output configurations.

Following are 4 standard models which are typical of the other 54 standard items; prices from \$85.00 for 2-ways to \$265.00 for 8-ways.

MODEL No.	POWER DIVISION	FREQUENCY RANGE (GHz)	ISOLATION dB(MIN)	INSERTION LOSS dB(MAX)
PDM-22-.75G	2:1	.50-1.0	20	.30
PDM-42-3.95GA	4:1	3.7-4.2	18	.50
PDM-82-6GA	8:1	4.0-8.0	17	1.0
PDM-22-15G	2:1	12.4-18	14	1.0

For complete detailed specifications on the above 4 models as well as our other 54 Standard Microwave Power Dividers:

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NEW '77 MICROWAVE  
CATALOG**

CIRCLE NUMBER 70

now there is one...in signal processing

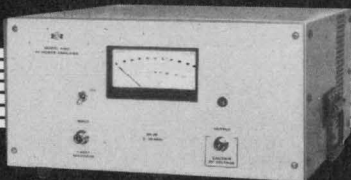
EXPORT REPRESENTATIVES DAGE CORP.  
STAMFORD, CONNECTICUT 06902  
(203) 324-3123 TWX 710-474-2490 Telex: 96-5928

# Merrimac

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# WILL DO THE WHOLE JOB!

If your application requires only moderate power, ENI's new Model A150 will do the job. All it takes is a laboratory signal generator and you've got a perfect match for RFI/EMI testing, NMR/ENDOR, RF transmission, ultrasonics and more.

Capable of supplying more than 150 watts of RF power into any load impedance, the A150 covers the frequency range of .3 to 35 MHz.

We could mention unconditional stability, instantaneous failsafe provisions and absolute protection from overloads and transients, but that's what you expect from any ENI power amplifier, and the A150 is no exception!

For additional specifications, a demonstration, or a copy of our new, full-line catalog, contact ENI, 3000 Winton Road South, Rochester, New York 14623. Call 716-473-6900 or Telex 97-8283 ENI ROC.

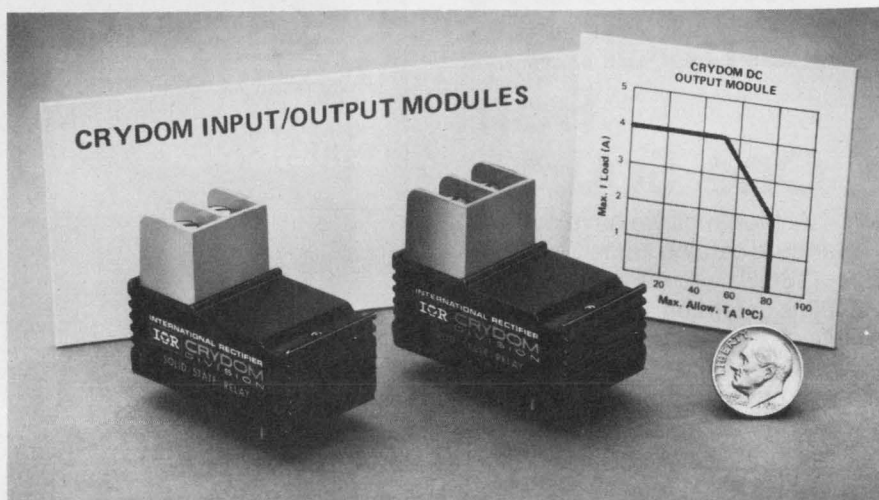
## ENI

The World's Leader in Power Amplifiers

CIRCLE NUMBER 71

## COMPONENTS

# Solid-state I/O relays control loads of up to 4 A



International Rectifier, Crydom Div., 233 Kansas St., El Segundo, CA 90245. (213) 322-3331. P&A: See text.

Packing more punch to the cubic inch, the Series-4 solid-state input/output switches can handle 4 A at up to 40 C—about 25% more than the closest competing units. These I/O circuits from the Crydom Div. of International Rectifier come in 1.75 × 1.3 × 0.96-in. panel-mount packages, compatible with the Teledyne Relays (Hawthorne, CA) 671 Series of I/O modules.

There are five input models and three output models in the series. Each module contains a LED status indicator and color-coded barrier-type power terminals. Output models can deliver 4 A at up to 40 C and are derated to 2.75 A at up to 70 C. All the units are essentially four-terminal solid-state relays that accept logic-level signals and switch a dc or ac power output. And all of them are available in two pinout versions, are optically isolated and have internal transient protection.

The S410, S411 and S412 (and the S450, S451 and S452 alternate pinouts) handle dc inputs of 10 to 32 V, 10 to 55 V and 40 to 120 V, respectively. Their maximum output voltage capability is 30 V dc from open-collector transistors. Two ac-input models, the S420 and S421 (and the S460 and S461) can handle inputs of 90 to 135 V and 180 to 270 V rms, respectively, and can also control output voltages of up to 30 V

dc via an open-collector output transistor.

One dc output model, the S430 (and the S470) accepts inputs of 4 to 8 V dc and handles output voltages of up to 55 V dc at currents to 4 A. Two ac output models, the S440 and S441 (and the S480 and S481) accept 3.5 to 8-V-dc control inputs and can handle 140 V ac and 280 V ac, respectively, at 4 A. The ac output models also have a maximum surge current of 80 A for 10<sup>2</sup> surges with a pulse duration of about 18 ms. Lower surges can be handled with higher repetition numbers. For instance, 30-A surges can occur 10<sup>10</sup> times, and last 18 ms.

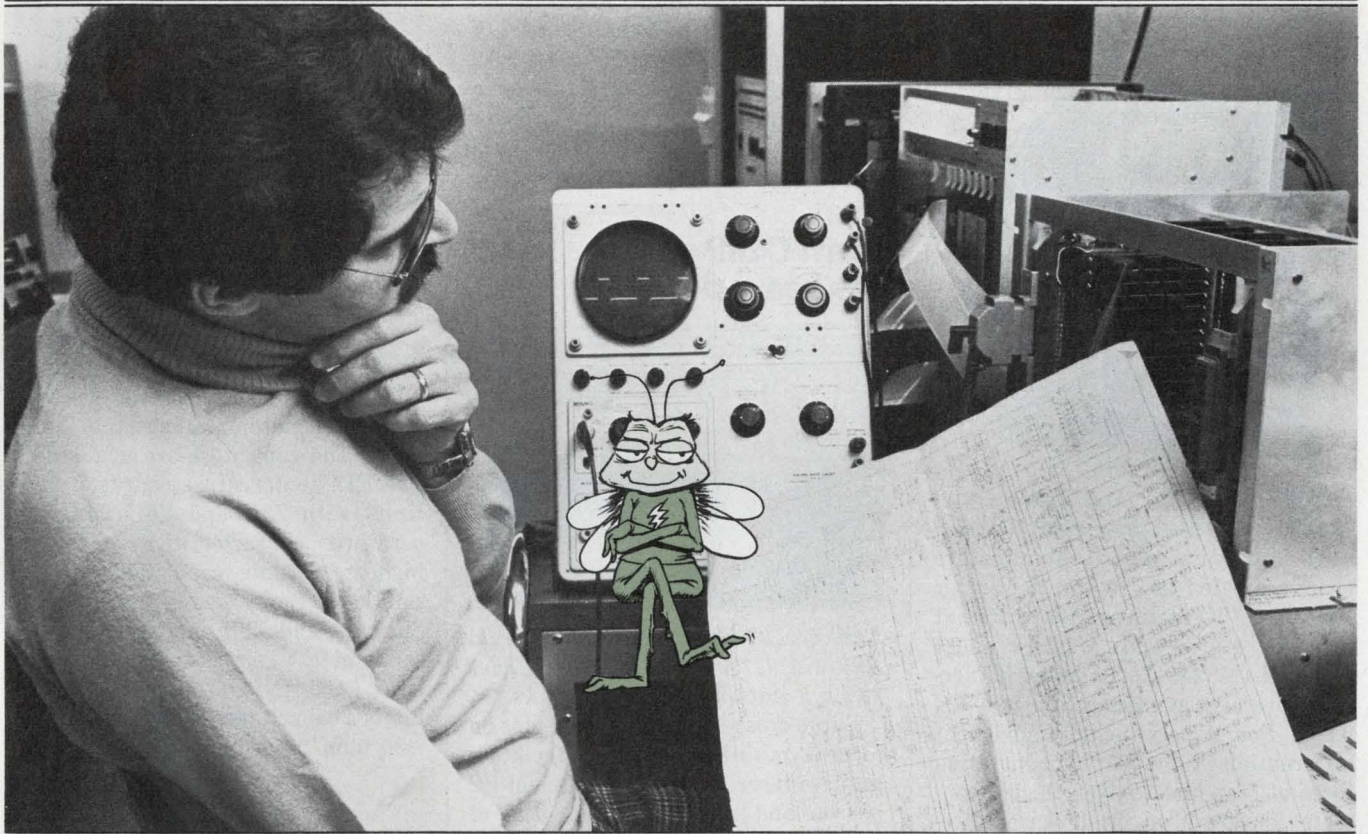
Competing units in the Teledyne 671 series are available with current-output ratings of up to 3 A at 25 C and derate down to 0.75 A at 70 C. They measure 3.1 × 2.06 × 0.99 in. Another Teledyne series, the 673 family, comes in 1.93 × 1.5 × 0.96-in. cases; dc models can handle 3-A loads up to 40 C and ac models up to 55 C. The units derate to 1.5 and 2 A, respectively, at 70 C. Typical price for a dc output model is \$12.75 in 100-unit quantities.

Prices for the Crydom Series 4 family, in 50 to 99 quantities, are as follows: \$10.65 for the S410, \$11.40 for the S420, \$18.15 for the S430, and \$15.15 for the S440. Delivery is from stock.

Crydom Div. of IR      CIRCLE NO. 305  
Teledyne Relays      CIRCLE NO. 306



# SOME STABILITY PROBLEMS ARE EASIER TO CURE THAN YOU MIGHT THINK.



Possibly you have become so accustomed (and inured) to a slight instability or drift in your equipment that you no longer regard the problem as soluble. You've learned to live with it.

But have your customers? They're still waiting for a solution. And if you can't provide one, someone else may.

There are so many stability problems directly traceable to resistive devices that skimping on the quality of a few critical resistors, resistive networks, or trimming potentiometers is simply bad design—and poor business.

Of course not every resistance application calls for the ultra precision and stability of a Vishay Bulk Metal<sup>®</sup> component. But in those circuits that are causing you trouble, you just may cure your customers' field-adjustment and MTBF problems with

a few well-placed Vishay resistors or trimmers.

Sure, they cost more. But the extra initial cost for Vishay precision often pays for itself in reduced compensating circuitry or temperature-controlling systems. And, too, the resulting higher reliability and better overall system performance prove you've got a good design—and that's good business.

Now a word, please, about the real meaning of precision in resistors. If you're paying for a tolerance of, say,  $\pm 0.05\%$  and after a few hundred hours it's loosened to  $\pm 1\%$ , you haven't gotten what you paid for. Vishay treats you much better than that. One of our unique contributions to your peace of mind is long-term load-life stability (within 0.05% for 2,000 hours under full rated power at 125°C as standard).

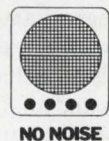
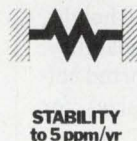
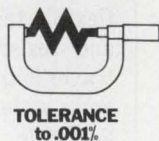
In fact, only from Vishay can you get the complete set of top performance characteristics (see below), a combination which will most often free your equipment from that tormenting bug.

Would you like to learn—in a half-day seminar in or near your plant—how to *make your own* custom bulk-metal resistors from Vishay chips, for breadboarding, prototype, or even production use in your products? Call us or write for information. Vishay

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Malvern, PA 19355; phone  
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TWX 510-688-8944.



## Only Vishay resistors give you all six top performance specs.



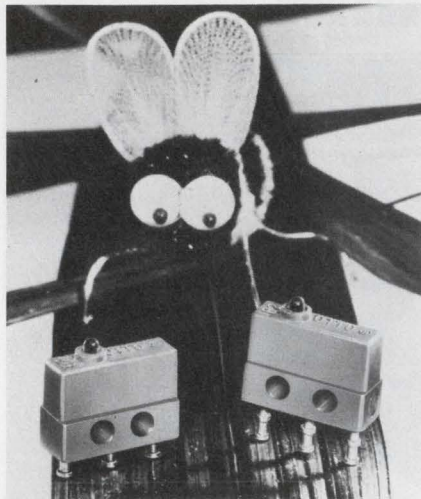
© Vishay

#6843

CIRCLE NUMBER 72



### Snap action provided by submini switch

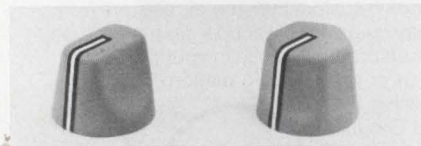


Otto Controls, 36 Main St., Carpentersville, IL 60110. Ron Sparks (312) 428-7171. \$1.93 (100 qty); stock to 6 wks.

The B2 snap-action subminiature switch is rated at 7 A for 28 V dc or 115 V ac. It features five different terminal styles and qualifies under M8805/4 (MS24547). Commercial versions are also available. Size is 0.5 × 0.2 in. Some specs include movement differentials to 0.005 in., operating force of 5 oz max., silver or gold contacts for low-level or dry-circuit requirements.

CIRCLE NO. 340

### Knobs ease control with tactile shapes



Aerospace Knob, 9835 Dupree St., South El Monte, CA 91733. (213) 442-4700.

Eight different tactile-knob shapes allow the user to differentiate among several controls located in the same area. An operator can easily distinguish between controls both visually and by tactile feel. Each knob shape has the same base diameter and height, thereby allowing interchangeability. Available options include assorted colors, markings and shaft-hole sizes, for a total of 192 part numbers.

CIRCLE NO. 341

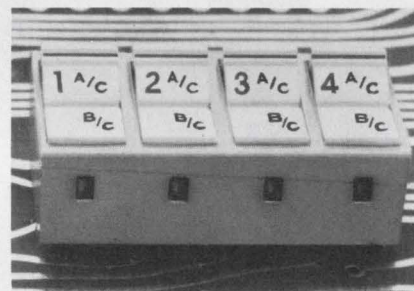
### Phone-hybrid Xformers carry up to 120 mA dc

Pulse Engineering, P.O. Box 12235, San Diego, CA 92112. (910) 335-1527. See text.

Three types of hybrid transformers, PE61555/6/7, include units capable of carrying up to 120 mA dc. All units provide a 2-wire return loss of 26 dB minimum and trans-hybrid balance of 45 dB minimum. Insertion loss is 5 dB max. They are priced at \$11.00 for a zero dc current model and \$26.85 for 900:900-Ω impedance at 120 mA dc.

CIRCLE NO. 342

### Form-C DIP switch has heavy-duty pins



EECO, 1441 E. Chestnut Ave., Santa Ana, CA 92701. (714) 835-6000. Under \$1.90: 2-station (1000 qty); 6 wks.

Large cross-section terminal pins on form-C mini-DIP switches facilitate positive insertion into sockets and PC boards and reduce the potential of misalignment and bending. A locking design ensures against accidental actuation and gold contacts feature positive wiping. Switches are available in 1-to-5 station models with green body, white rocker and red marking.

CIRCLE NO. 343

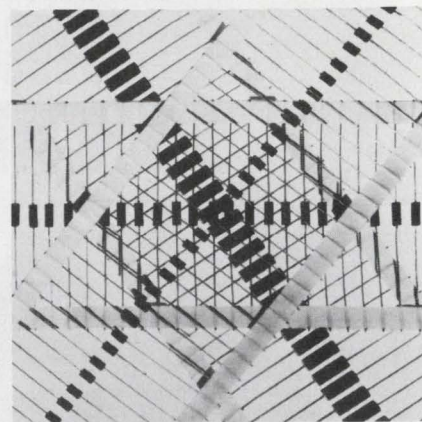
### Metalized capacitors are flame retardant

W-K Industries, 1960 Walker Ave., Monrovia, CA 91016. (213) 358-4914.

Flame-retardant film capacitors in several case styles have been added to the H-Series of metalized-polycarbonate types. They feature the same sizes and electrical characteristics as non-flame-retardant styles. And they are available in wrap-and-fill and epoxy packages, also in round and rectangular hermetically sealed styles. The units meet the highest classification standards of proposed UL 94 tests for flammability and oxygen-index test of ASTM D-2863-74.

CIRCLE NO. 344

### Capacitors packaged for high-speed insertion

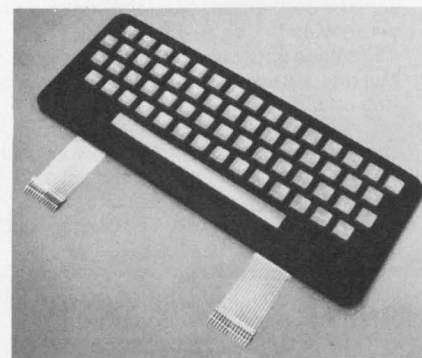


Sprague Electric, 347 Marshall St., North Adams, MA 01247. (413) 664-4411.

Type 292C capacitors, intended for volume production, are furnished mounted on lead tapes for use with high-speed automatic-insertion equipment. The capacitors are available in five EIA temperature characteristics. Units with Z5U and Y5U EIA temperature characteristics have the highest possible capacitance in the smallest case size, according to Sprague, and X5R and X7R types are semistable. Temperature characteristic COG (NPO)—neg-pos-zero—exhibits a capacitance change of less than ±30 ppm/°C from -55 to 125 C.

CIRCLE NO. 345

### Alphanumeric keyboard features 60 keys



Chomerics, 77 Dragon Ct., Woburn, MA 01801. Dick Seeger (617) 935-4850.

Alphanumeric keyboard, Model EA, provides 60 keys and a space bar coded into as few as 24 output lines on a flexible tail. Bounce is less than 3 ms and resistance less than 50 Ω. Key travel is 0.125 in. Custom key legends and a wide range of coding matrices are available.

CIRCLE NO. 346



# What is a BREECH-LOK™?

If you can imagine what the first transistor meant to the electronic industry, you have some idea what the Breech-Lok means to a connector user. It is truly unique in that the Breech-Lok provides a rugged, fool-proof mating system in a miniature electrical connector and meets all MIL-C-38999 specifications.

The Breech-Lok mechanism distributes the coupler load over solid metal locking lands, while internal drive threads provide the mechanical advantage required to engage contacts and interfacial seals.

## Features:

The interlocking metal lands replace bayonet pins and provide:

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- Withstands greater shock (MIL-S-901C high intensity) with backshells.

- Higher vibration (to 3G<sup>2</sup>/Hz) with backshells.
- Backshell threads suitable for MIL-C-915 cable.
- Scoop proof-all configurations.
- Quick coupling (90° to lock or unlock)
- 3 full mate indicators (audible, tactile, visual)
- Standard shell types, sizes, contact-inserts & tools.

## Applications:

Breech-Lok is a general purpose connector rugged enough for cabling, high shock or sustained vibration and is optimized for Electromagnetic Compatibility (EMC).

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## G&H Technology, Inc.

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CIRCLE NUMBER 73



# MIL-C-38999G SERIES IV



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Art

### Heard the one about the 8 poles?

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Further requirements included a change in bandwidth and a low cost objective. What to do? Fortunately we were able to help (or we wouldn't be writing this). By switching from board-mounted filter components to a P.C. filter assembly which plugs into the same space we came up with an economical eight-pole answer — and in jig time. Result: An improved product and a satisfied customer. We're happy too, with a substantial production order.

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# Pi

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The standard in  
monolithic crystal filters.

CIRCLE NUMBER 74

## COMPONENTS

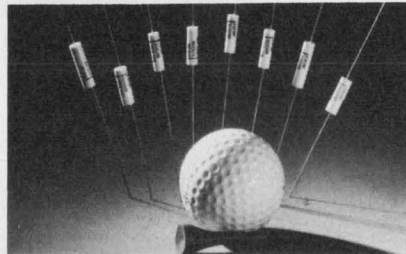
### Low-profile Xformers mount on PC boards

Abbott Transistor, 639 S. Glenwood Pl., Burbank, CA 91506. (213) 841-3630. \$5.75; stock.

Packaged for PC mounting with a height of only 1.03 in., the Model 6LP12-1 power transformer supplies 12 V ac at 0.1 A or 24 V ac center-tapped at 0.05 A at 1.2 W. Output-voltage tolerance is within 5% at full load with 115-V-ac input. Voltage regulation is better than 20%.

CIRCLE NO. 347

### Capacitors with high WV reduced in size



TRW Capacitors, 301 West "O" St., Ogallala, NE 69153. (308) 284-3611. \$0.40 up; stock.

Subminiature polystyrene dielectric capacitors with metallized carrier feature high-voltage breakdown capability and reduced size. The X1263UW has a 100-V-dc rating and is available in sizes from 0.001 to 1.0  $\mu$ F. A low controlled negative TC ( $50 \pm 50$  ppm/ $^{\circ}$ C) permits easy compensation in RC circuits. Dissipation factor is less than 0.1% at 1 kHz. Operating temperature is 0 to 70 C.

CIRCLE NO. 348

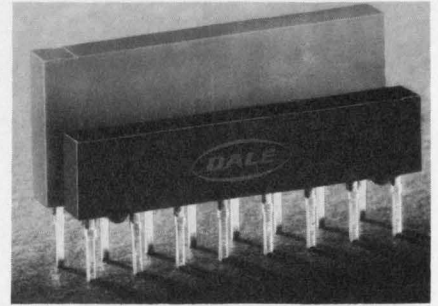
### Mercury thermostat senses within 0.03 C

Mack Electric Devices, 211 Glenside Ave., Wyncote, PA 19095. Ken McKinney (215) 884-8123. \$10 (25 qty); 4 wks.

Hermetically sealed mercury-in-glass thermostats accurately sense high or low temperatures within 0.03 C of set points. Factory calibrated, the drift-free precision units require no adjustment after installation. Temperatures are set from  $-57$  to  $+300$  C. Straight or angle-shaped, the units are 0.125-to-0.25-in. OD by 1.5, 3 or 7-in. long. Contact load is rated 110/220 V ac or dc, 10-mA noninductive.

CIRCLE NO. 349

### Thick-film network packs in 9 resistors

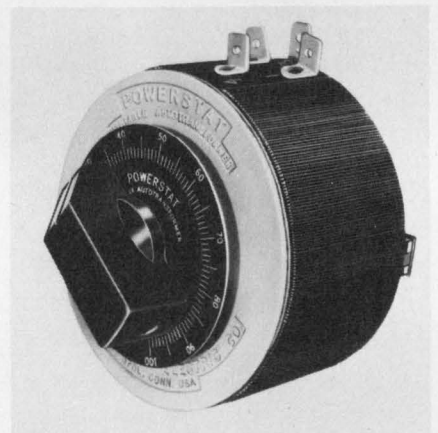


Dale Electronics, Box 74, Norfolk, NE 68701. Dave Dossett (402) 371-0080. See text.

A low-profile thick-film resistor network, MSP Series, accommodates up to nine resistors in a high-density package. The network with a 0.195-in. height and tough, molded coating is available in 6, 8 and 10-pin models. Individual resistors have a max rating of 0.18 W with a total max rating of 1.7 W per 10-pin package. Standard resistance range is 10  $\Omega$  to 1 M $\Omega$  with  $\pm 2\%$  tolerance. TC is  $\pm 100$  ppm/ $^{\circ}$ C from  $-55$  to 150 C. A five-resistor model with a resistance of 1 k $\Omega$  is priced at \$0.31 in 1000 quantity.

CIRCLE NO. 350

### Variable Xformer saves back-of-panel space



Superior Electric, 383 Middle St., Bristol, CT 06010. Ivan Bourgojn (203) 582-9561. \$16; stock.

Handling up to 1.5-A constant-current or up to 2-A constant-impedance loads, the Type 9 Powerstat variable transformer occupies a depth of 1.72 in. in back of a panel. The unit is offered only as a 120-V, single-phase, manually operated assembly. Taps permit an output voltage of 0 to 132 V. Any frequency between 50 and 2000 Hz can be used with no reduction in allowable output current.

CIRCLE NO. 356



## ICs & SEMICONDUCTORS

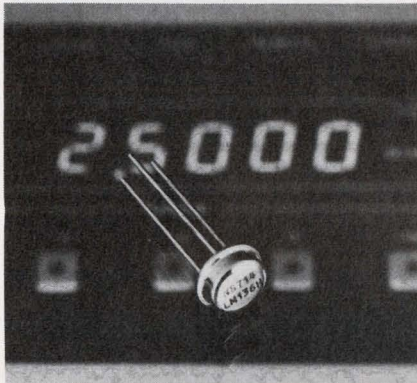
### Quad package combines op-amp and comparator

Motorola, P.O. Box 20912, Phoenix, AZ 85036. Bob Benzer (602) 962-3151. \$1.15 to \$7.50 (100 qty); stock.

A versatile IC, MC3405/3505, combines a pair of op-amps and a pair of dc comparators. The comparators and op amps are capable of common-mode inputs down to the negative supply, and operate from a single supply of 3 to 36 V, or dual supplies from  $\pm 1.5$  to  $\pm 18$  V. The devices are available in two temperature ranges in plastic and ceramic 14-pin DIPs. The MC3405 operates from 0 to  $+70$  C and the MC3505 is specified from  $-55$  to  $+125$  C.

CIRCLE NO. 357

### Precision reference lets you adjust TC



National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. Dave Whetstone (408) 737-5856. See text; stock.

Using a differential input circuit, a 2.5-V band-gap reference IC (LM136/236/336) has adjustable TC and performs as if it were a zener shunt regulator. The device is usable as either a positive or negative reference with adjustable breakdown voltage. Regulation is over a range of 300  $\mu$ A to 10 mA. Dynamic impedance is 0.6  $\Omega$  max. The LM136 operates from  $-55$  to  $+125$  C and the LM236 range is  $-25$  to  $+85$  C. Both come in TO-46 metal packages. The LM336 operates from 0 to  $+70$  C and is available in a three-lead TO-46 metal or a TO-92 plastic package. Unit prices for 100-up quantities are: \$6.00, \$4.20, \$2.20 and \$1.20 for the LM 136, 236, 336 (TO-46), and 336 (TO-92), respectively.

CIRCLE NO. 358

### Quad devices serve as plasma-display drivers

Texas Instruments, P.O. Box 5012, M/S 308 (Attn: Plasma Display Drivers), Dallas, TX 75222. Dale Pippenger (214) 238-2165. 100-qty. prices: \$1.41 (75426), \$1.76 (75427); stock.

Two IC plasma-display drivers, the SN75426 and SN75427, are quad devices capable of 90-V output swings. The devices have CMOS-compatible in-

puts, 1-M $\Omega$  input impedance and 30-mA clamp diodes on the output. Independent addressing of each gate permits serial or parallel use. Logic of the two drivers is complementary to permit controlled writing or erasing at a specified point on the display. The devices require two power supplies, one for the logic section and one for the high-voltage outputs. Both drivers operate from 0 to 70 C.

CIRCLE NO. 359

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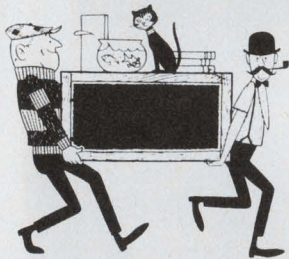
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CIRCLE NUMBER 77

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## ICs & SEMICONDUCTORS

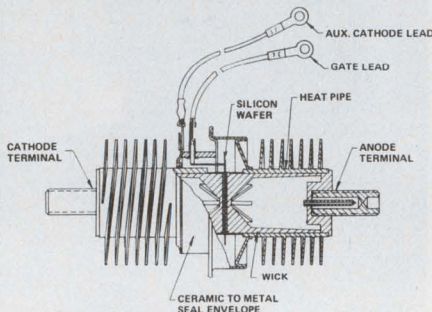
### Static RAM keeps power drain low

Mitel Semiconductor, 18 Airport Blvd., Bromont, Quebec, Canada JOE 1LO. (514) 534-2321. \$12.30 to \$22.40; stock.

A 1024-bit static RAM, the SIL 1902A, keeps the power drain low, even at high temperatures. At 125 C, the worst-case standby current is only 190 nA/bit with a  $V_{cc}$  of 5 V, less than 1 mW total. The device has a maximum access time of 800 ns. It is TTL compatible, including its three-state output, and features a low supply-voltage memory-retention capability. Prices vary with package type and operating temperature range.

CIRCLE NO. 360

### Power devices have heat pipes bonded to wafer



RCA, New Holland Ave., Lancaster, PA 19604. (717) 297-7661. See text.

Silicon power devices that have heat pipes bonded directly to the device wafers feature high current, high blocking voltages, light weight and small size. They are called "Transcalent" devices. Types are the P95000EB 250-A rectifiers with blocking voltages to 1200 V, the P95200EE4 100-A npn transistors, and the P95400EB 400-A thyristors (SCRs) with blocking voltages to 1200 V. The rectifier and thyristor series weigh 12 oz and have volumes of less than 14 in<sup>3</sup>. The transistor has a dissipation of 500 W, yet weighs less than 2 lb and requires less than 70 in<sup>3</sup>. The devices can be supplied with radiator structures for either air or liquid cooling. Prices in sample quantities are: \$1125 for the rectifier, \$1375 for the thyristor, and \$1825 for the transistor.

CIRCLE NO. 361

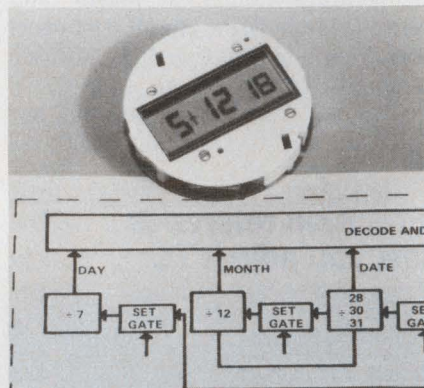
### Bridge rectifier handles 10 A

Solitron Devices, 8808 Balboa Ave., San Diego, CA 92123. Larry Simmons (714) 278-8780.

Using a process that maximizes thermal transfer, the TJ118 bridge rectifier operates at high current levels. The units handle up to 10 A and 600 PRV. Fast-recovery versions with  $t_{rr}$ 's of 250 ns are available.

CIRCLE NO. 362

### Six-function watch chip drives 5½-digit LCD



Solid State Scientific, Montgomeryville, PA 18936. A. Genchi (215) 855-8400. \$2.95 (100 qty).

The SCL 5450 chip provides all six timekeeping functions and directly drives a 5½-digit alphanumeric LCD. Time, including seconds, is displayed continuously. Month, date and day of week are displayed upon interrogation. The chip features a high-density CMOS process and measures only 142 mils per side. Operating from a 1.5-V battery, the chip includes a high-efficiency voltage doubler/tripler to provide the LCD drive voltage.

CIRCLE NO. 363

### 4-k static RAM accesses as fast as 100 ns

Zilog, 10460 Bubb Rd., Cupertino, CA 95014. Jim Gibbons (408) 446-4666. See text; stock.

The Z-6104 is a 4096 × 1-bit static RAM with an access time as fast as 100 ns and low standby current. The memory is available in five speeds from 100 to 300-ns access time. Pricing for 100 to 999 quantity in ceramic package is \$20 for a 250-ns circuit and \$22 for a 200-ns version.

CIRCLE NO. 364



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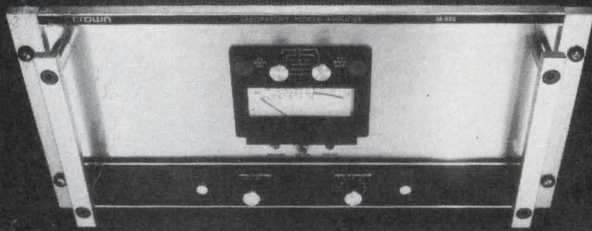
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CIRCLE NUMBER 79





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CIRCLE NUMBER 80

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**Model D-72C**  
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Model D-72C permits time recording by two systems; mechanical recording chart feed and time axis sweep by time.

**2. High performance chart attraction**

Troubles due to faulty attraction of the chart due to friction during chart feed has been completely eliminated regardless of the temperature or feed rate.

**3. Automatic chart replacement in XY recording**

The chart can be automatically fed and stopped at the end of chart replacement with one touch by loading roll chart.

**4. Remote control terminals**

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**5. Easy-to-install optional chart take-up device (Optional)**

**6. Felt tip pen (Optional)**

**7. High input impedance 10MΩ fixed**

• For further information, please contact:

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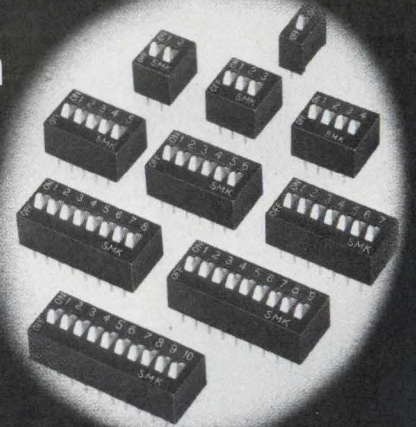
5-5-2, Yutenji, Meguro-ku, Tokyo, Japan. TELEX: 0246-8107

**PAYTON ASSOCIATES INC.**

244 Delaware Avenue, Buffalo, New York 14202 Phone: (716) 852-6213, 855-1314

CIRCLE NUMBER 81

## DIP Switch Line from SMK



The **JS-8722 Series** is a complete line of DIP Switches, from 1 to 10 positions, featuring sealed construction to prevent flux contamination during wave soldering. A clip-type wiper design assures positive 2-sided contact to provide excellent shock and vibration characteristics.

Available in SPST configuration, the switches are rated at 24V DC at 300mA switching, resistive load, and will operate from -20°C to +60°C.

Typical price for a 4 position DIP Switch in 100 piece quantity would be \$1.16 each.



SMK Electronics Corporation  
 of America

118 East Savarona Way Carson, California 90746

Tel: (213) 770-8915

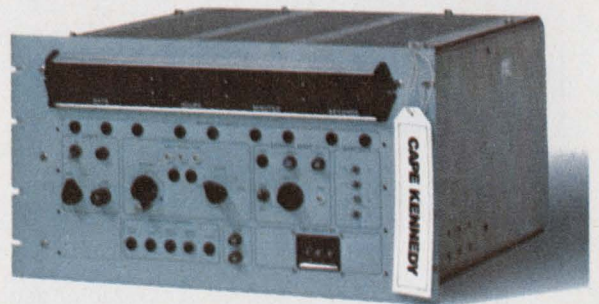
CIRCLE NUMBER 82

ELECTRONIC DESIGN 25, December 6, 1977



# Great Timing Products...

## One generation



## after another

## after...



## Introducing Moxon's new Model 175 system that performs in more timing applications...

Since time measurement began there have been constant improvements in techniques and accuracy. So too, since the aerospace days of Astrodata timing equipment leadership... a tradition of leadership that Moxon continues today.

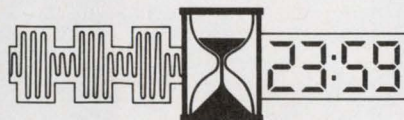
Moxon's newest state-of-the-art Model 175 timing systems have the same precision, quality, and *reliability*... not only for military and aerospace applications, but also for numerous medical, scientific, industrial and related appli-

cations, as well.

To meet these requirements, Moxon designed the Model 175... modular timing systems which let the user select what's needed now, and expands it as needed in the future. Complete timing systems start at \$800.

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CIRCLE NUMBER 281



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CIRCLE NUMBER 282



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CIRCLE NUMBER 283

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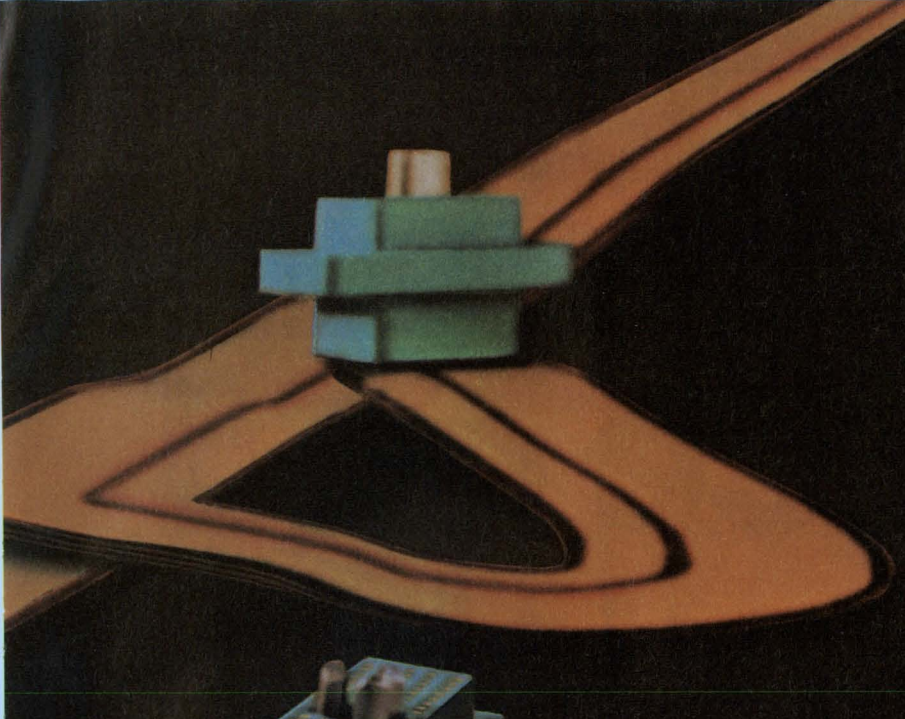


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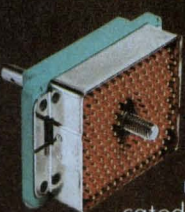
When it's a complex fighting machine like the Navy's A-6E and its TRAM target-sensing system's highly sophisticated avionics, you connect with Hughes capability. Hughes, because of our deep involvement in high-technology military and aerospace programs: Phoenix, Maverick, Lance, Minuteman, AWACS, F-14, F-15, Space Shuttle, Viking, Sonobuoy, F-4, A-7, Condor, Standard Missile, F-8, Trident, Hobo, Sprint, and many more.

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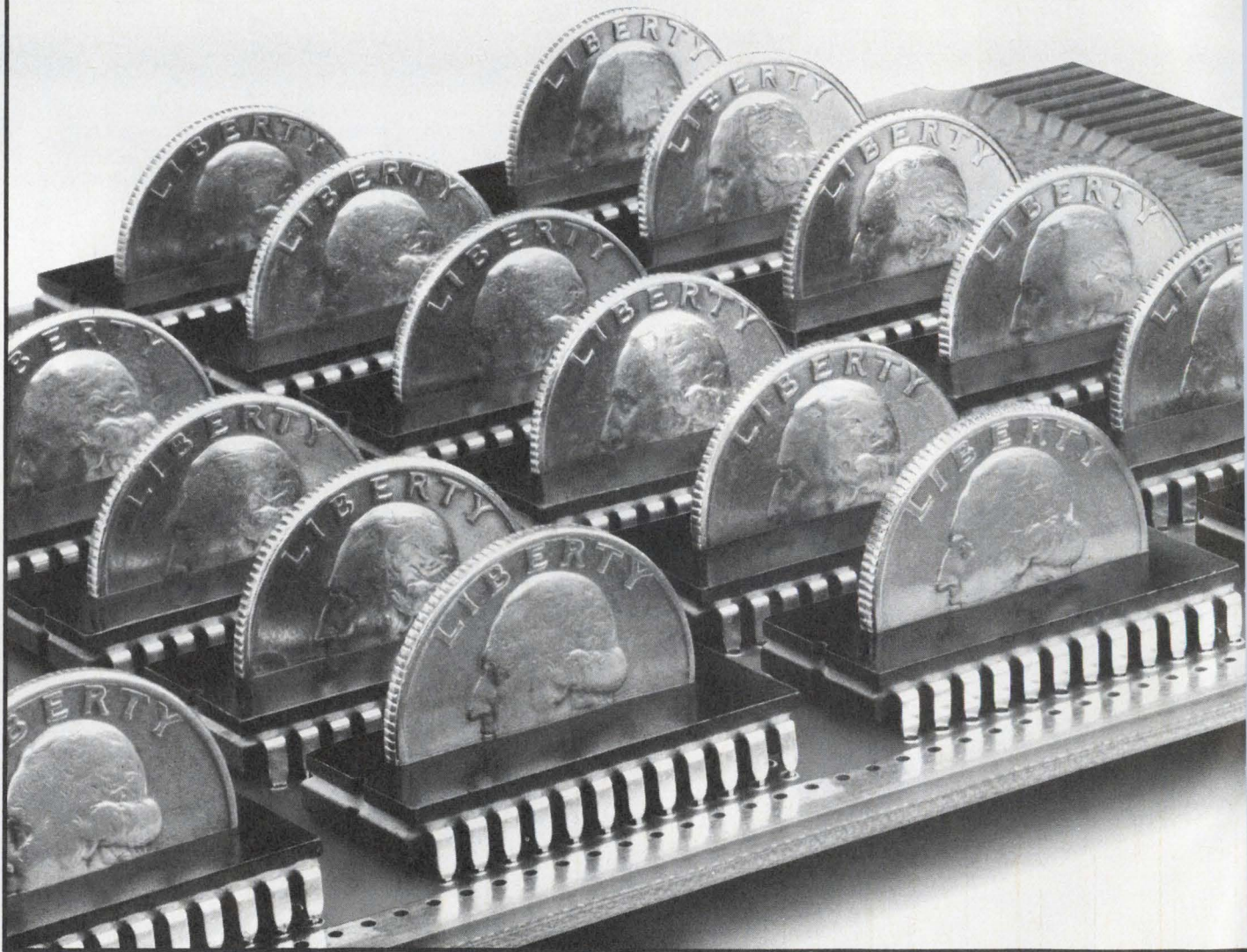
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For higher density applications we've got 9K (6260-1) and 10K (6255-1) ROMs, both with 100nS access.

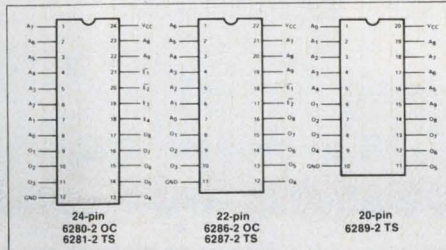
Or for the ultimate in bipolar ROM density, look into our 6275-1 bipolar 16K ROM, the world's fastest at 110nS access. All are available in open collector or tri-state outputs and in commercial or MIL-temp ranges.

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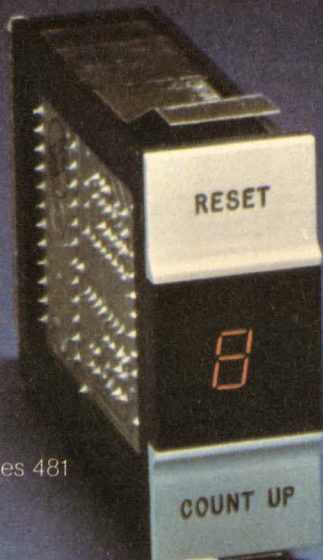
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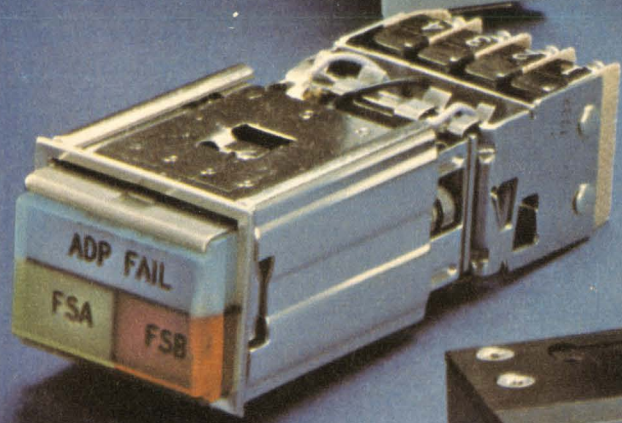
Series 481



Series 800



Series 600



Series 10



Series 925



Series 90



Series 440

Series 10, Circle No. 131    Series 600, Circle No. 135  
 Series 90, Circle No. 132    Series 800, Circle No. 136  
 Series 440, Circle No. 133    Series 925, Circle No. 137  
 Series 481, Circle No. 134



Modern electronics demands switches of all types. Switches capable of withstanding the most rugged working conditions. And giving reliable service that continues throughout the life of the systems they serve.

The same electronic technology demands displays that speak to you clearly. Conveying vital information without confusing the issue.

MSC manufactures a wide range of switches and displays that meet the many applications of today's technology. All have unique characteristics which help to make your system just that little bit more easy to operate and comprehend.

Small wonder that MSC switches and displays are an everyday word in avionics, military and shipboard applications. And in computers, telephone panels and hundreds of other uses which have a daily influence on your life.

Take a look at the variety:

#### **Series 10**

This rugged, versatile four lamp pushbutton switch has become the standard of the industry with many diverse applications in control panels for fields and power

ships, oil generating plants, just to name a few. This switch has UL approval, is QPL (MIL-S-22885/9/10) listed and features positive indexing and front panel re-lamping without tools. RFI protection, solid state switching, and "high shock" modifications are available as options.

**Series 90**—This two lamp pushbutton switch is cased in stainless steel and is resistant to most environmental extremes. A favorite of designers everywhere because of its overall versatility and the wide variety of terminations available for low cost assembly. Standard features include: UL approval, QPL (MIL-S-22885/58), relamping and legend change from front panel without tools, and a wide choice of switch actions.

**Series 440**—This switch series provides the electronic designer with a microprocessor compatible, touch activated solid state switch. The 440 switch becomes part of the electronic circuitry without the need for interface. Because it is a capacity transducer, the reliability of the switch equals that of any transistor. The compact design eliminates the need for deep panel clearance. The touch face incorporates an optional LED as a visual activation indicator.

**Series 481**—A true solid state electronic "thumbwheel" switch with the same design advantages as the Series 440. Incorporating two series 440 switching functions with an encoder/decoder/driver IC which makes an all solid state lighted thumbwheel switch with true BCD output. The seven segment LED display occupies the center section of the switch plate. The bottom plate advances the count and the top plate resets the switch to zero.

**Series 600**—The Series 600 computer-grade switch is the most versatile switch in its class; unmatched performance is provided by the

performance is provided by the wiping action contact design unavailable in any other line of low-cost, computer-grade lighted pushbutton switches. Available in many different mounting configurations, sizes, styles and colors, the 600 also offers a wide choice of switch actions.

**Series 800**—Ideal for matrix mount applications, this four lamp pushbutton switch is available in two display face sizes. A standard 3/4" square and a 3/4" by 1" provide the flexibility needed in panel design. Standard features include positive indexing and front panel relamping without tools. Optional solid state models and electrical interlock holding coils are available. The 800-H has received MIL-S-22885/74/80 approval.

**Series 925**—Designed to meet MIL-R-28803, the 925 offers sunlight readability, required for avionic displays and other control panels used in high ambient light conditions. Utilizing fiber optics, this compact unit can be ordered with 7 or 16-segment displays. Other sizes and character configurations are also available. All MSC fiber optic displays are re-lampable and replaceable from the panel front.

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# Digital announces a PDP-8 with an enormous memory.

Something big has just happened to the world's most famous small computer. In fact, something enormous.

Digital has just put 128K of memory into the PDP-8.

This act is brought to you by a powerful new memory management option called KT8-A. And by two new MOS memory modules that fit large amounts of memory into small amounts of space. Simply by adding these 16K or 32K modules in whatever combination you choose, you now expand your PDP-8/A into something bigger. What's even better, you can mix MOS and core. And that means you can protect your program in non-volatile core while you expand your data base in MOS.

And thanks to the KT8-A all this memory is under new management. Not only does the KT8-A let you address up to 128K words of memory, but it also offers you memory relocation and memory protection, while asking little in operating system overhead so you get faster system performance.

What's the cost of these enormous advancements? That's the next attraction.

The new PDP-8A MOS memory models are available at prices that are as crowd-pleasing as their performance. For a 16K 8A205 you'll pay as little as \$3900 (quan. 1). 8A425 with 64K

is as low as \$11,000. And the top of the line 8A625 with 128K is yours for as little as \$18,050.

They're the new big-memory Eights from Digital. Step right up.

**Large memories aren't our only new trick.**

New hardware and software improvements are also in the PDP-8 spotlight.

The VK8-A is a new low cost PDP-8A option that provides high quality video output plus keyboard and printer interfaces. Video character generation uses a super-sharp 9x9 dot matrix for high resolution on single or multiple CRT monitors up to one thousand feet away.

Also new for PDP-8 users is MACREL/LINKER — a sophisticated assembler with MACRO facilities that lets you implement, expand and update your system faster while reducing software development time.

And last but not least there's DECNET 8 — a series of software protocols that let you

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could want from an  
optoelectronics source.**

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Foremost among the new technologies and products are LCD displays, high-power infra-red emitters, green, yellow and red GaP LEDs, and a full line of photo detectors. Nearly all types of optoelectronic products will now be available from Litronix.

Litronix will operate under its own name and market all products in the U.S. and abroad through the same distributors and sales representatives as before.

## **All resources devoted to components**

Litronix ceased manufacture of calculators and digital watches in January 1977. All the design and production capability once devoted to these products is now directed entirely to components. The component portion of the company's business has always been highly successful. Now, operating from a strong financial position, Litronix will resume its place as

the leading source of advanced, cost-effective optoelectronic components.

## **New, advanced products coming fast**

Already in 1977 Litronix has developed 21 new products. With the recent affiliation, new product development is being further accelerated. The company's line of displays, lamps and other opto devices is being broadened and upgraded. Special emphasis is being placed on "intelligent" displays and indicators — devices which incorporate a display and integrated logic in the same package.

The recently introduced DL-1416 alphanumeric display, which interfaces exactly like a RAM, is an apt example. Such devices eliminate need for much associated interface and logic circuitry — simplifying design and producing a sizable net saving in the production cost of customers' products. Litronix is the uncontested leader in this promising extension of optoelectronic integration.

When you have need for virtually anything in optoelectronics, contact Litronix at 19000 Homestead Road, Cupertino, California 95014. Phone (408) 257-7910.

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CIRCLE NUMBER 289



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## INSTRUMENTATION

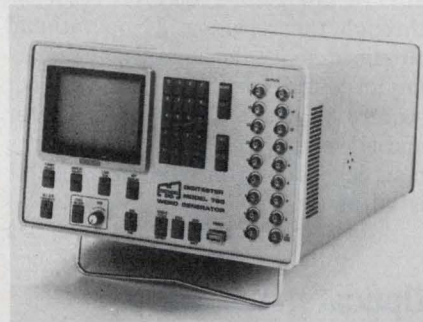
### Broadband sweep osc boasts lower price tag

Wavetek Indiana, 66 N. First Ave., Beech Grove, IN 46107. Mari Vian (317) 783-3211. \$625; 4 wks.

Model 1061 sweep generator is said to be one-half the cost of comparable units on the market. The instrument has a frequency range of 1 to 400 MHz and features p-i-n diode leveling to provide an output flatness of  $\pm 0.25$  dB. Both harmonic and nonharmonic spurious signals are 30-dB below the output. The unit has provision for up to six crystal-controlled, birdy bypass markers with amplitude adjustment of 2 mV to 2 V pk-pk and width adjustment of about 100 to 400 kHz. The markers are accurate to 0.005%. The sweeper is available with 50 or 75- $\Omega$  outputs. Also included are programmable center frequency, sweep width and amplitude over the 20-dB vernier range.

CIRCLE NO. 365

### Data gen has keyboard entry and CRT display

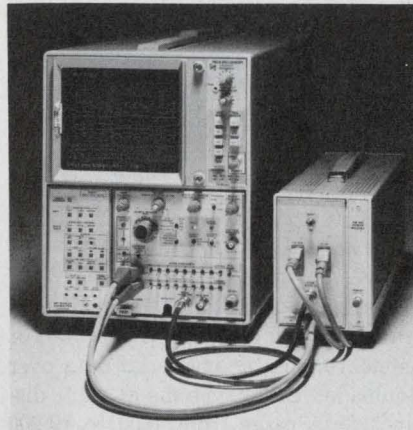


Moxon, 2222 Michelson Dr., Irvine, CA 92715. Tom Clark (714) 833-2000. \$3950; stock to 4 wk.

Data generator, Model 720, features a hex keypad and scratchpad memory that directs the integral CRT display to show programming of 1024 serial bits or 64-word, 16-bit parallel channels as they are being formulated for loading into a transmit memory. In operation, the 720 can generate an algorithmic pattern that will pin-point faults, thus simplifying testing. Output data rates to 20 MHz can be generated internally or fed in from an external source. Operators are offered a choice of 1 bit, 1 word, start-stop bits or continuous run at true positive and negative TTL levels.

CIRCLE NO. 366

### 16-channel digital latch added to logic analyzer



Tektronix, P.O. Box 500, Beaverton, OR 97077. Wyn Giluck (503) 644-0161. \$1350; 4 wk.

An extension of the Tektronix logic-analyzer line, the 16-channel DL 502 digital latch makes asynchronous measurements by latching pulses as narrow as 5 ns and amplitudes as small as 500 mV—centered on a threshold set by the user. It plugs into any TM 500 mainframe/power module. The digital latch is interfaced to the LA 501W logic analyzer with both housed in a TM 500 mainframe. It can also be used for convenient connection to the 7D01 analyzer in a configuration such as the 7603 scope/7D01F logic-analyzer/display-formatter combination. The P6451 low-capacitance data-acquisition probes connect to the DL 502 which then interfaces to either the 7D01 or LA 501W logic analyzers.

CIRCLE NO. 367

### Auto multimeter spans 5 Hz to 520 MHz

John Fluke Mfg., P.O. Box 43210, Mountlake Terrace, WA 98043. (800) 426-0361. \$620; 6 wks.

The 1912A automatic multimeter provides a frequency range of 5 Hz to 520 MHz and has period, period average and totalize capability. Up to  $10^4$  periods can be averaged in the period-average mode giving a resolution range of 100 ns to 10 ps. Up to 9,999,999 events can be counted in totalized mode at a rate of up to 125 MHz. Input impedance is 1 M $\Omega$  from 5 Hz to 125 MHz and 50  $\Omega$  from 50 to 520 MHz. Sensitivity is 15 mV. The display is a 7-digit LED. The counter may be ordered with a 2 ppm or 0.5 ppm TXCO.

CIRCLE NO. 368

# Available Now!



## MICROPROCESSOR

**BASICS**, edited by Michael S. Elphick. Here's the nitty-gritty on design selected from *Electronic Design* for the eight currently popular microprocessors: 8080, 6800, F8, PACE, IMP, 2650, 1802, and 6100. Each chapter discusses one model, detailing its advantages, disadvantages, architecture, capabilities, and includes many illustrations of its applications. #5763-6 paper 224 pp., \$10.95

## ORGANIZING AND DOCUMENTING DATA PROCESSING INFORMATION,

by Thomas R. Gildersleeve. Write sharp, precise DP documents that command attention. This book will show you how to... prepare a first draft... shape your sentences for reading ease... organize a document for quick study. Filled with examples of great DP writing and scores of exercises for practice. #5739-3 paper, 160 pp., \$7.95

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## DATA PROCESSING

### Direct-dial data station offers fast operation



*International Communications, 8600 NW 41st St., Miami, FL 33166. (305) 592-7654. 6 to 8 wks.*

A high-speed direct-dial data station, the 40+TK1, cuts costs and improves operator efficiency in communication systems. It stores messages in a MOS solid-state buffer rather than on paper tape or magnetic tapes and can replace low-speed, leased-line and tape-operated terminals. Speed ranges from 1200 to 2400 bit/s. Operation is over dial-up lines. The data station includes an ICC 40+ display, keyboard, control modules, buffer, and a 110-char/s printer and desk.

CIRCLE NO. 369

### 6-bit computer has enhanced software

*Interdata, 2 Crescent Pl., Oceanport, NJ 07757. (201) 229-4040. \$27,645 (typ); 6 wks.*

The Model 8/16E processor, Interdata's first 16-bit computer system, is capable of addressing 256 kbytes of mainframe memory. The system includes the 8/16E computer as well as two enhanced software packages, the OS/16 MT2 operating system and Extended Fortran IV. The 8/16E processor includes such big-machine features as 16 general purpose registers, an IBM-like instruction set, list-processing instructions, dual input/output bus architecture and 255 automatic input/output channels. Its integral memory-management hardware permits addressing up to 256 kbytes. Memory is available in 32 kbyte increments with an access time of 275 ns and a cycle time of 750 ns.

CIRCLE NO. 370

### Limited-distance modem handles 8 data rates

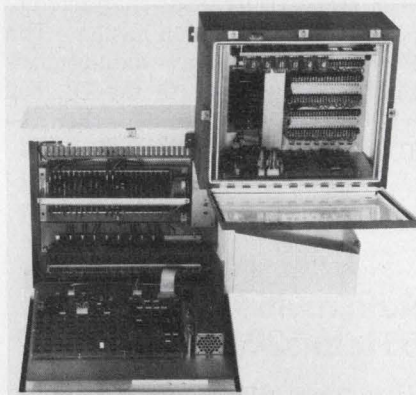


*General DataComm Industries, 131 Danbury Rd., Wilton, CT 06897. (203) 762-0711.*

The LDM-1 limited-distance modem transmits and receives synchronous or asynchronous binary serial data over nonloaded cable systems at eight distinct data rates from 1800 to 19,200 bits/s. The device contains a continuous or controlled carrier feature, operates half or full duplex over 4-wire systems and can be used in point-to-point and multipoint networks. A phase-delay method of data encoding permits the sending of a narrower spectrum. The modem has diagnostic functions, with LED indicators, that permit local and remote verification of operation.

CIRCLE NO. 371

### Remote terminals mate with any popular $\mu$ C

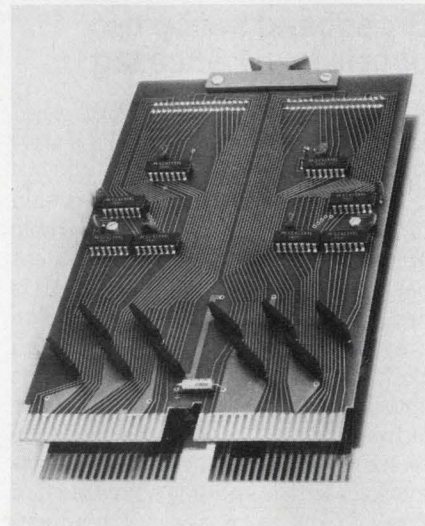


*LFE Control System Ind., 2920 San Ysidro Way, Santa Clara, CA 95051. (408) 732-9400.*

Model 5000/6000 remote terminal units (RTU) can be linked to central computers via in-plant wiring, phone circuits, microwave or uhf/vhf radio. U/ART-compatible word formats and an RS232-C serial interface permit RTU-CPU communications via any computer's standard serial asynchronous interface port at bit rates to 1200 baud. Geometric coding assures virtual elimination of undetected command and data errors. The units can have up to 16 kbytes of PROM or RAM memory.

CIRCLE NO. 372

### Fast bus-repeater is for PDP-11 systems



*Datafusion, 21031 Ventura Blvd., Woodland Hills, CA 91364. Dick Erickson (213) 887-9523. \$995.*

The OSB11-A bus-repeater allows for the physical and electrical extension of the Unibus for the DEC PDP-11 series computer. Each repeater will drive up to 19 extra bus loads or up to a 50-ft extension of the bus cable length. It is compatible with the DEC DB11-A repeater and has the following features: approximately four times faster in MSYNC to return SSYNC response through the repeater; 34 operational circuit components; installed by replacing an M920 jumper module; does not require an extra system unit. Master and slave sync response time is 80 ns max. Signal delay through the repeater is 40 ns max.

CIRCLE NO. 373

### Optical mark reader eliminates keypunching

*NCS/Equipment Div., 4401 W. 75 St., Minneapolis, MN 55435. Tom Probst (612) 830-7600. \$1050/mo. lease.*

Sentry 7005 is a high-speed unit that can read and record nearly  $7 \times 10^6$  items of information from 2400 response sheets every hour, eliminating keypunch operation. The device is available in both stand-alone and on-line models. The on-line feeds information to a computer mainframe; the stand-alone puts the information onto a reel-to-reel tape for processing. Options include a sorter that automatically selects out mismarked response sheets, and a transport printer to encode or abstract key information and print it on each sheet.

CIRCLE NO. 374



# Datel's Microelectronic Data Acquisition System

HDAS-16/HDAS-8

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- ▶ 12 bits Resolution
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- ▶ Priced at \$295.00\* (1-9)

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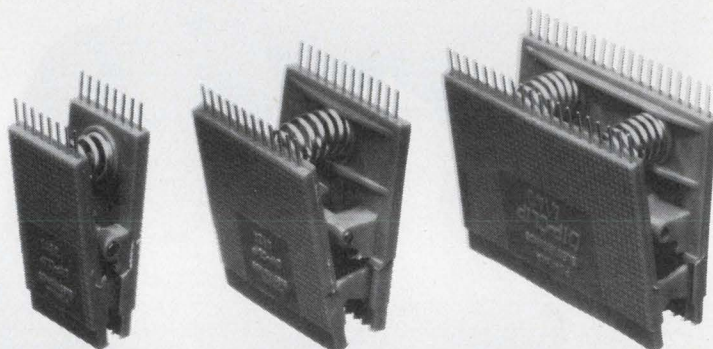
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CIRCLE NUMBER 83



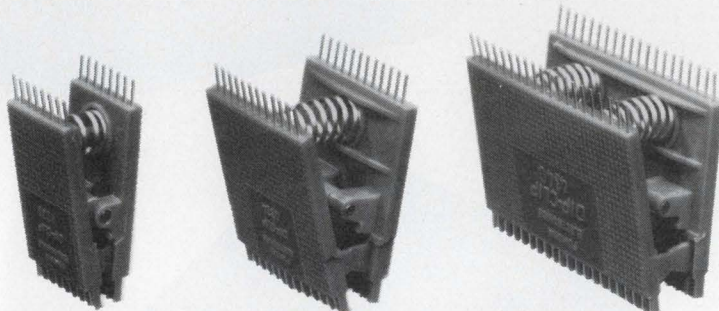
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**Model 4124**  
24 Pin

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**Model 4236**  
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CIRCLE NUMBER 84

## DATA PROCESSING

### CRT terminal handles bilingual characters

*Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. Mike Fournell (415) 493-1501. \$4000; 12 wks.*

Offering 64 Japanese characters (Katakana) and a 128-character Roman set, the HP 2645K is easily switched from one character set to another. It can even mix the characters within the same display. The terminal uses a Japanese keyboard layout as well as the standard Roman layout, having both legends on the keycaps. The unit can transmit or receive bilingual information using either shift-in or shift-out control characters or an 8-bit code-extension protocol. Operation is up to 4800 baud and asynchronous point-to-point data communication uses an RS232C interface.

CIRCLE NO. 375

### Display formatter gives 3 formats on scope

*B P Instruments, 10601 S. De Anza Blvd., Cupertino, CA 95014. (408) 446-4322. \$1128; 6 wks.*

The 50D011 formatter expands the capabilities of Models 50D and 50D16 logic analyzers. The unit permits displaying digital data on any X-Y display or oscilloscope in any of three formats: timing domain, data domain, and map mode.

CIRCLE NO. 376

### Fixed-head disc system features high speed

*Data General, Route 9, Westboro, MA 01581. Bob Palmer (617) 366-8911. \$9900/\$13,900; 12 wks.*

High speed, extended-controller features and configuration flexibility make the fixed-head DG/disc subsystems useful where high-speed data access or acquisition rates are required. The subsystems transfer data at the rate of 910 kbytes/s; average access time is 10.12 ms. Drives are available in 2-Mbyte (Model 6064) and 1-Mbyte (Model 6063) capacities. Maximum subsystem capacity is four drives per subsystem in any combination of the two sizes. The devices can be used with NOVA or ECLIPSE computers.

CIRCLE NO. 377



# Datel's 16 Bit, Microelectronic D/A Converters

DAC-HP16BMC & DAC-HP16DMC

- ▶ 16 Bit Binary or 4 Digit BCD Coding
- ▶ 15ppm/°C Tempco, max.
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- ▶ 0 to +10V or ±5V Output
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- ▶ Priced from \$119.00\* (1-24)

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(100's)

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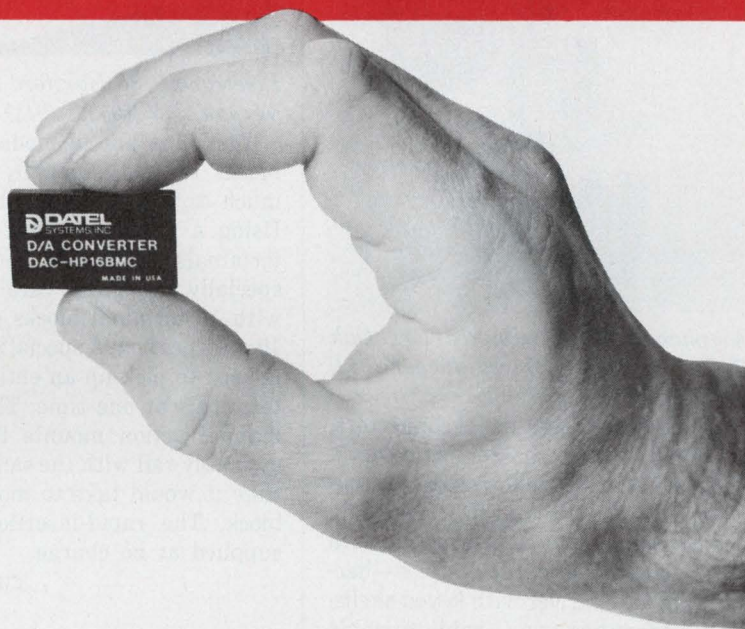
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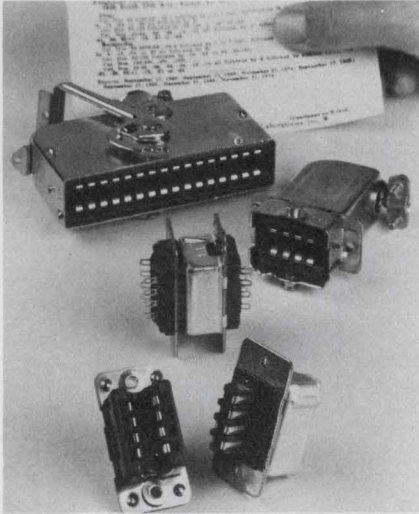
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CIRCLE NUMBER 85



## Line of connectors get blanket UL listing



Amphenol, 900 Commerce Dr., Oak Brook, IL 60521. Harry Jaeger (312) 986-3770. See text; stock.

A line of rack-and-panel connectors, the Blue Ribbon 26 Series, recently obtained UL's "yellow-card" recognition. The connectors are offered in choice of 8, 16, 24 and 32 contacts with three shell-polarization styles—barrier, pin and barrier with keyed shells. Cable-to-panel and cable-to-cable shells that can accommodate both top and side cable entry are available. Current-carrying capacity is 5 A per contact and voltage rating is 750 V dc at sea level. Connectors are priced from \$1.69 a mated pair in 1000 quantity.

CIRCLE NO. 378

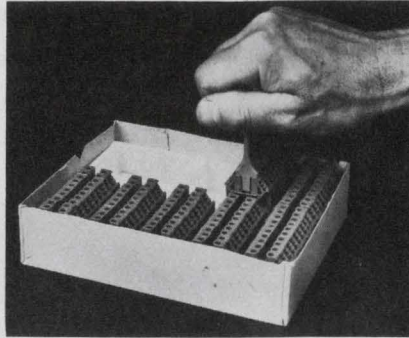
## IC socket inserts with low force

AMP, 449 Eisenhower Blvd., Harrisburg, PA 17105. Jim Pletcher (717) 564-0100.

Intended for high-pin-count  $\mu$ P packages, the LIF-Lock connector socket is a low-insertion-force socket. Its contacts don't transmit force to the leads during insertion or extraction, thus minimizing package and lead damage. After insertion, a screwdriver-operated, cam-actuated mechanism releases the contacts with a force of about 200-gm each. Available in 24, 28 and 40-position sizes, these sockets fit  $0.1 \times 0.6$  PC-board hole patterns. Contacts are rated at 3 A and have less than 25-m $\Omega$  of contact resistance.

CIRCLE NO. 379

## Modular terminal blocks reduce assembly time



Electrovert, 86 Hartford Ave., Mount Vernon, NY 10553. (914) 664-6090.

The Wiba line of modular terminal blocks reduces assembly time by as much as 90%, according to its maker. Using a rapid-mounting system, the terminals are packed and shipped in specially designed cardboard boxes with 10 terminal blocks per row and 10 rows per box. A special insertion tool is used to pick up an entire row of 10 terminals at one time. Then, an easy manual action mounts them on the assembly rail with the same effort and time it would take to mount a single block. The rapid-insertion tools are supplied at no charge.

CIRCLE NO. 380

## Epoxy adhesive holds up at 190 C



Tra Con, 55 North St., Medford, MA 02155. Jim Hart (617) 391-5550.

Tra-Bond 2248, a high-temperature epoxy adhesive for bonding and staking to 190 C, has good high and low-temperature mechanical and electrical properties. This thixotropic, two-component, 100%-solids adhesive bonds to metal, glass, ceramics and plastics. The adhesive is mixed, handled and applied at room temperature, but needs a final high-temperature cure for satisfactory bonding. It resists water, weather, oxygen and ozone, most petroleum solvents and fuels, mild acids and alkalis and many organic and inorganic compounds.

CIRCLE NO. 381

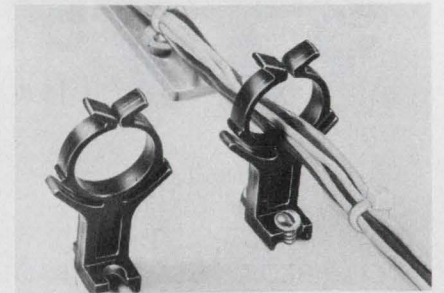
## Slide-on connectors are MIL-spec interfaces

Sealectro, 225 Hoyt St., Mamaroneck, NY 10543. (914) 698-5600.

Conhex rf connectors mate modules to modules, or panels to panels. Interface is to MIL-C-39012, except engagement is not detented, thus reducing the engagement and disengagement forces. Engagement is about 6 lb max, while disengagement is 0.5 lb min. For use up to 12.4 GHz, the connectors are suited where several rf connections must be made between components simultaneously, and where other mechanical fastening devices are employed.

CIRCLE NO. 382

## Hold wire bundles with bundle retainer



Panduit, 17301 Ridgeland Ave., Tinley Park, IL 60477. (312) 532-1800.

The BR75-E6-C wire-bundle retainer supports  $\frac{3}{4}$ -in. diameter wire bundles at a uniform height off a harness board. The overlapping mounting feet allow two or more bundle retainers to be mounted close together for wire breakouts. The retainer is installed with No. 6 screws, and wires are snapped in or out of the top of the device. Material is black acetal.

CIRCLE NO. 383

## High-temp coatings do and don't conduct

Delta Electro-Chemical Products, 49 Brunswick Rd., Montclair, NJ 07042. J.J. Cole (201) 744-8117.

Two coating compounds withstand continuous service to 800 F. Electro-Chem 100 is a conductive coating of carbon in a solution of silicone resin. The surface resistance is 100  $\Omega$ /cm. Electro-Chem Mica 10 contains mica suspended in a silicone resin, which after curing has a surface resistivity of  $10^{15}$   $\Omega$ /cm. Both compounds conform to MIL-P-20087A.

CIRCLE NO. 384



# Datel's New Low Priced Digital Panel Meter

MODEL DM-3100

## FEATURES

- ▶ Miniature case with 0.5" LED display
- ▶ Bipolar, differential  $\pm 2$ VFS input
- ▶ 3½ Digit resolution with Autozeroing
- ▶ LCD display available at additional cost
- ▶ Additional ranges — customer programmable
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- ▶ Additional current and ohmmeter capability — customer programmable

**\$29\***

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CIRCLE NUMBER 86



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**TECHMAR** 

CIRCLE NUMBER 90

## PACKAGING & MATERIALS

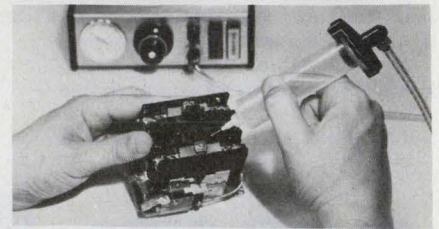
### Crimping tool installs insulated terminals

Panduit, 17301 Ridgeland Ave., Tinley Park, IL 60477. (312) 532-1800.

A heavy-duty crimping tool, CT250, installs insulated terminals, splices, disconnects and wire joints. The tool cuts wire and crimps terminal products on wire ranging in size from #10 to #22. Its extra-length handle reduces hand fatigue.

CIRCLE NO. 385

### Applicator deposits fluid at exact point required



Electro Fusion Devices, 977 Waterman Ave., East Providence, RI 02914. Jim McGovern (800) 556-3484. \$340; stock.

The 1000D lubricant applicator provides highly accurate deposits of lubricants or almost any other fluid at the exact point required, even in difficult access spots in completed assemblies. For set-up, the fluid is loaded into a disposable polypropylene reservoir with a preselected dispensing tip. The air pressure is regulated to suit the material's viscosity and a solid-state timer is set between 50 ms and 1 s. In operation, the tip is placed at the application spot and a foot pedal pressed.

CIRCLE NO. 386

### Nomex spiral wrap has high-temp stability

Icore International, 180 N. Wolfe Rd., Sunnyvale, CA 94086. (408) 732-5400.

DuPont Nomex, an aramid paper that is extremely light and absorbs very little moisture, is now available for cable spiral wrapping. UL tests show that the material retains about 2/3 of its room-temperature dielectric strength at 225 C. Ultimate elongation is essentially constant up to 200 C, and shrinkage is less than 2% at 300 C. An advantage of this spiral-wrap material is its ability to be entered or broken out of the cable bundle at any point.

CIRCLE NO. 387



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its AC horsepower*



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And our new 48-frame TEFC parallel shaft and right angle gearmotor designs are shorter, too. Proven gearheads with ratios from 5:1 through 60:1. Speeds from 340 through 28 Rpm. And torques through 330 Lb-in. Available in all popular AC windings and voltages. In a wide range of mounting configurations. You can get continuous duty ratings through 1/3 Hp—with gearhead or without. But get all the facts. Write for Catalog S.

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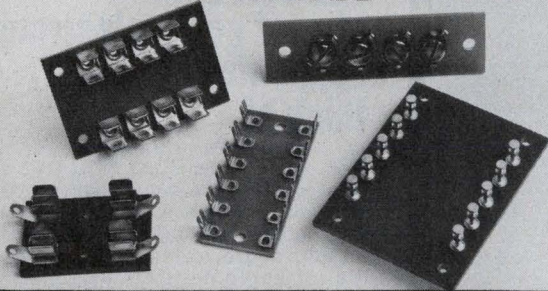
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Bodine Electric Company, 2500 W. Bradley Place, Chicago, IL 60618.

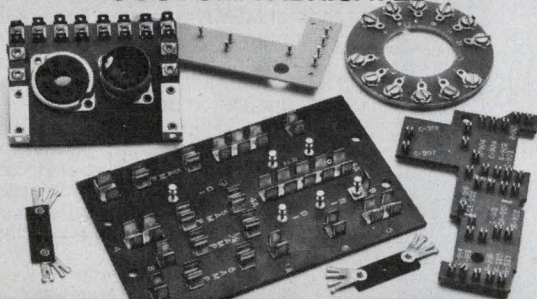
CIRCLE NUMBER 91

## Terminal Boards

### READI-MADE



### CUSTOM FABRICATED



NEW FREE CATALOG ON REQUEST

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CIRCLE NUMBER 92

CIRCLE NUMBER 93 ▶

# The Big Performer:

## The Portable 3½-Digit Model 175 \$189

If you want a high level of accuracy and performance you can rely on, it's yours in our Model 175 3½-digit DMM. This truly compact unit (1¾"H x 5½"W x 3½"D—4.45 x 13.97 x 8.89 cm) gives you 32 ranges of measurement capability, six functions, 0.1% DCV accuracy, and 100 microvolts resolution.

**You can measure:** DCV from ±100 microvolts to ±1000V, ACV from 100 microvolts to 500V with a frequency response of 30Hz to 50kHz, DC Current from ±100 nanoAmps to ±2A, AC Current from 100 nanoAmps to 2A with a frequency response of 30Hz to 50kHz, Resistance from 100 milliohms to 20 Megohms in two excitation voltages for in-circuit & out of circuit resistance measurements and for testing diodes.

### Other Features

The Model 175 also features auto-polarity, automatic zero, 100% overrange, and a big, bright 0.43" LED display.

### Field-to-Lab Flexibility

You can use the Model 175 as a bench instrument by connecting it to AC line. Meanwhile it will be recharging for the next time you go into the field. A rechargeable NiCd battery module, line cord with recharger, a pair of test leads, alligator clips, and carrying case and documentation are standard accessories. A full line of optional accessories is also available.

### Price is still only \$189\* complete.

For complete information or a demonstration, contact your local Data Precision representative or Data Precision Corporation, Audubon Road, Wakefield, MA 01880, (617) 246-1600. TELEX (0650) 949341.

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## POWER SOURCES

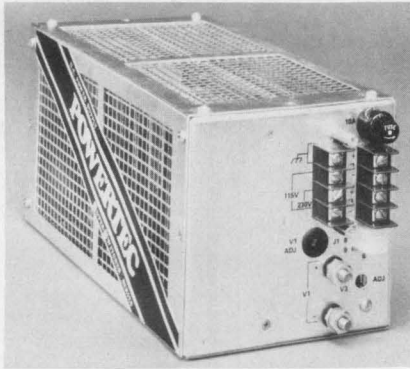
### Thrifty switcher supply is in open frame

California DC, 2348 Towngate Rd., Westlake Village, CA 91361. Jim Burens (213) 991-1168. \$99 up; stock to 4 wks.

Open-frame switching supply models (LR7500, 7700, 7800) include 75-W single, triple and quad-output units offering weight, volume and cost savings. The units protect against transient loss of input voltage and brownout conditions down to 92 V ac. Efficiencies are greater than 70% on multi-output models and 80% on single-output units. Regulation is 0.2% and foldback current limiting is provided. LR7500 models offer outputs of 5 V at 15 A, 12 V at 6.5 A and 15 V at 5 A in a 4.9 × 2.1 × 7 in. package. LR7700 models contain a 7500 supply and two 5, 12 or 15-V units at up to 15 W each in a 4.87 × 2.1 × 9 in. size. LR7800 adds a fourth unit in a 4.87 × 2.1 × 10 in. size.

CIRCLE NO. 388

### 80% efficiency delivered by 40-kHz switcher

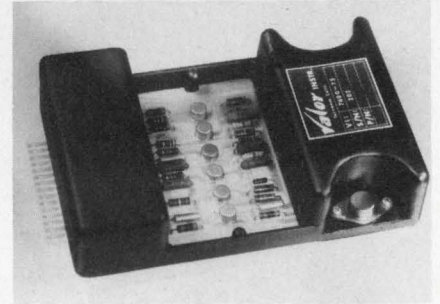


Powertec, 9168 De Soto Ave., Chatsworth, CA 91311. Larry Keenen (213) 882-0004. \$550 up.

Operating at 40 kHz, the Model 9F switching-regulated power supply is a natural-convection-cooled unit boasting approximately 80% efficiency. Up to three independent dc outputs from 2 to 28 V can be provided. Input voltage is 115 or 230 V ac with a tolerance of -20% to +10% and storage time is 30 ms. Size: 5 × 5 × 10.8 in. Weight: 8.5 lb.

CIRCLE NO. 389

### Dual outputter needs no external heat sink



Valor Instruments, 1122 Llewellyn, Torrance, CA 90501. (213) 320-5471. \$65 (100 qty); stock to 2 wks.

The Model 7600 power supplies feature die-cast housings with built-in heat sinking and card-rack mounting. External heat sinking is not required. The units are available in eight standard dual or ± tracking models from ±5 V at 1 A to ±28 V at 0.15 A. Specs include: 105 to 125-V-ac input at 50 to 400 Hz, ±0.1% regulation, ±0.01%/°C tempco and -20 to +60 C. Size is 6.5 × 4.75 × 1.6 in.

CIRCLE NO. 390



CIRCLE NUMBER 94

## There's a Hoffman enclosure for almost every electronic application you can think of.

One company uses our NEMA 12 enclosures to house water-testing instrumentation. Whatever your electronic application, Hoffman probably offers an enclosure to match it, whether it's for servo controls or sensitive instruments.

Hoffman electronic rack enclosures, consoles, instrument boxes, and a full range of NEMA types are just some of the components in a broad-spectrum 1700-product line. All are quality-built in the materials, finishes, and sizes your application requires.

There's a Hoffman enclosure for almost every electronic application you can think of. Check with your Hoffman distributor, or write directly for specifications — we'll match our enclosures with your thinking any time you like.

For complete data write:  
HOFFMAN ENGINEERING COMPANY  
Division of Federal Cartridge Corporation  
DEPT. ED673, ANOKA, MN 55303

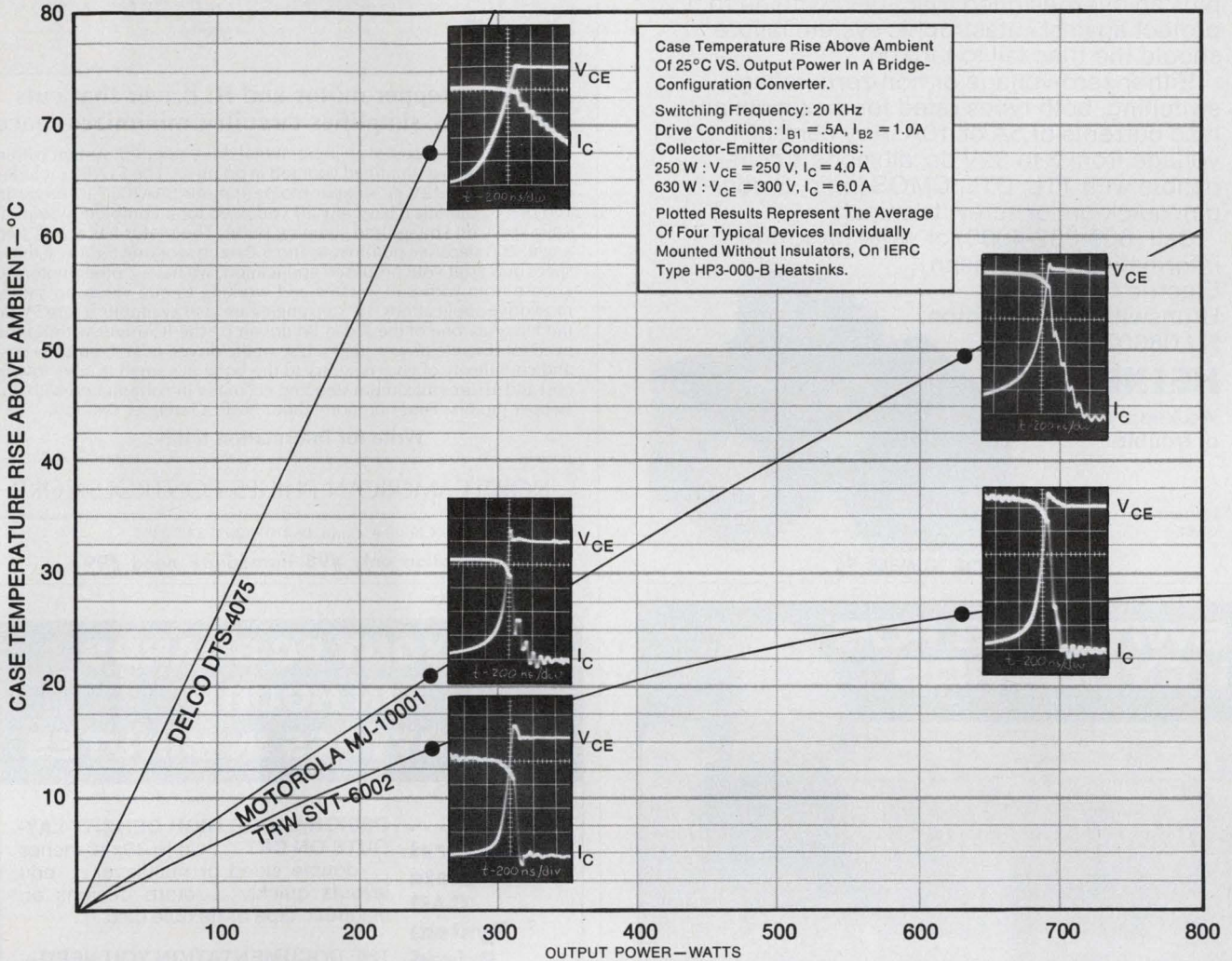
**Hoffman**<sup>®</sup>  
ELECTRICAL ENCLOSURES



# Pure logic and hard facts

1. In high-frequency power switching, heat is a prime factor in Darlington failure.
2. Turn-off time is the dominant cause of destructive temperature rise.
3. The faster the turn-off, the cooler the Darlington, the greater the reliability.

Take a look at competitive Darlings in an actual 20 KHz bridge converter circuit:



**TRW operates at the lowest temperatures for the greatest reliability in high-frequency Darlington off-line switching regulators**

And when you're working with high-power, fast-switching Darlings that's no small thing. When you need reliability at high frequencies, the best combination of switchoff time and energy capability add up to greater efficiency and longer life. And what circuit are you about to design that doesn't deserve the best?

Particularly when TRW Darlings are not only competitively priced, but are also immediately available in any quantity.

To get all the facts on TRW's high-frequency Darlington, use coupon or phone John Power at (213)679-4561.

**TRW Power Semiconductors**  
 An Electronic Components Division of TRW, Inc.  
 14520 Aviation Boulevard, Lawndale, California 90260

Please send me data sheets on TRW's Darlington transistors.

Please send me samples for \_\_\_\_\_ voltage and \_\_\_\_\_ current.

\_\_\_\_\_  
 Name

\_\_\_\_\_  
 Company Name

\_\_\_\_\_  
 Position

\_\_\_\_\_  
 Address

\_\_\_\_\_  
 City

\_\_\_\_\_  
 State

\_\_\_\_\_  
 Zip

ED

## TRW POWER SEMICONDUCTORS

ANOTHER PRODUCT OF A COMPANY CALLED TRW

CIRCLE NUMBER 95



# You've been looking for a more reliable solid-state relay.

## Just look at this one.

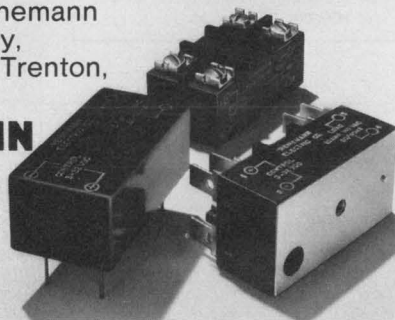
A unique combination of dv/dt snubber, fusible-link protection in the trigger circuit, plus an oversized triac—all combine to protect against catastrophic system failure should the triac fail to turn on.

Either zero-voltage or non-zero-voltage switching, both types rated for maximum ac load currents of 5A or 10A. Any control voltage from 3 to 32V dc; all models compatible with TTL, DTL, CMOS logic. Solder-pin, quick-on, or screw terminals.

Call (609-882-4800) or write for further information. Heinemann Electric Company, Brunswick Pike, Trenton, NJ 08602.

**HEINEMANN**

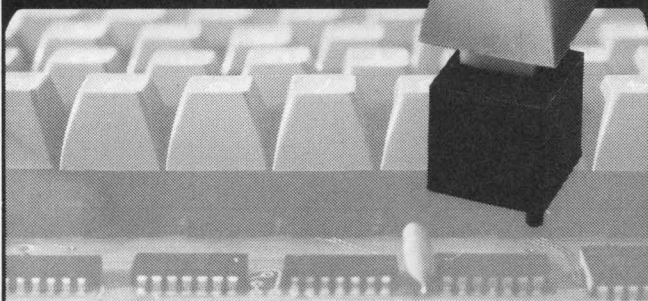
We keep you out of trouble.



© Heinemann 6961

CIRCLE NUMBER 96

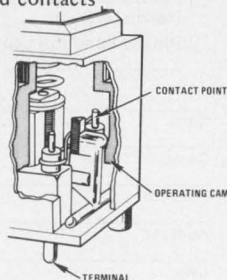
## SWITCHES FOR KEYBOARDS



We offer the following for OEM's producing their own keyboards.

- Keyswitch sizes for 5/8" or 3/4" centers
- Gold Bar mechanical contacts or sealed contacts
- Front panel relampable lighted models
- Single and double pole contacts including NC
- Alternate action models
- Doubleshot molded keytops for 3/4" or 5/8" mounting
- Easy change legend systems
- 100,000 pc. quantity prices as low as \$0.21 each

Letterhead request or phone call brings free sample switch w/keytop.

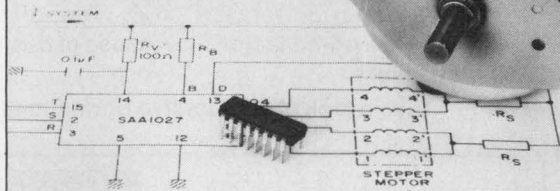


**MECHANICAL ENTERPRISES, INC.**  
8000 Forbes Place Springfield, Virginia 22151  
(703) 321-8282 TWX 710-832-0942

In Germany - NEUMÜLLER GMBH, MUNICH  
In U.K. - TEKDATA Ltd., STOKE-ON-TRENT

CIRCLE NUMBER 97

## A stepper drive system for only \$12.60!



### A quality stepper motor and IC driver that cuts design costs, simplifies circuitry, minimizes space

We've just put the cost of an incremental drive stepping system within reach! And we've simplified your job in doing so. The \$12.60 includes our K82701-P2 12V dc stepper motor and our SAA1027 IC driver in 100 piece quantities, basically all you need for a complete system, if you supply dc voltage and stepping pulse. The motor has a 7½° step angle, 200 steps/sec pull-in rate and 6.0 oz-in working torque. If these specs don't suit your proposed application, we have 7 other motors to choose from with pull-in rates and working torque values to satisfy most drive applications. 15° step angles are also available, as are 5V dc models. Any one of the 7 can be driven by the IC driver without the need for discrete power stages. Use of the driver, in fact, cuts the cost and complexity of your circuitry to the bone. It's small in size, low in cost and assures maximum stepping accuracy in conjunction with our stepper motors. Find out more about NAPCC stepper systems.

Write for information today!

NORTH AMERICAN PHILIPS CONTROLS CORP.

Cheshire, Conn. 06410 • (203) 272-0301

Information only #98 Immediate need #99

## LAYOUT PC BOARDS IN HOURS PROTOTYPES IN MINUTES

**PC50 . . .**  
**The First Complete CAD System Priced Below \$16,000**

**DESIGN LARGE HIGH DENSITY LAYOUTS ON CRT . . .** Up to 30x40 inches . . . double sided or multilayer . . . edit layouts quickly . . . store designs on magnetic tape or flexible disc . . .

**THE DOCUMENTATION YOU NEED—WHEN YOU NEED IT . . .** Layouts, silk-screen art, solder mask art, drilling drawings, ground planes, fabrication and assembly drawings . . . generate complete camera ready documentation on plotter.

**PRODUCE DOUBLE SIDED PROTOTYPES IN A SINGLE DAY . . .** Output layout directly on copper clad PCB stock . . . use etch resist ink pens and plotter to prepare your board for etching and drilling . . .

**PC50 ELIMINATES MANUAL TAPE-UP . . .** Complete layouts in one-third to one-tenth the time spent on manual tape-up . . .

## SECOND SOURCE INDUSTRIES

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CIRCLE NUMBER 100

ELECTRONIC DESIGN 25, December 6, 1977-



# Application notes

## Isolation v/f converters

Isolation techniques for industrial systems are covered in an eight-page brochure. Objectives and approaches are discussed and specific application techniques using the isolation v/f converter are presented. Dynamic Measurements, Winchester, MA

CIRCLE NO. 391

## Real-time analyzer

How successful in-field trim balancing of rotating machines is accomplished using a real-time analyzer is shown in a 12-page note. The application note includes a pocket-calculator program to simplify implementation. Nicolet Scientific, Northvale, NJ

CIRCLE NO. 392

## Alarm and security cable

A 16-page guide for selecting and installing alarm and security cable provides information for use on the job and during initial evaluation and specification of alarm/security cable interconnection requirements. Belden, Geneva, IL

CIRCLE NO. 393

## Opto-isolators

A well-illustrated 22-page handbook describes how to use opto-isolators effectively. The handbook defines terminology and specifications, shows connecting circuits for use with TTL devices, describes techniques for increasing speed, and contains several circuit diagrams of popular applications. Litronix, Cupertino, CA

CIRCLE NO. 394

## Programmable ACE

Ac and dc electrical characteristics, timing waveforms and block diagrams are included in an app. note describing the INS8250 asynchronous communications element. National Semiconductor, Santa Clara, CA

CIRCLE NO. 395

## Minicomputers

An unbiased, "no-nonsense" guide for the prospective minicomputer user deals with all of the requirements for a successful minicomputer installation. Turnkey Sales & Leasing, New York, NY

CIRCLE NO. 396

## Spectrum analyzer

How a calibrated spectrum analyzer

CIRCLE NO. 398

can be used for making accurate measurements on either AM or FM signals is explained in an application note. Marconi Instruments, Northvale, NJ

CIRCLE NO. 397

## Data communications

Some of the technical aspects and applications of modems, automatic dialers and associated equipment is covered in a 16-page handbook. Vadec, Mountain View, CA

# Revolutionary cooling extrusion cuts size and cost in half.

Here is the first in a new series of unique cooling extrusions from Wakefield.

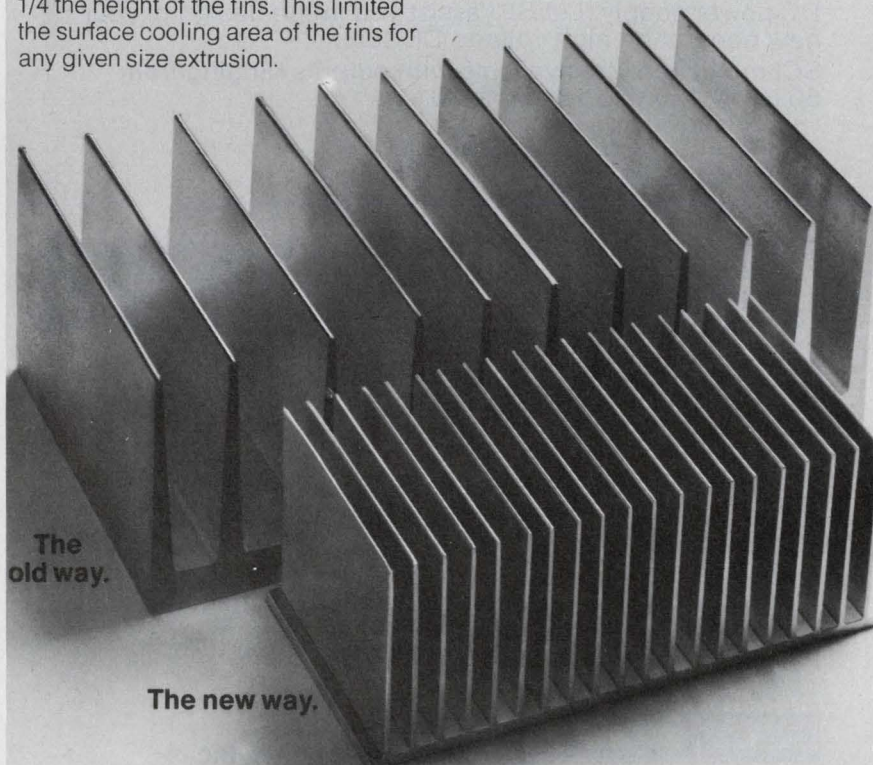
A totally different design concept called "High Fin Density" allows Extrusion 5113 to give the same cooling performance as devices needing nearly twice as much space.

And because of substantial material savings, the 5113 is half the price of the larger units—only \$1.10 per inch.

Until now, the space between fins of an extrusion could be no less than 1/4 the height of the fins. This limited the surface cooling area of the fins for any given size extrusion.

"High Fin Density" has changed all this by reducing the space between fins to as little as 1/10 their height. The result is a tremendous gain in cooling efficiency with 130 sq. in. of cooling surface per linear inch of extrusion.

Knowledgeable people say this is the most significant breakthrough in the history of cooling devices. But then, what would you expect from the leader? Write or call for full details.



**WAKEFIELD ENGINEERING INC.**

77 AUDUBON ROAD, WAKEFIELD, MA 01880 (617) 245-5900  
TWX 710-348-6713

AN **EG&G** COMPANY

CIRCLE NUMBER 101



# New literature

## Variable resistors

Dimensional drawings, key electrical and mechanical characteristics of 3/4-in. dia series 550 cermet variable resistors are given in a six-page catalog. CTS of West Liberty, West Liberty, OH

CIRCLE NO. 403

## Security systems

A 72-page catalog describes over 900 burglar and fire-alarm products. Mountain West Alarm Supply, Phoenix, AZ

CIRCLE NO. 404

## Connectors

Connecting systems and related products are described in an 8-page catalog. Viking Industries, Chatsworth, CA

CIRCLE NO. 405

## Temperature measurement

The 1977 Temperature Measurement Handbook, second edition, contains over 200 pages of temperature-measurement products. The introductory 38-page data section contains complete current/temperature/millivolt tables for all practical thermocouple calibrations prepared by the National Bureau of Standards in both degrees Celsius and Fahrenheit. Omega Engineering, Stamford, CT

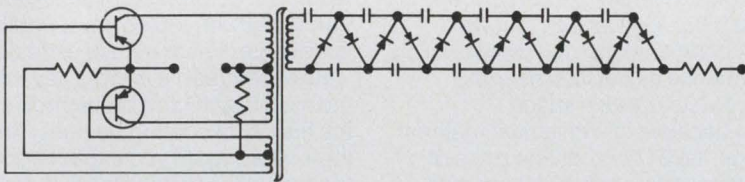
CIRCLE NO. 406

## Oscillators

In addition to specifications, outline drawings and performance data on voltage-controlled oscillators, a 16-page catalog includes a selection guide, VCO capabilities and a list of pertinent definitions. Watkins-Johnson, Scotts Valley, CA

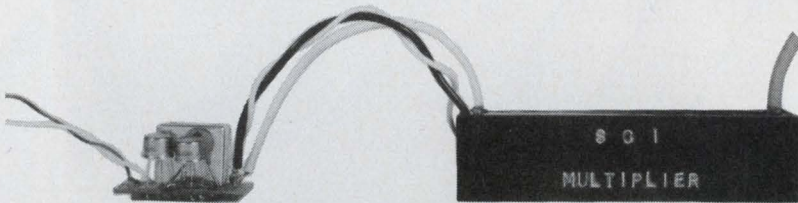
CIRCLE NO. 407

# When you take the high (voltage) road, we take the low (cost) road.



A switching oscillator coupled with an SCI Cascade Multiplier makes a reliable, low cost, compact high voltage DC power supply. Let SCI assist you in the design of your new generation high voltage DC supply.

SCI multipliers are available with outputs ranging from 50 uA @ 15 kV to 15 mA @ 70 kV.



SCI multipliers are an attractive alternative to conventional circuits in designing high voltage supplies for such applications as:

### DC

CRT and radar displays, radiographic equipment, photo-multiplier, tubes, electrostatic paint sprayers, test equipment.

### Pulse

Starting arc welders, lasers, photo flash, igniting oil and gas burners.

For more details, ask for Joe LaBruna:



**Scientific Components, Inc.**  
Subsidiary of CODI Corporation  
350 Hurst Street  
Linden, New Jersey 07036  
201-791-9500  
CIRCLE NUMBER 102

## Electronic hardware

A 110-page catalog covers collars, couplings, fasteners, ferrules, hand screws and nuts, spacers, standoffs, universal joints and washers. Accurate Screw, Nutley, NJ

CIRCLE NO. 408

## Air conditioners

Industrial air conditioners for computer-controlled machine-tool systems, and/or other electronic or computerized applications are described in a four-page brochure. McLean Engineering Laboratories, Maple Grove, MN

CIRCLE NO. 409

## Instrument applications

Featured in a 60-page instrument catalog are technical articles, which provide detailed information on methods to improve accuracies of transmissions, reflection and phase measurements. Wiltron, Mountain View, CA

CIRCLE NO. 410

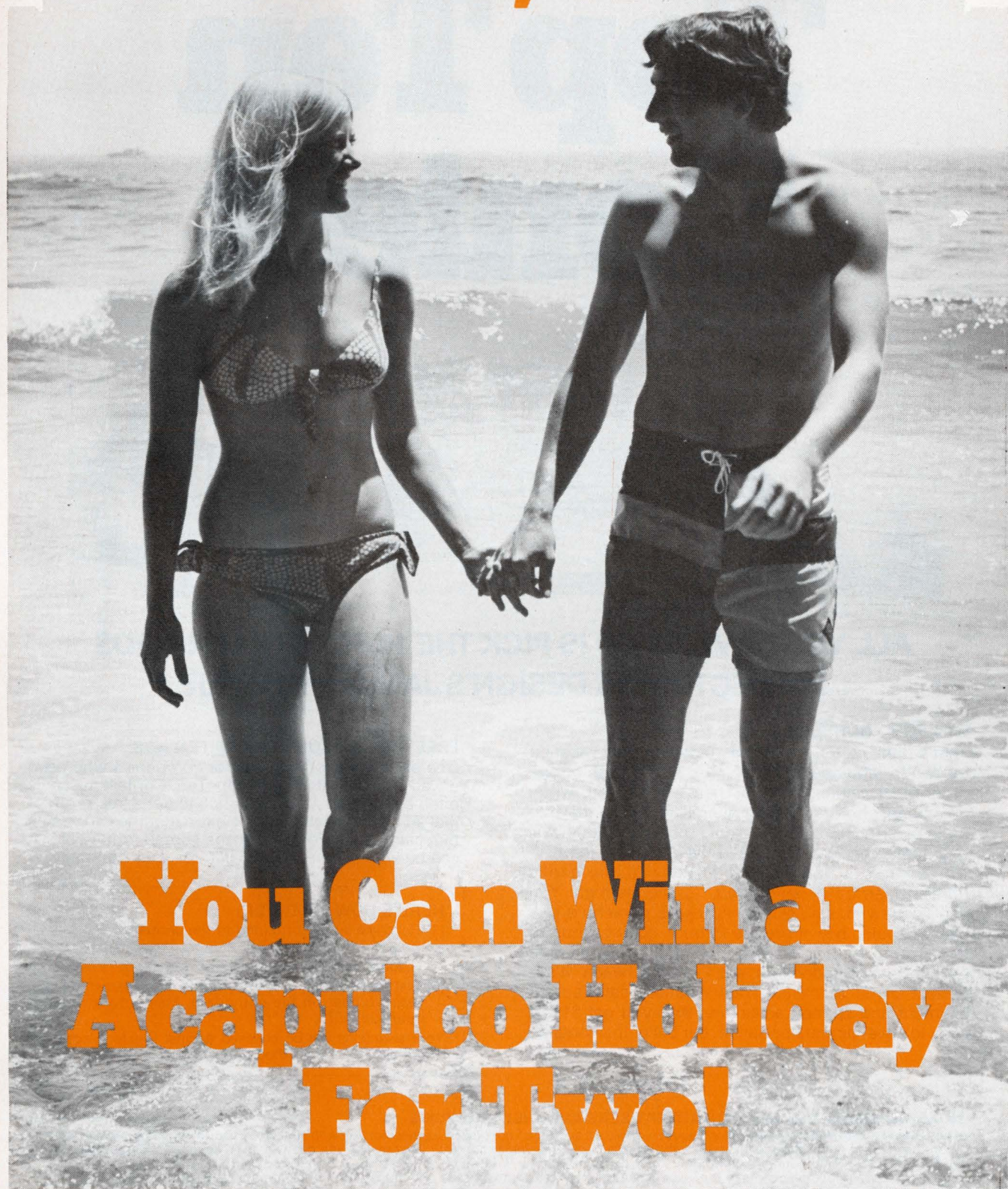
## Data-conversion products

A 288-page handbook features monolithic and hybrid data-conversion components and computer-interface systems. Datel Systems, Canton, MA

CIRCLE NO. 411



**On  
Jan. 4, 1978**



**You Can Win an  
Acapulco Holiday  
For Two!**



# Electronic Design's Famous Top Ten Contest



**ALL YOU HAVE TO DO IS PICK THE 10 TOP SCORING ADS  
IN ELECTRONIC DESIGN'S JANUARY 4 ISSUE**

#### **WIN FOR YOURSELF**

That's right ... you can win a 10-day prepaid vacation for two in fabulous Acapulco *plus* \$1,000 cash or one of 99 other valuable prizes. There's nothing to write; no slogans; no drawings or gimmicks. All you have to do is pick the 10 advertisements that our readers will best remember having seen in the January 4 issue.

Acapulco is paradise. You'll stay at the exotic Paraiso Marriott — an "island" 22 stories high. You can sun, swim, sail, skin dive, take a parachute ride over Acapulco bay or browse through quaint shops. In the evening you can choose from sizzling night life or take a relaxed moonlight stroll on the beach. It's a perfect blend of casual sophistication, carefree excitement and spirited adventure. *And* you get \$1,000 cash to cover air transportation, bar bill or incidentals!

#### **FREE RERUNS FOR THE TOP TEN ADS**

One of the biggest bonuses for companies who have an advertisement in the Top Ten Contest issue is often overlooked. It's the chance to get a free rerun of that ad with the extra impact, extra inquiries and sales that can result. (For a two-page spread in full color it can be worth more than \$5,000 for your company.)

#### **HERE'S HOW TO ENTER:**

- (1) Read the rules contained in the January 4 issue.
- (2) Pick the 10 ads that you think *Electronic Design's* readers will best remember having seen.
- (3) List these ads by company name and Reader Service Number on the entry card. Mail before February 28, 1978.

Your selections will be checked against Reader Recall, *Electronic Design's* method of measuring readership.

#### **NOTE: SEPARATE CONTEST FOR ADVERTISERS AND THEIR AGENCIES**

If you are an advertiser or an advertising agency, there's a separate "advertiser" contest for you with separate prizes for the top three winners. First and second prizes are the same in both the advertiser and reader contests. That means you can win an Acapulco holiday for two plus \$1,000 cash or a \$600 personal computer. Third prize is a digital wristwatch, \$100 value. The free reruns for the winning ads and extra readership for *all* advertisements in the issue make the Top Ten Contest issue one of the year's outstanding advertising opportunities.





# First Prize!

## 10-Day Vacation for Two at the Exotic Paraiso/Marriott in Acapulco Plus \$1,000 Cash!

Includes first class air conditioned accommodations for two, plus modified American plan meals (breakfast and dinner) for 10 days, 9 nights. Subject to space availability May through Dec. 1978. The \$1,000 cash award may be used for incidental expenses, luncheons, local transportation, air transportation etc.

### 2nd PRIZE

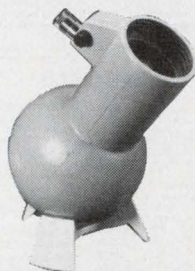


#### PET PERSONAL COMPUTER

The Personal Electronic Transactor computer by Commodore Business Machines is a complete home data processing system that features BASIC language, a CRT display and cassette-tape mass storage. You can do your taxes, balance your checkbook, plus much, much more.

**\$600 VALUE**

### 3rd PRIZE



#### WIDE FIELD TELESCOPE

There's no other telescope like it! Edmund's Astroscan® 2001 4¼" F/4.4 Newtonian wide field reflector gives clear, bright, spectacular wide-angle views of stars, moon, comets. It's portable, easy to use. No complicated set up. Just insert the eye piece and focus. Top quality optical system.

**\$150 VALUE.**

### 4th & 5th PRIZES



#### DIGITAL WRISTWATCH

**\$100 VALUE**

### 6th through 100th PRIZES

Hayden Technical Books

NOTE: COMPLETE ENTRY BLANKS  
AND RULES WILL APPEAR IN  
JANUARY 4, 1978 ISSUE



# Type 9 CdS photoconductive material

**TYPE 9 MATERIAL**

- LOW TEMPERATURE ERROR
- LOW LIGHT HISTORY EFFECT
- HIGH LINEARITY
- FAST RESPONSE TIME
- RESISTANCE TOLERANCE AT 2 Ft.C. ± 3%
- TEMPERATURE RANGE -50 C to +75 C

**RESPONSE TIME VERSUS LIGHT**

Foot Candles	0.1	0.3	1.0	3.0	10	30	100
Blue (Standard)	15.5	0.95	0.23	0.06	0.015	0.004	0.001
Green (Standard)	1.25	0.21	0.05	0.015	0.004	0.001	0.0002

**MEASUREMENT DATA** - All measurements at 25°C ± 0.5. Cells light exposed 18 hrs. at 20 ft-c prior to test. Maximum voltage is 0.5. C applied voltage for maximum resistance. All readings made at 20°C ambient.

**CLAIREX ELECTRONICS**  
A DIVISION OF CLAIREX CORPORATION  
560 South Third Avenue, Mount Vernon, N.Y. 10550 • (914) 664-6602

**offers:**

- Stability with temperature
  - Fast response time
  - Low light memory
  - Available in three packages: TO-5, TO-8, TO-18
- Call (914) 664-6602

**CLAIREX ELECTRONICS**  
A Division of Clairex Corporation

CIRCLE NUMBER 103

# STANDARD ELECTRONIC MODULES

Call Ed Gray (714) 759-2411

Or send for new brochure:  
500 Superior Ave., Newport Beach, CA 92663

**HUGHES**

HUGHES AIRCRAFT COMPANY  
MICROELECTRONIC PRODUCTS DIVISION

CIRCLE NUMBER 104

# CUSTOM CRYSTAL OSCILLATORS

Call Vic Gill (714) 759-2411

Or send for new brochure:  
500 Superior Ave., Newport Beach, CA 92663

**HUGHES**

HUGHES AIRCRAFT COMPANY  
MICROELECTRONIC PRODUCTS DIVISION

CIRCLE NUMBER 105

## Save on Calculators

### HEWLETT-PACKARD

Model	Your Cost	Model	Your Cost
HP 67 224 step programming	\$357.95	HP 97 224 Program Step/Printer	\$596.95
HP 19C Comb betw. HP25C/HP67ptr	274.95	HP 29C Comb bet. HP25C/HP67	154.95
HP 92 Bond Trader-Finance-Printer	496.95	HP 29C Scient. retains memory	127.95
HP 25 Scient-programmable	95.50	HP 27 Comb Bus-Science-Stat	138.95
HP 80 R/E-Bus-Fin-200 yr calendar	234.95	HP 91 Printer-Scient.-HP 45 specs	259.95
HP 21 Scient. slide rule	63.95	HP 10 hand held Ptr-mem., small	139.95
HP user lib. solut. books (40) each	9.50	HP 22 R/E Business-Finance	59.90

HP accessories at discount prices.  
We are an HP franchised dealer. Each unit comes complete with charger, batteries, case, manuals. One year guarantee by Hewlett-Packard. We will beat any deal. Try us.

### TEXAS INSTRUMENTS

Model	Your Cost	Model	Your Cost
TI 59 960 prog step-100 mems	\$225.95	TI 30 Scient. slide rule, parentheses	\$179.95
PC 100A printer for TI 59-58-56-52	146.95	TI 5100 Desk-Digital, mem-percent	43.95
SR 40 Scient. slide rule, parentheses	24.95	TI 1750 Thin, wall, LCD 2M Hrs. mem.	19.95
Bus. Analyst R/E and Finance	28.95	MBA Business-Finance-Stats.	67.95
SR 51-2 Super Slide Rule-Conv.	48.95	Little Prof. for kids 5 yr/grad.	12.95
Data Clip pencil thin, LCD 1000 Hrs.	28.95	Data-Man (Big Prof.) educ.	21.95
TI 1880 Instant Replay cards.	25.95	TI 5015 Printer-Grand Total-Percent	64.95
TI 2550-3 Business-Memory	25.95	TI 5100 Desk-Digital, mem-percent	43.95
TI 5040 Printer-Display-Memory	98.95	TI 1025 Memory Percent-1/2	10.95
TI 5050M AC-DC printer, memory	82.95	TI Digital Watches 5 funcns. from	9.95
TI 1050 Mem. percent-square root	12.95	TI Digital watches all models incl	9.95 up
Libraries for TI 59 and TI 58	29.00	Star Wars LED-Ladies-Mem's	9.95 up
TI 58 480 step prog.-80 memories	97.95	All styles	9.95 up
TI 57 150 step prog.-replaces SR56	63.95		

We are a TI franchised dealer and carry TI accessories at discount prices. We will beat any deal. Try us. All TI calculators are guaranteed by Texas Instruments, Inc.

### SPECIALS

Model	Your Cost	Model	Your Cost
Norelco #185 Dictating unit	99.95	Sony KV-1741R Color remote 17"	479.00
Norelco #88 Dictating unit	242.00	Sony KV-1921 Color Trinitron 19"	461.00
Norelco #186 Transcribing unit	245.00	Sony KV-1841R 19" remote	539.95
Norelco #NT1 new dictating unit	164.00	Sony KV-1201 Color Trinitron 21"	569.00
Norelco #87 dictating or trans.	298.00	Sony KV-2141R 21" remote	629.95
Norelco #98 dictating or trans.	409.00	Sony stereos-recorders and others	call us
Norelco Mini Cassettes	2.95	Calc-Watch, mem by Hughes Aircraft	125.00
Craig # 2625 elec. notebook	149.00	Star Wars LED-Ladies-Mem's	169.95
Craig # 2706A dictating/trans.	189.95	RCA new 4 hours video cassette	
Smith Corona # 2200 elec. type-cass.	239.95	recorder most revolutionary video	849.95
Olivetti Lexikon 82 ball typewrtr	249.00		
3M Dry photocopy machine #149	79.95	RCA Televisions,	
Chronograph 15 funct LCD or LED	59.95	all models best deal	79.95 up
Sony KV-1204 Color Trinitron 12"	314.00	Zenith Televisions, all models	109.00 up
Sony KV-1512 Color Trinitron 15"	\$361.00	Phone-Mate-Code A Phone-Record a Call	call us
Sony KV-1541R Color remote 15"	409.00		
Sony KV-1724 Color Trinitron 17"	418.00		

We carry: Royal-Olivetti-Smith Corona-Amama-Litton-Commodore-APF-Untrex-Canon-Casio-Sharp-Panasonic-Sanyo-Bally-JVC-HY Gain-Kosmos-Victor-Sinclair-Pearlco-der-Midex alarm-3M-Micromax-Loyds-Boshe-Rowell-Sentry Sales-Walton Gym equip-RCA-Zenith-Sony-Atari-Phone Mate-Record A Call-Code A Phone and many more. Over 20,000 units. (Try COFFEE PLUS at \$1.79 per one pound can by the case of 24 cans. Fragile prepaid. Good seller.) Prices are f.o.b. LA. Goods subject to availability. Ask for our famous catalog.

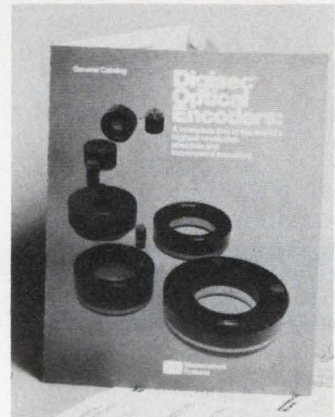
We will beat any prices if the competition has the goods on hand. Add \$3.00 for shipping hand held calculators. CA residents add 6% sales tax.

### OLYMPIC SALES COMPANY, INC.

216 South Oxford Ave. • P.O. Box 74545  
Los Angeles, CA 90004 • (213) 381-3911 • Telex 67-3477

CIRCLE NUMBER 106

## NEW LITERATURE



### Optical encoders

High-resolution absolute and incremental optical shaft-angle encoders are featured in a six-page catalog. Itek, Newton, MA

CIRCLE NO. 412

### Radio test equipment

The "Two-way Radio Test Equipment Catalog" describes 31 of the newest and most advanced additions to the line. Motorola, Communications Div., Schaumburg, IL

CIRCLE NO. 413

### Resistors, capacitors

A 12-page, information-packed catalog lists resistors and capacitors. Pan-asonic, Secaucus, NJ

CIRCLE NO. 414

### Microprocessors

PROM programmers,  $\mu P$  systems and support hardware and  $\mu P$  test instruments are covered in a 52-page catalog. Pro-Log, Monterey, CA

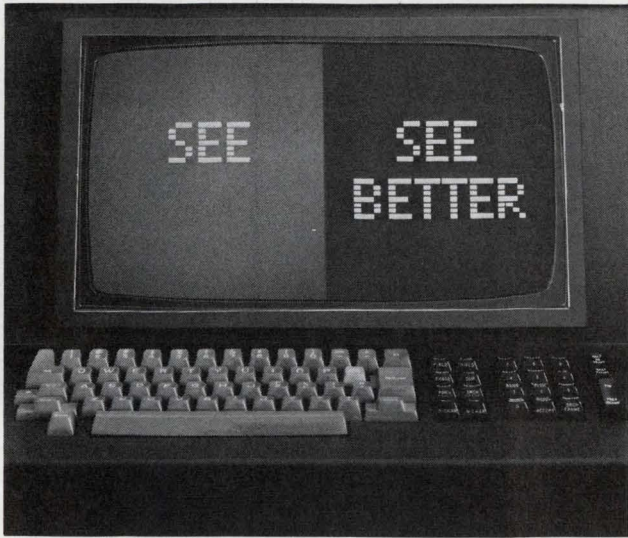
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### Timekeeping circuits

Block diagrams and background information on low-voltage aluminum-gate circuits used for LED and LCD watches, high-voltage B-series CMOS circuits for automobile clocks, high-frequency low-power silicon-on-sapphire circuits for battery-operated wall clocks, and industrial timers are covered in a 12-page brochure. RCA Solid State Div., Somerville, NJ

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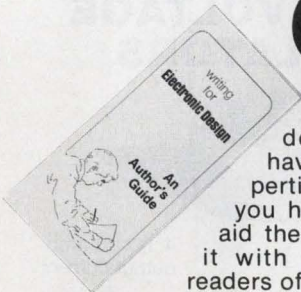
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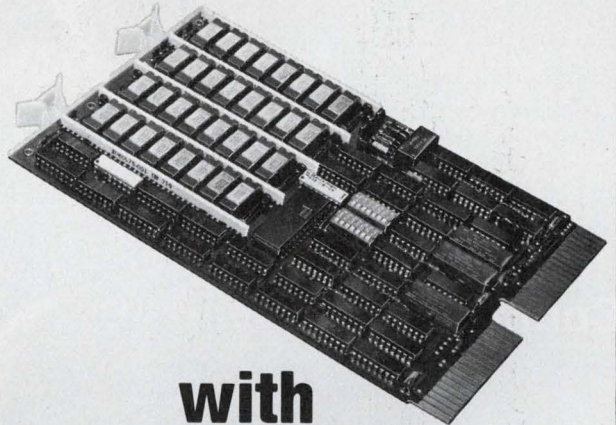
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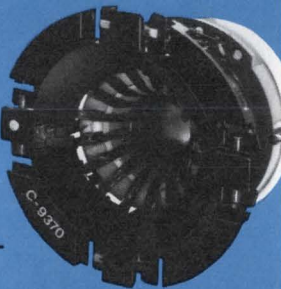
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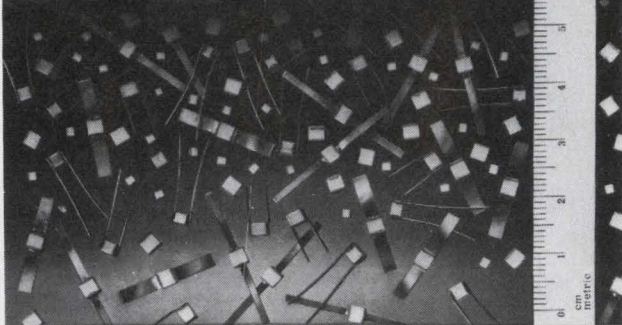
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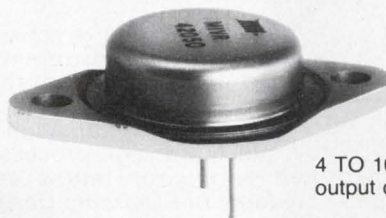
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ELECTRONIC DESIGN 25, December 6, 1977



## 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.

**Keene.** Industrial products and pollution-control/fluid-handling products.  
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**Basic Inc.** Steel-making refractories; specialized chemicals, and electronic products.  
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**INCO (formerly The International Nickel Co. of Canada).** Metals.  
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**Four-Phase Systems.** Computers.  
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**Warner Electric.** Motion-control devices.  
CIRCLE NO. 421

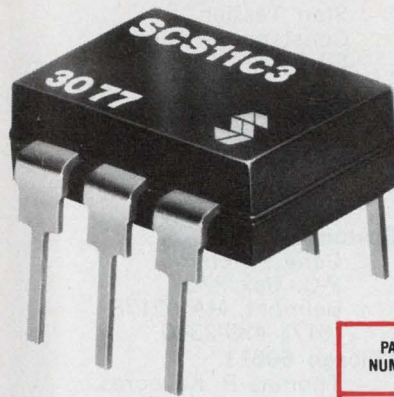
**Honeywell.** Information systems and industrial control systems.  
CIRCLE NO. 422

**RCA.** Commercial and consumer electronics products; broadcasting; communications; government systems; and vehicle renting and related services.  
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**Applied Materials.** Chemical vapor deposition reactors.  
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**Intel.** Integrated electronic devices, microcomputers and electronic circuits.  
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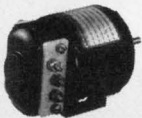




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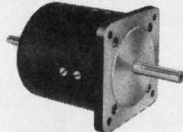
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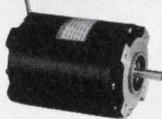
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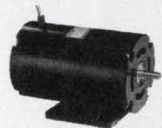
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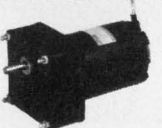
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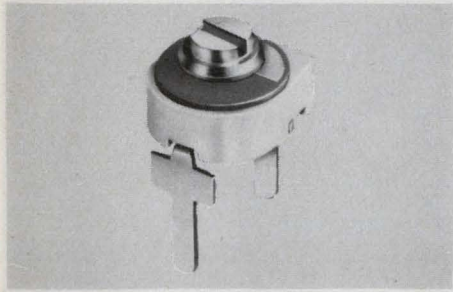
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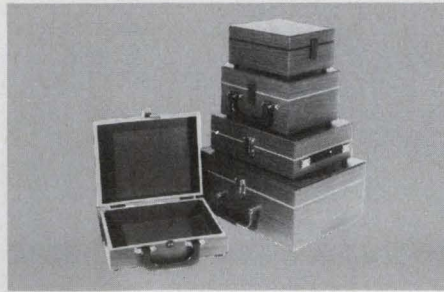




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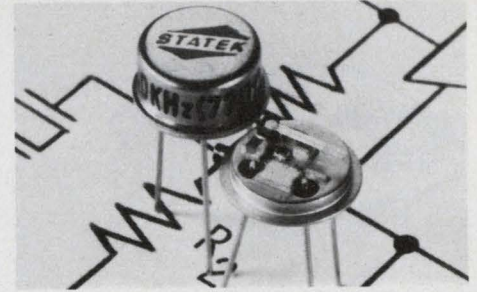
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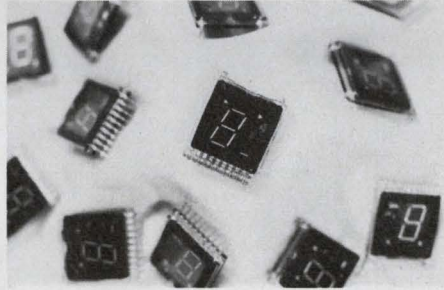
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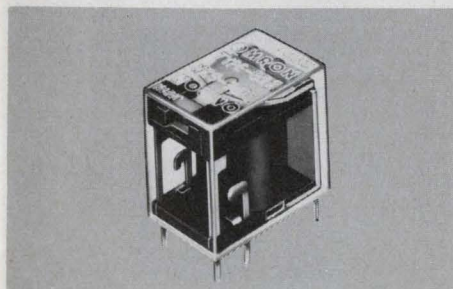
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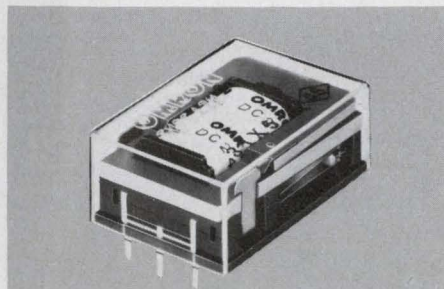
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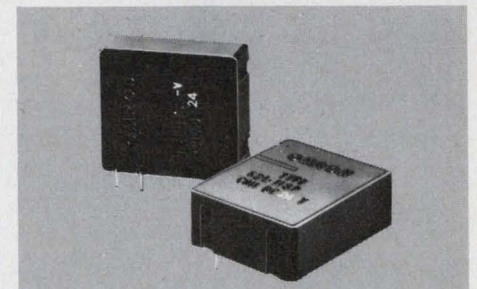
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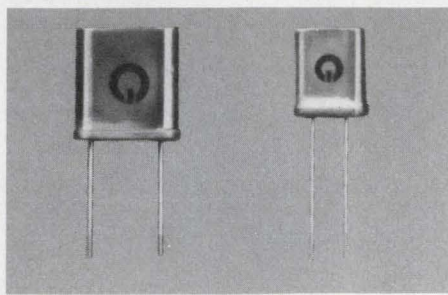




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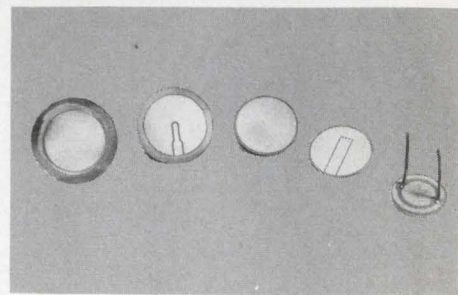
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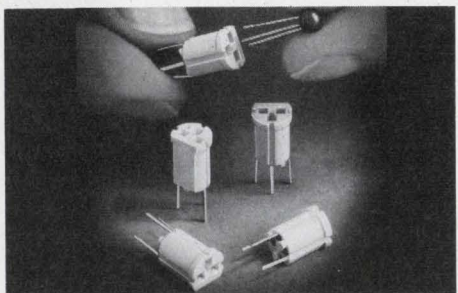
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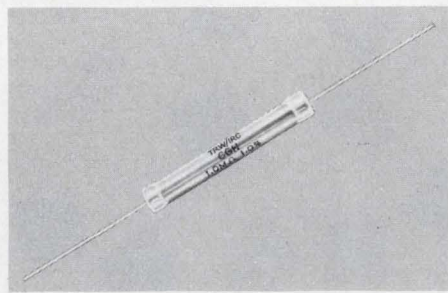
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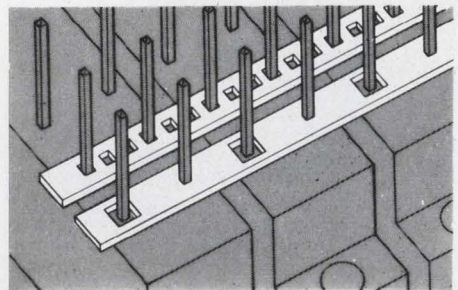
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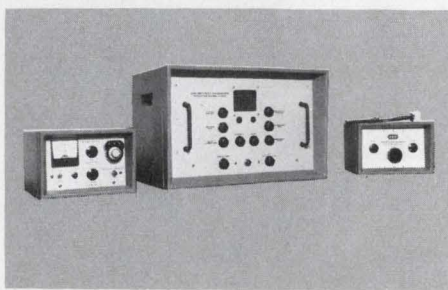
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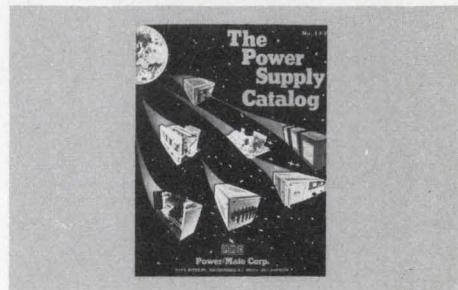
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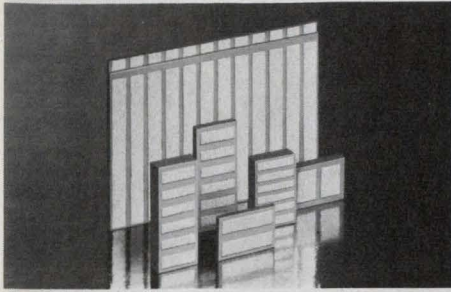


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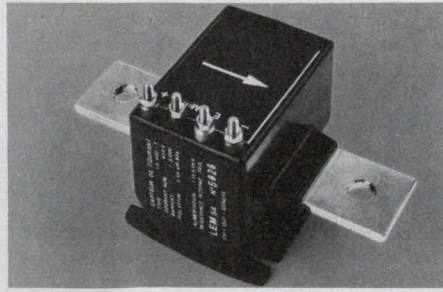




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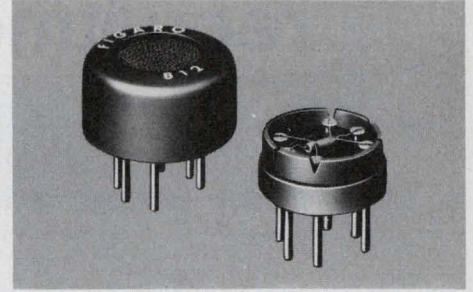
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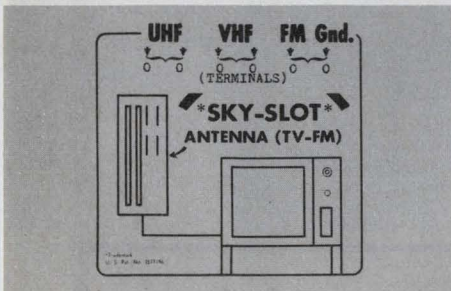
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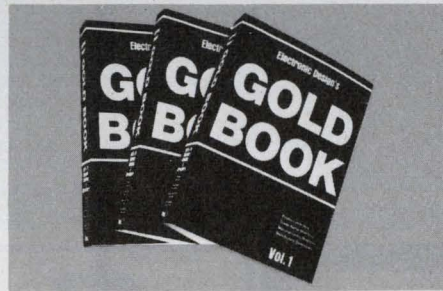
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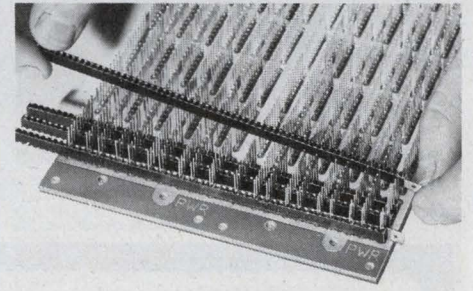
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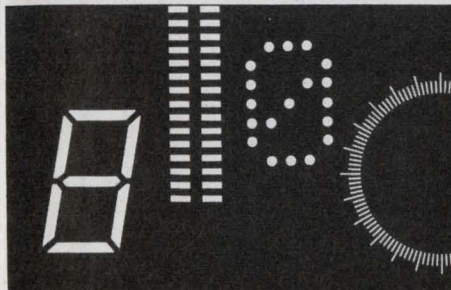
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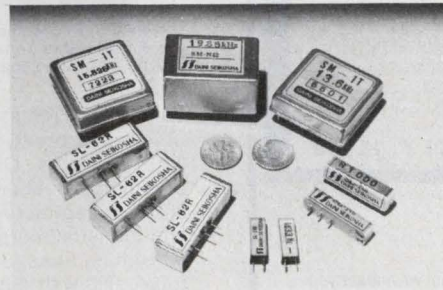
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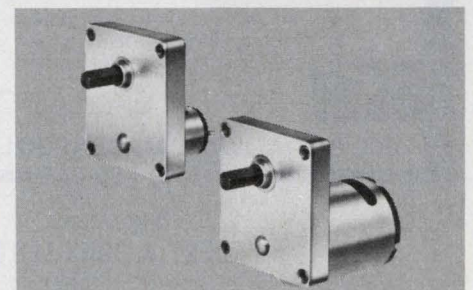
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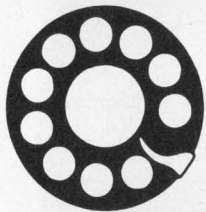
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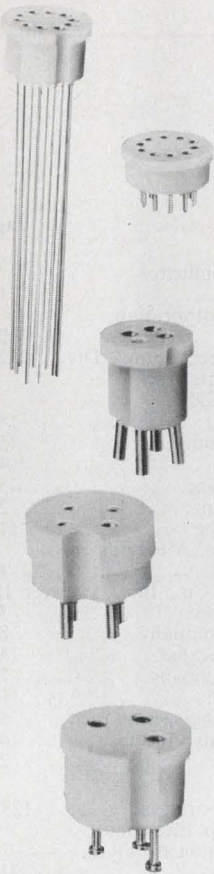
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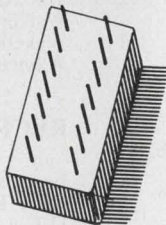
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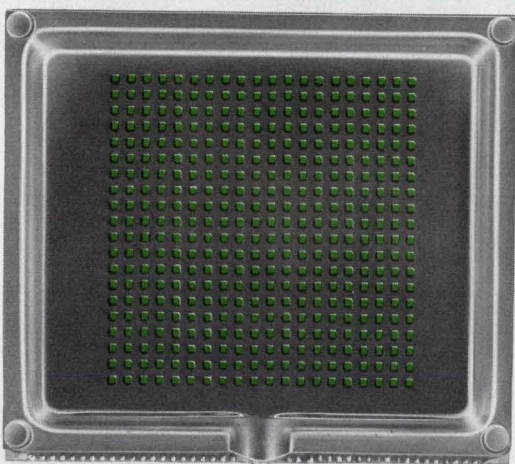
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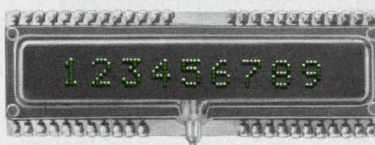
**DC209A2**

Dimension: 41(H) x 208(W) x 10.5(D)mm Character Size: 9.0(H) x 6.3(W)mm



**DM400A1**

Dimension: 114(H) x 130(W) x 17(D)mm



**DC95A2**

Dimension:  
24(H) x 75(W) x 7.2(D)mm  
Character Size:  
5.05(H) x 3.55(W)mm



**FG48D6**

Dimension:  
25.5(H) x 56.5(W) x 7(D)mm  
Character Size:  
8.0(H) x 4.2(W)mm



**F6120S1**

Dimension: 39(H) x 138(W) x 12.5(D)mm



**FG209M2**

Dimension: 41(H) x 208(W) x 10.5(D)mm Character Size: 9.0(H) x 5.4(W)mm

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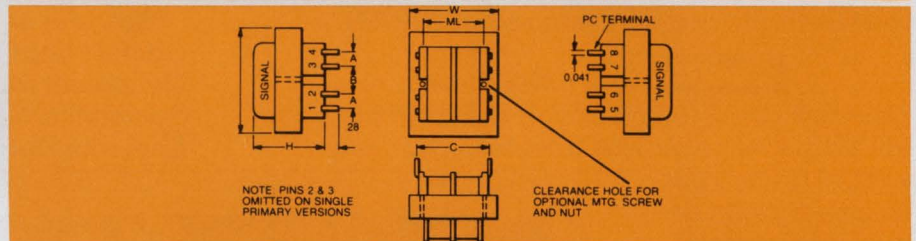
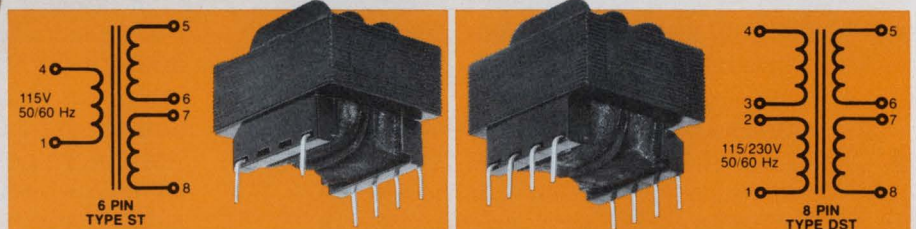


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3	2.4	1 3/8	1 1/8	1 3/16	1 15/16	.250	.250	1.200	None	0.25
4	6	1 5/8	1 5/16	1 5/16	1 1/16	.250	.350	1.280	4-40 x 1 3/8 Nylon	0.44
5	12	1 7/8	1 9/16	1 7/16	1 1/4	.300	.400	1.410	4-40 x 1 3/8 Nylon	0.70
6	20	2 1/4	1 7/8	1 7/16	1 1/2	.300	.400	1.600	4-40 x 1 3/8 Nylon	0.80

\*Available from Signal: Part No. ST-MS (Screw) & Part No. ST-MN (Nut).

PART NUMBER*		SECONDARY RMS RATING		PART NUMBER*		SECONDARY RMS RATING	
Single 115V 6 Pin	Dual 115/230V 8 Pin	Series	Parallel	Single 115V 6 Pin	Dual 115/230V 8 Pin	Series	Parallel
ST 3-10	DST 3-10	10V C.T. @ 0.25A	5V @ 0.5A	ST 3-28	DST 3-28	28V C.T. @ 0.085A	14V @ 0.17A
ST 4-10	DST 4-10	10V C.T. @ 0.6A	5V @ 1.2A	ST 4-28	DST 4-28	28V C.T. @ 0.2A	14V @ 0.4A
ST 5-10	DST 5-10	10V C.T. @ 1.2A	5V @ 2.4A	ST 5-28	DST 5-28	28V C.T. @ 0.42A	14V @ 0.84A
ST 6-10	DST 6-10	10V C.T. @ 2A	5V @ 4A	ST 6-28	DST 6-28	28V C.T. @ 0.7A	14V @ 1.4A
ST 3-12	DST 3-12	12.6V C.T. @ 0.2A	6.3V @ 0.4A	ST 3-36	DST 3-36	36V C.T. @ 0.065A	18V @ 0.13A
ST 4-12	DST 4-12	12.6V C.T. @ 0.4A	6.3V @ 0.8A	ST 4-36	DST 4-36	36V C.T. @ 0.17A	18V @ 0.34A
ST 5-12	DST 5-12	12.6V C.T. @ 1.0A	6.3V @ 2.0A	ST 5-36	DST 5-36	36V C.T. @ 0.35A	18V @ 0.7A
ST 6-12	DST 6-12	12.6V C.T. @ 1.6A	6.3V @ 3.2A	ST 6-36	DST 6-36	36V C.T. @ 0.55A	18V @ 1.1A
ST 3-16	DST 3-16	16V C.T. @ 0.15A	8V @ 0.3A	ST 3-48	DST 3-48	48V C.T. @ 0.05A	24V @ 0.1A
ST 4-16	DST 4-16	16V C.T. @ 0.4A	8V @ 0.8A	ST 4-48	DST 4-48	48V C.T. @ 0.125A	24V @ 0.25A
ST 5-16	DST 5-16	16V C.T. @ 0.8A	8V @ 1.6A	ST 5-48	DST 5-48	48V C.T. @ 0.25A	24V @ 0.5A
ST 6-16	DST 6-16	16V C.T. @ 1.25A	8V @ 2.5A	ST 6-48	DST 6-48	48V C.T. @ 0.4A	24V @ 0.8A
ST 3-20	DST 3-20	20V C.T. @ 0.12A	10V @ 0.24A	ST 3-56	DST 3-56	56V C.T. @ 0.045A	28V @ 0.09A
ST 4-20	DST 4-20	20V C.T. @ 0.3A	10V @ 1.5A	ST 4-56	DST 4-56	56V C.T. @ 0.11A	28V @ 0.22A
ST 5-20	DST 5-20	20V C.T. @ 0.6A	10V @ 1.2A	ST 5-56	DST 5-56	56V C.T. @ 0.22A	28V @ 0.44A
ST 6-20	DST 6-20	20V C.T. @ 1A	10V @ 2A	ST 6-56	DST 6-56	56V C.T. @ 0.35A	28V @ 0.7A
ST 3-24	DST 3-24	24V C.T. @ 0.1A	12V @ 0.2A	ST 3-120	DST 3-120	120V C.T. @ 0.02A	60V @ 0.04A
ST 4-24	DST 4-24	24V C.T. @ 0.25A	12V @ 1.0A	ST 4-120	DST 4-120	120V C.T. @ 0.05A	60V @ 0.1A
ST 5-24	DST 5-24	24V C.T. @ 0.5A	12V @ 1.0A	ST 5-120	DST 5-120	120V C.T. @ 0.1A	60V @ 0.2A
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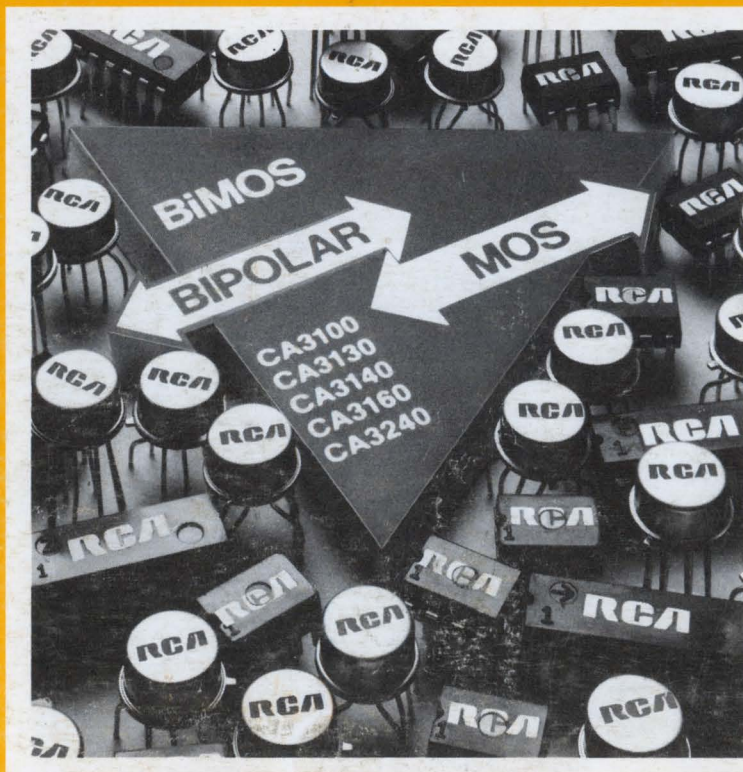
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