

# Electronic Design

FOR ENGINEERS AND ENGINEERING MANAGERS

VOL. 18 NO.

# 4

FEB. 15, 1970

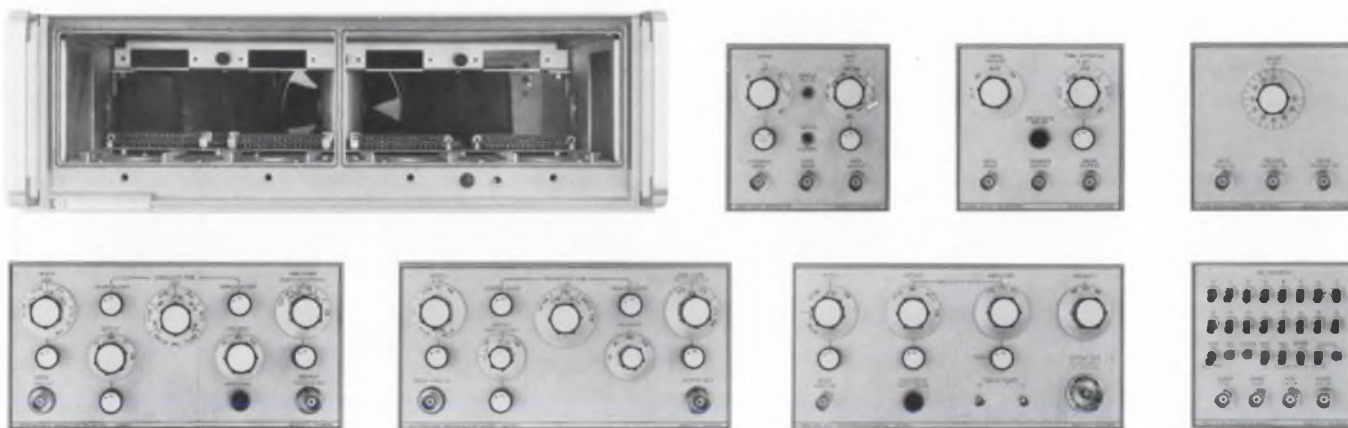
**He led two lives** — as magazine editor and as hospital attendant in coronary and intensive-care units. He saw firsthand how electronic equipment and devices

are used in a modern hospital— where performance can mean the difference between life and death. For his on-the-spot views of the technology and people, see p.24.



# Pulse problems change and change and change and change.....and

so does the 1900 pulse system



HP's brand new solution for people with pulse problems is a set of multi-purpose building blocks. You put what you want in your pulse generating system. With the HP 1900 Pulse System, you start with a standard mainframe that contains only power supplies and optional programming wiring.

Where do you go from there? That's up to you. HP is currently offering seven different functional plug-ins with more to come later. You can start with a relatively simple system and add to it as your needs change. Even complex pulse systems can be formed easily by using several mainframes and appropriate plug-ins.

Just to give you an idea of the capability of the 1900 system, here is a very brief description of the 7 existing plug-ins and some of their capabilities. And, keep in mind that the optional programming wiring allows you to make the 1900 completely automatic!

**HP 1905A Rate Generator**—provides output triggers variable in fre-

quency from 25 Hz to 25 MHz; it includes a pushbutton for single pulse triggers. (\$200)

**HP 1908A Delay Generator**—delays or advances pulses up to 25 MHz over a range of 15 ns to 10 ms and includes a double pulse mode. (\$200)

**HP 1910A Delay Generator**—pulses up to 125 MHz can be delayed from 5 to 100 ns in 5 ns steps. It has a 3 ns risetime and sufficient output to drive two variable transition time output plug-ins. (\$150)

**HP 1915A Variable Transition Time Output**—varies pulse risetime and falltimes from 7 ns to 1 ms and output currents from 40 mA to 1A, amplifies RZ or NRZ word formats. (\$1600)

**HP 1917A Variable Transition Time Output**—varies pulse risetime and falltimes from 7 ns to 500  $\mu$ s, amplifies RZ or NRZ word formats, 0.2 to 10 V amplitude at frequencies up to 25 MHz. (\$525)

**HP 1920A Pulse Output**—provides very fast 350 ps fixed risetime and 400 ps falltime with variable width and 0.5 to 5 V amplitude. Reversible

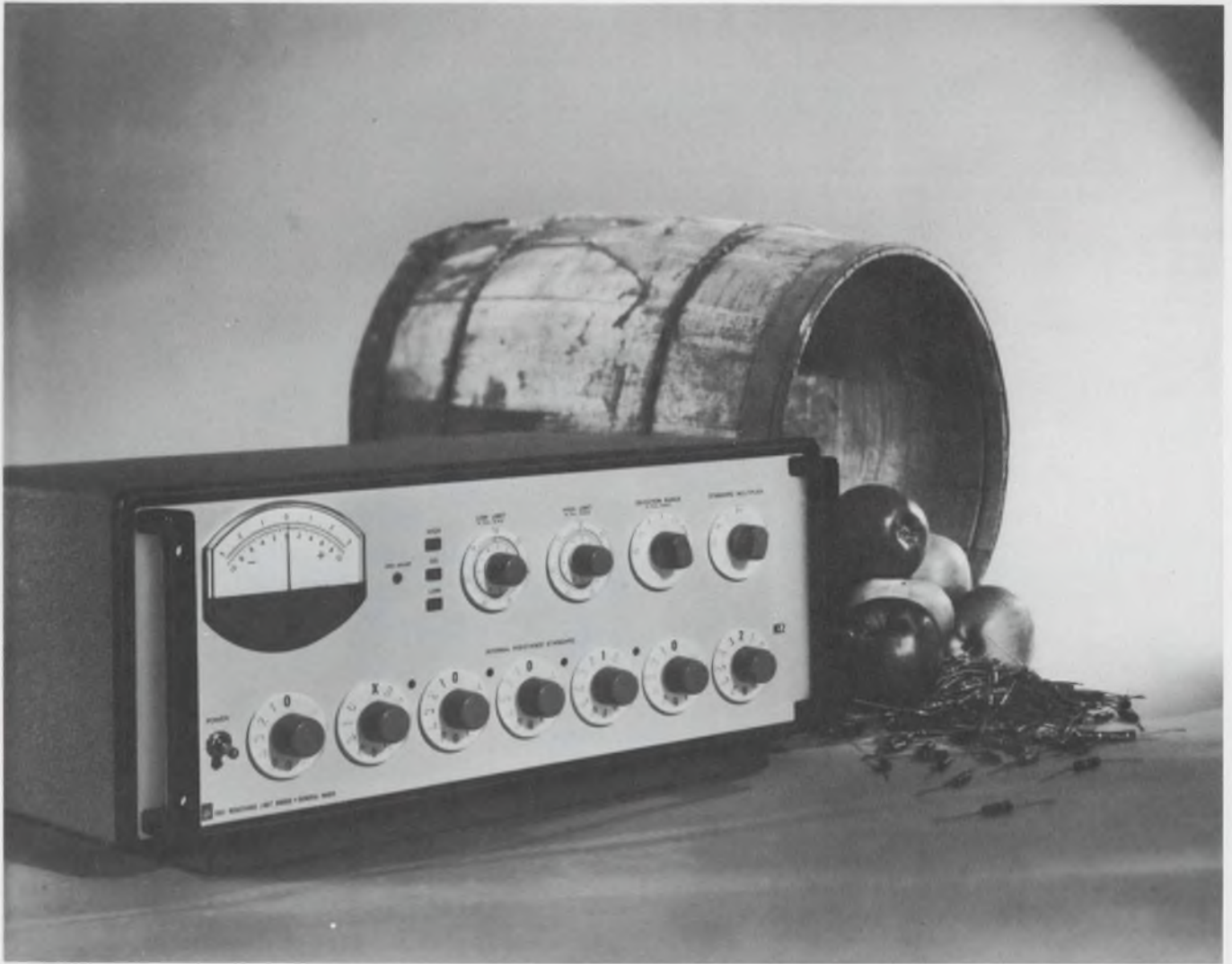
polarity and offset capability. (\$1750)

**HP 1925A Word Generator**—provides 2 to 16-bit words, RZ or NRZ format at frequencies to 50 MHz. Has remote programming and pseudo-random noise sequence generation capabilities. (\$850)

**Two mainframes**—are available to let you select the one that best meets your power requirements. Price: HP 1900A Mainframe, \$750; HP 1901A Mainframe, \$450.

Put together the system that best fits your needs. No other pulse system will do so much, so well—at such an economical cost! For more information, contact your local HP field engineer. Or, write to Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland.

**HEWLETT  PACKARD**  
S I G N A L S O U R C E S



## The \$1200 **Bad-Apple** Finder....

### ..... GR's New 1662 Resistance Limit Bridge!

You can't plug an apple into the new GR 1662 (it's only a one-terminal device), but if you have barrels of resistors to sort, the 1662 will find the out-of-tolerance components for you — quickly, easily, and inexpensively! It's the ideal instrument for selecting and qualifying resistors by percent deviation either manually or in an automatic system.

To handle all the resistance test requirements you're likely to face, the 1662 has percent-deviation ranges of  $\pm 0.3$ ,  $\pm 1.0$ ,  $\pm 3.0$ ,  $\pm 10$ , and  $\pm 30\%$ . Test results are indicated by meter reading, dc-voltage levels, and HIGH-GO-LOW lights. The high limit and low limit can be adjusted independently (by front-panel controls or external dc voltage) to any value within the full-scale meter range.

Use the 1662 for manual sorting and get precise meter readings in one second or use the HIGH-GO-LOW lights for faster sorting limited only by the speed of the operator. Use

automatic sorting equipment like the GR 1782 Analog Limit Comparator (from \$550) to get maximum test rates of four components per second. The 1782 allows simultaneous multiple-tolerance-limit sorting. (Apples can be tested only with a core-memory device.)

For straight resistance measurements, 1662 has a basic bridge accuracy of 0.02%, a comparison accuracy of 100 ppm, and a total range of 1 ohm to 111.1111 megohms. The resolution of the 1662 is 0.01 ohm on the 111-kilohm range to 10 ohms on the 111-megohm range.

Oh, yes. Even at \$1200, the 1662 Resistance Limit Bridge is available with a quantity discount for two or more. For more information, write General Radio Company, West Concord, Massachusetts 01781 or telephone (617) 369-4400. In Europe write Postfach 124, CH 8034 Zurich, Switzerland.

Prices apply in U.S.A.

**GENERAL RADIO**



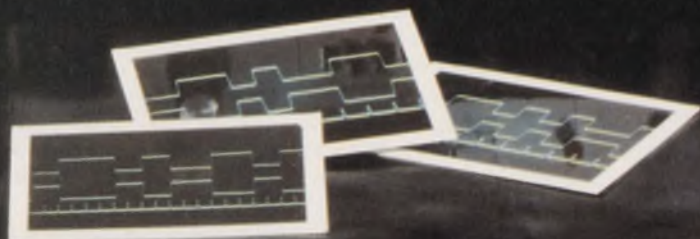
This newest of 13 data generators from Datapulse fires 16-bit words at clock rates from 10 Hz to 75 MHz. At \$2715, it's the first (and only) economical high-speed data generator.

Our Model 212 is fast enough to challenge your most advanced digital circuits, and variable enough to simulate nearly any input requirement. Baseline zero level can be independently adjusted from +2v to -2v on both the "positive true" and "negative true" outputs. The "true" level of each output is adjustable to 5v from the baseline, and word complement is available by front panel switch.

Model 212 is only the fastest. Other Datapulse data generators produce words up to 100 bits long, have as many as 13 channels, and provide NRZ and/or RZ outputs. Applications range from PCM simulation to pattern sensitivity testing with pseudo-random data. Prices start at \$680.

Our catalog will give you the whole story of the types, models, and options available. Contact Datapulse Division, Systron-Donner Corporation, 10150 W. Jefferson Blvd., Culver City, Calif. 90230. Phone (213) 836-6100.

## A fast talker to test your hottest logic circuits



SYSTRON  DONNER

### Another S-D instrument first!

Electronic counters	Digital voltmeters
Pulse generators	Digital panel meters
Microwave frequency indicators	Microwave signal generators
Digital clocks	Laboratory magnets
Memory testers	Data acquisition systems
Analog computers	Microwave test sets
Time code generators	
Data generators	

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## NEWS

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An inside look at hospital electronics by a staff member who took a job as an attendant.
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Modulation and power problems are expected to be solved in system that NASA will test in 1972-1973.
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- 40 **NASA's relay satellite faces a wobbly future**  
Spinning orbit delays tests with ATS-V, and the opposition of fishermen may force system redesign.
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## TECHNOLOGY

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- 76 **For Sales/EE interface: sell—don't battle.** Who knows? You might lose the customer in the war.
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- D1 **Product Source Directory: Power Supplies**
- D10 **Avoid the pitfalls of power-supply connections**
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- D24 **Tables of specifications**

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## PRODUCTS

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Information Retrieval Service Card inside back cover

**Cover:** Designed by Art Director Cliff Gardiner and photographed by Henry Ries

# UNIVERSALLY AVAILABLE...UNIVERSALLY APPLICABLE.

## STANDARD CIRCULAR

MIL-C-83723  
ITT Cannon  
Amphenol\*  
Bendix\*

## MINIATURE CIRCULAR

MIL-C-83723  
ITT Cannon  
Amphenol\*  
Bendix\*  
Deutsch  
Pyle-National

## SUBMINIATURE CIRCULAR

MIL-C-38999  
ITT Cannon  
AMP  
Bendix  
Burndy  
Hughes

## RECTANGULAR MECHANICAL COUPLING

ITT Cannon  
Bendix  
Deutsch

## RACK AND PANEL

ARINC 404  
ITT Cannon

## SUBMINIATURE RECTANGULAR

MIL-C-24308  
ITT Cannon  
Bendix  
Cinch  
Matrix

## QUICK DISCONNECT TERMINAL BLOCKS

MIL-T-81714 Types  
ITT Cannon  
AMP  
Burndy  
Deutsch  
Matrix  
Microdot

## SINGLE WIRE CONNECTORS

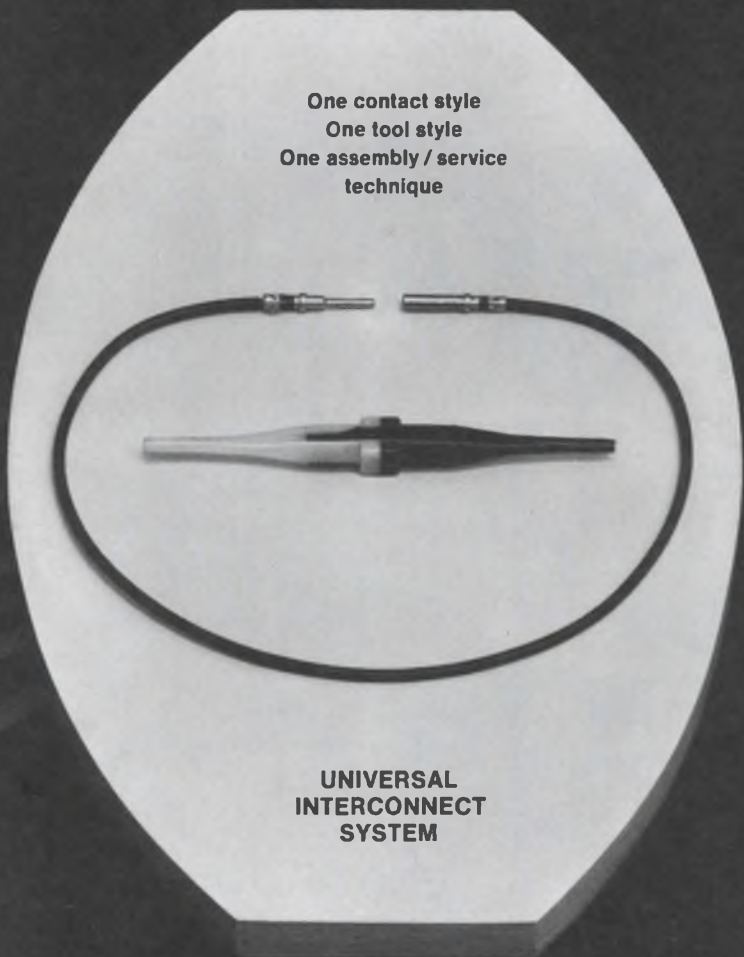
ITT Cannon  
Deutsch

## QUICK DISCONNECT COMPONENTS

Manufacturers of relays, switches, instrument packages, etc.

# THE UNIVERSAL INTERCONNECT SYSTEM.

One contact style  
One tool style  
One assembly / service  
technique



UNIVERSAL  
INTERCONNECT  
SYSTEM

Universal Interconnect is the *only* system that can perform *all* interconnection missions. It includes connectors in all shapes and sizes, terminal modules and individual wires—even plug-in components such as relays, meters and switches.

It does this with *one* contact style, *one* service tool and *one* assembly / service technique.

This system\* is now part of numerous military and industrial specifications: MIL-C-38999, MIL-C-83723, MIL-C-24308, MIL-T-81714 and ARINC 404.

And now these products are available to you from multiple sources—the leaders of the connector industry... and ITT Cannon makes them *all*.

The Universal Interconnect System evolved from the LITTLE CAESAR® rear-release contact retention assembly. It permits rear insertion and extraction of crimp snap-in contacts, lets you service connectors without unmating.

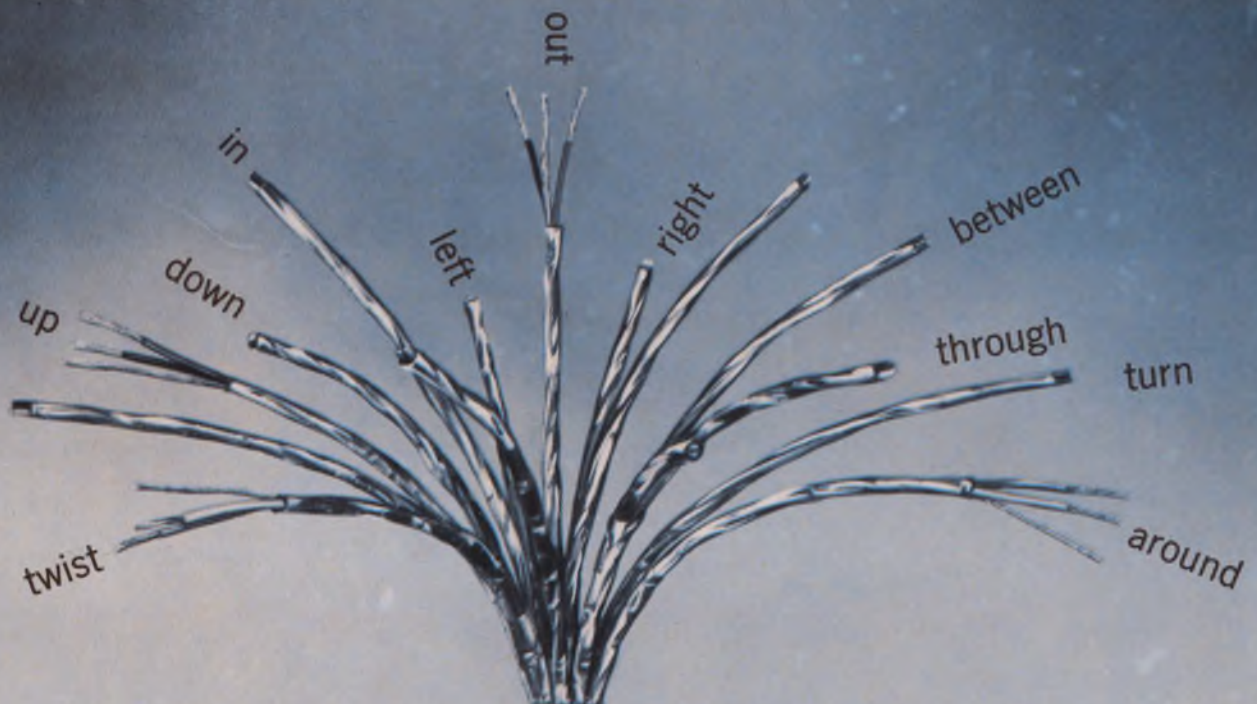
Find out how Universal Interconnect can solve your wiring system problems. Write to ITT Cannon Electric, 3208 Humboldt Street, Los Angeles, California 90031. A division of International Telephone and Telegraph Corporation.

\*ITT CANNON ELECTRIC PATENTS #3110093, #3158424

INFORMATION RETRIEVAL NUMBER 4

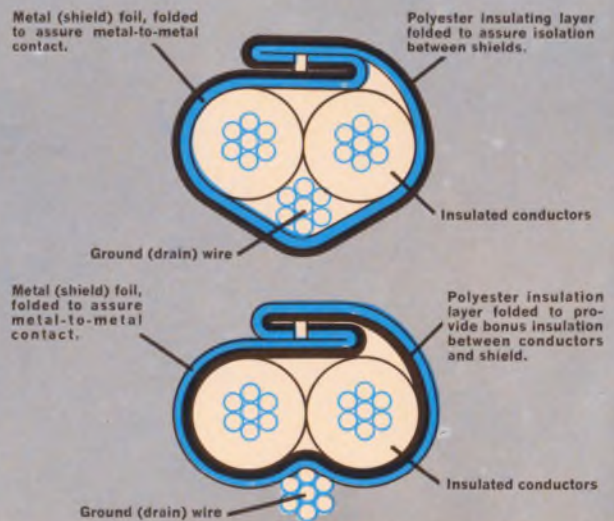
CANNON **ITT**

# Feel Free To Flex



Yes, we know . . . we used to recommend Beldfoil Shielded Cable only for fixed applications. We were too modest. Extended testing proves Beldfoil, even after repeated flexing, provides more physical shield coverage than braided wire or spiral wrapped (served) shields. And greater shield effectiveness. □ Beldfoil is a layer of aluminum foil bonded to a tough polyester film (for insulation and added strength). A Belden invention. We apply it in different ways for different applications. We can even form a unique shield that's like a continuous aluminum tube. This we call ISO-Shield™. □ When new (or in fixed applications) Beldfoil ISO-Shield is extremely effective in limiting crosstalk or interference . . . whether from outside sources or between shielded elements in the same cable. □ Under frequent flexing minor separations may occur in the foil. But special Beldfoil construction features prevent performance from becoming seriously affected. We do, however, recommend that you tell us if cable flexing is to be extreme. We have special designs available to meet severe flexing requirements. □ Beldfoil makes possible a small, lightweight cable that terminates easily and is modest in

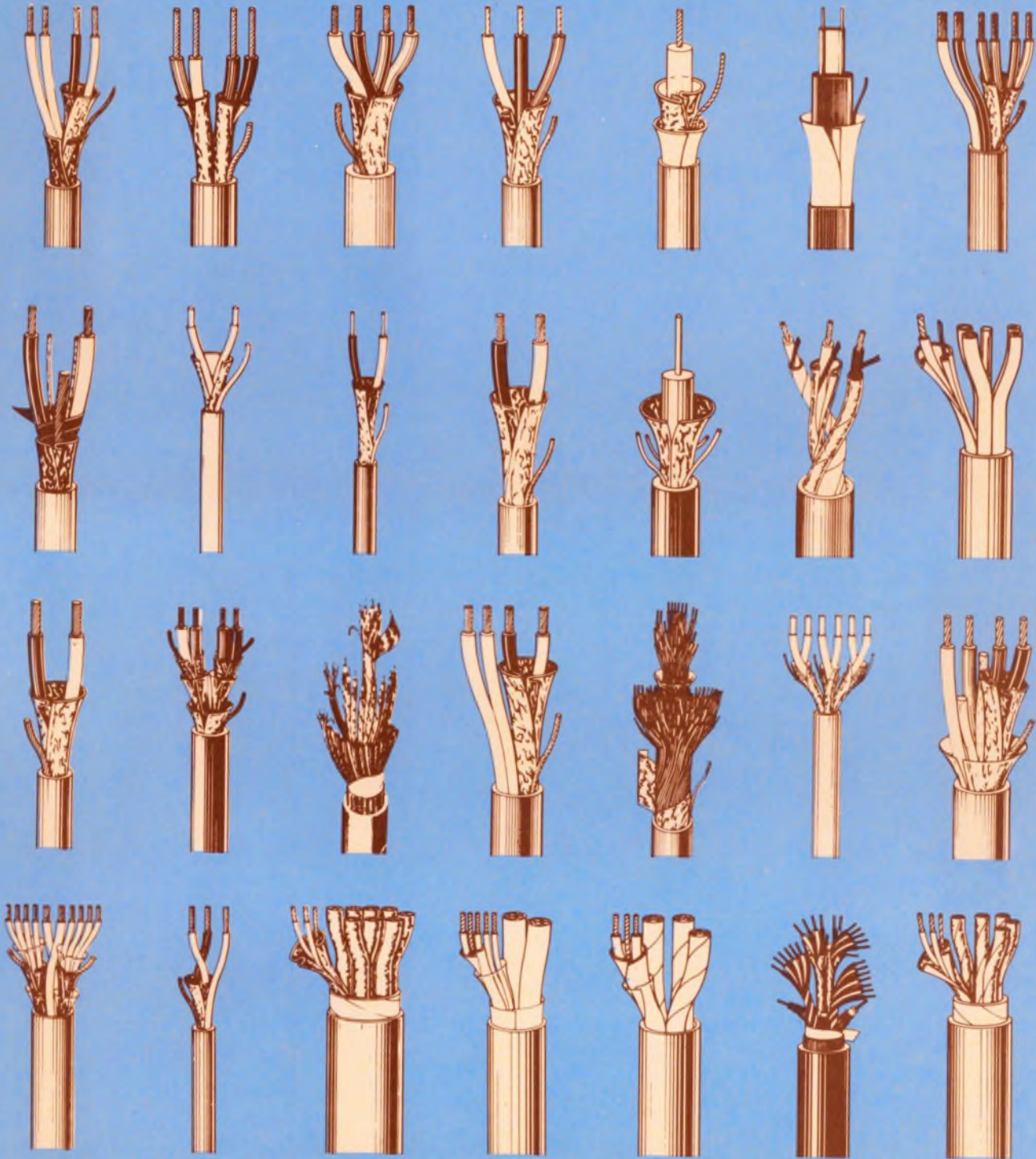
price. Your Belden distributor stocks or can quickly obtain just about any size or type you need . . . from single conductor audio and sound cable up to data cable having 27 individually shielded pairs (more pairs available on special order). Ask him for the latest "Belden Electronic Wire and Cable Catalog." Or for technical information, contact Belden Corporation, P. O. Box 5070-A, Chicago, Illinois 60680; phone (312) 378-1000.





# Beldfoil<sup>®</sup> Shielded Cable

-shield effectiveness remains outstanding

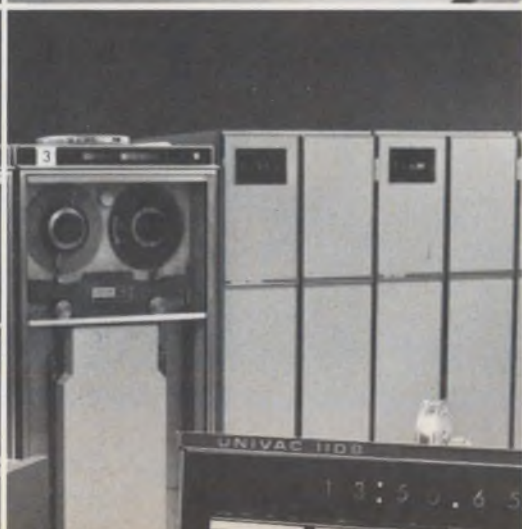
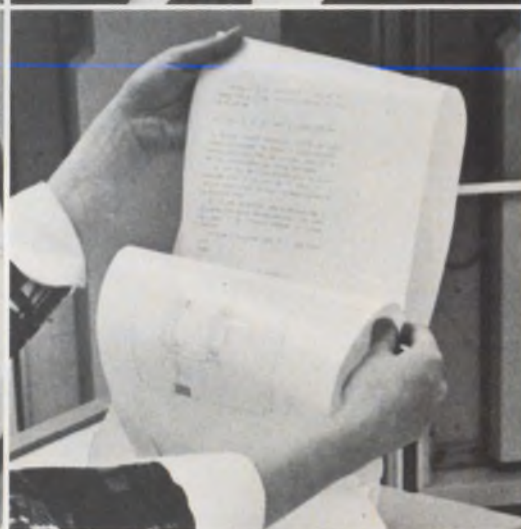
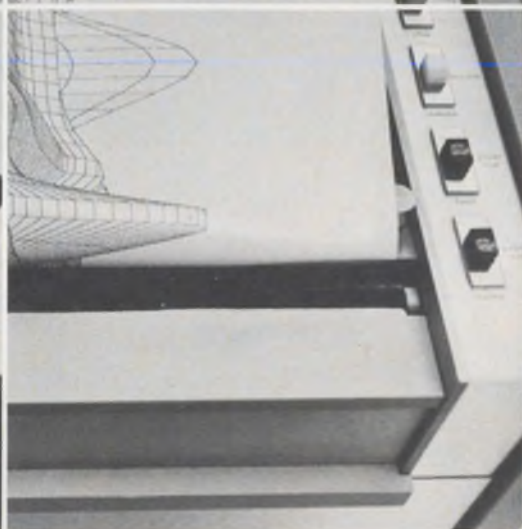
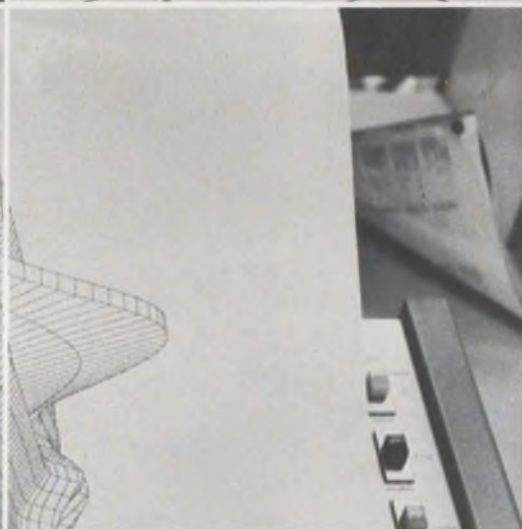


**BELDEN** 

8-5-9

*new ideas for moving electrical energy*

INFORMATION RETRIEVAL NUMBER 5



# "The Clevite electrostatic printer increases our printout capability anywhere from eight to two hundred times."

That's how Mr. Stanley Y. Curry, President of Chi Corporation sums up their experience with the Clevite 4800 hardcopy printer.

A Cleveland-based computer service firm founded by Case Western Reserve University, Chi wanted a fast, versatile printer to complement its third generation Univac 1108. Chi uses its Clevite 4800 printer to perform a wide variety of highly sophisticated scientific and engineering computations, for both the university and over 100 customers currently using the firm's many services.

Here are some more of Mr. Curry's observations . . .

"We use the Clevite 4800 in three principal areas . . . text editing; intermixing text and pictures; circuit diagrams, plotting and perspective drawings. Currently, we're experimenting with applying it to our billing procedures and are exploring its use for high-speed label printing. It looks as if the printer is useful for just about any output.

"Take text, for example. The 4800 is ideal because of the speed with which it provides copies. Change, delete, add, then program the computer accordingly. Almost instantly the electrostatic printer provides a clean copy of the edited material.

"Our experience with core dump has been quite impressive. Here is an area where the printer's diagnostic

ability really comes to play. Our computer stores some four million binary bits of information, and core dumping used to take around twenty minutes. With the Clevite Printer, we're now completing a core dump in just two minutes," Mr. Curry concludes.

#### **MORE FACTS ON THE CLEVITE 4800**

Clevite 4800 reproduces signals from any source of digital input or data transmission by telemetry, radio microwave, and/or land line. It produces accurate printouts of both alphanumerics and graphics almost as fast as the computer supplies them.

A productivity rate of 412,000 characters per minute means fast-acting computers are no longer hampered by mechanical equipment, noisily hammering out a few hundred lines per minute.

No other printer gets as much out of your computer as fast as Clevite 4800. And no other printer is so economical. The Clevite 4800 reduces capital investment, because conventional equipment costs more per unit. Also, there are few moving parts, reducing the need for constant maintenance and servicing. Clevite 4800. It's faster, more versatile, quieter, and more dependable than anything else you can buy.

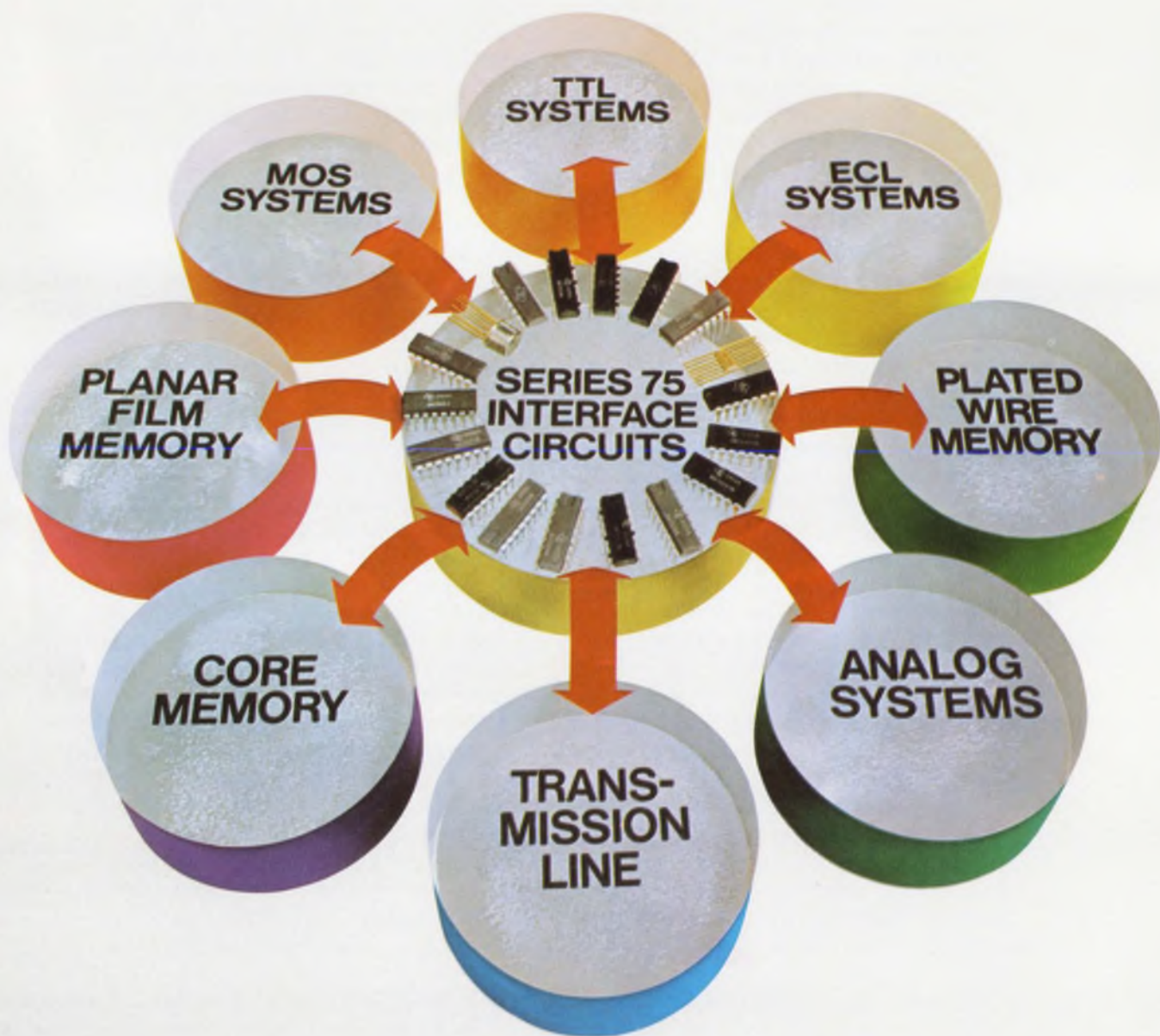
Drop us a line to find out how it fits into your computer room. Graphics Division, Gould Inc., 3631 Perkins Ave., Cleveland, Ohio 44114.

## GOULD CLEVITE

Clevite 4800. The next generation of high-speed printers.

INFORMATION RETRIEVAL NUMBER 6

# TI's quiet revolution in Linear ICs



# Here's your biggest choice for system interface design—10 sense amps, 2 memory drivers, 6 line circuits.

System interface designers have long needed an IC line big enough to work with. TI's quiet revolution in Computer Interface has provided the answer—the biggest family now available. Choose from 18 proven functions—all in stock.

The 10 sense amps (Series 7520N) offer you a selection of three basic circuit designs—three versions of dual preamplifiers driving common-output circuits, or two complete sense amps in a single package. You gain low propagation delay, fast overload recovery, high d-c noise margin, individual channel strobing, TTL compatible out-

puts—and substantial cost savings.

From the group of six drivers and receivers, you can pick dual line receivers which translate transmission line signals to logic signals or perform level shifting operations (SN75107/SN75108). Or receivers which can be applied as differential or single-ended receivers or as comparators (SN75100/SN75120). Or pick dual channel line drivers useful in balanced, unbalanced and party line systems (SN75109/SN75110).

Of the two memory drivers, the SN75303—a 150 mA transistor array—interfaces between bipolar

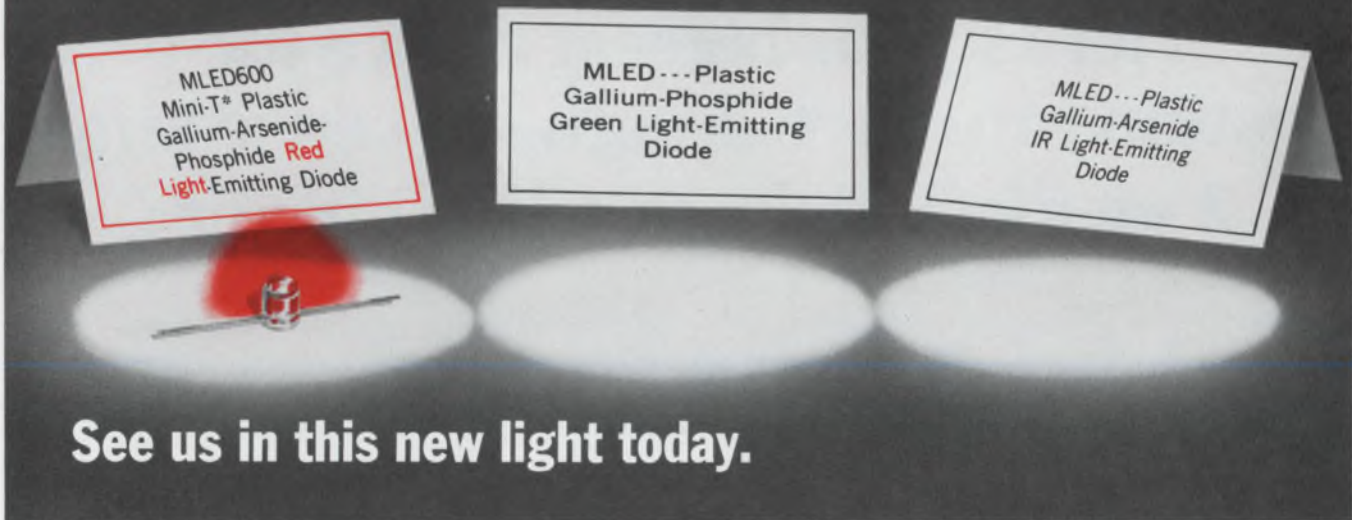
logic levels and magnetic memory systems. The SN75324 replaces traditional discrete high-current transistor-transformer circuits in magnetic memory systems.

If you're ready to whip interface problems the IC way, we'll send you our new brochure on our Computer System Interface Circuits. Circle 288 on the Reader Service Card or write Texas Instruments Incorporated, P.O. Box 5012, M.S. 308, Dallas, Texas 75222. That's where the quiet revolution is going on. Or call your authorized TI Distributor.



## TEXAS INSTRUMENTS INCORPORATED

# L.E.D. users: 3 things will be evident in low-cost, high-volume, state-of-the-art designs!



We're new in L.E.D.'s. So our first of three new device announcements — the MLED600 red L.E.D. — offers you performance advantages unseen elsewhere.

Low, 45 mA typical drive current furnishing 700 foot-lamberts brightness. Unique, molded Mini-T lens. Reliable, oxide-passivated construction. Low-nanosecond response time. 660 nanometer typical emission wavelength. And the first, clear-plastic package stripline-produced in volume economy...

**\$1.45 each, 1,000 up!**

The MLED600 will be a distinct asset in panel indicators, light modulators, shaft or position encoders, punched card readers, optical switching and logic circuits, or any

application requiring high visibility, low drive power, long life and stability.

And, our 5,600-angstrom green and 9,000 angstrom infra-red L.E.D.'s will soon appear in similar volume and low-cost!

In the meantime, send to Box 20912, Phoenix 85036 for AN508, "Applications Of Phototransistors In Electro-Optical Systems." It handles theory, characteristics and terminology, design of E-O systems using device information and geometric considerations and includes circuit designs for DC, low and high-frequency applications.

We'll include a data sheet on the state-of-the-art MLED600.

Both should be seen to be appreciated.

®TM. Motorola Inc.  
†Patented Process

*- where the priceless ingredient is care!*



**MOTOROLA**  
**OPTOELECTRONICS**

# Designer's Calendar

## MARCH 1970

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Mar. 11-13

Scintillation & Semiconductor Counter Symposium (Washington, D.C.) Sponsor: NBS, IEEE. R. L. Chase, Brookhaven National Laboratory, Upton, N.Y. 11973

CIRCLE NO. 320

Mar. 23-26

IEEE Convention and Exhibition (New York City) Sponsor: IEEE. H. L. Nicol, The Institute of Electrical and Electronics Engineers, 345 E. 47th St., New York, N. Y. 10017

CIRCLE NO. 321

## APRIL 1970

S	M	T	W	T	F	S
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5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

Mar. 31-Apr. 2

International Symposium on Submillimeter Waves (New York City) Sponsor: IEEE et al. J. Fox, Microwave Research Institute, Polytechnic Institute of Brooklyn, 333 Jay St., Brooklyn, N. Y. 11201

CIRCLE NO. 322

Mar. 31-Apr. 2

Symposium on Law Enforcement Science and Technology (Chicago) Sponsor: U.S. Dept. of Justice. IIT Research Institute, Law Enforcement Science & Technology Center, 2024 West St., Annapolis, Md. 21401

CIRCLE NO. 323



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## Simpson panel instruments on your equipment

Simpson's advanced self-shielding annular and core magnet construction provides optimum torque-to-mass ratio. Rugged Taut Band and Pivot & Jewel movements can withstand punishing shock and vibration. Your assurance of an instrument that will *stay* accurate. No wonder so many manufacturers with reputations to protect (or build!) specify Simpson.

Over 1,400 stock ranges, sizes, and types. Get "off the shelf" delivery from your local electronic distributor.

For special needs contact your local Simpson Representative. He's ready to help.

**Simpson** ELECTRIC COMPANY



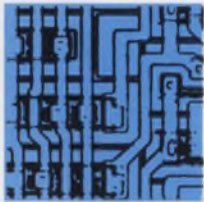
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INSTRUMENTS THAT STAY ACCURATE

INFORMATION RETRIEVAL NUMBER 9

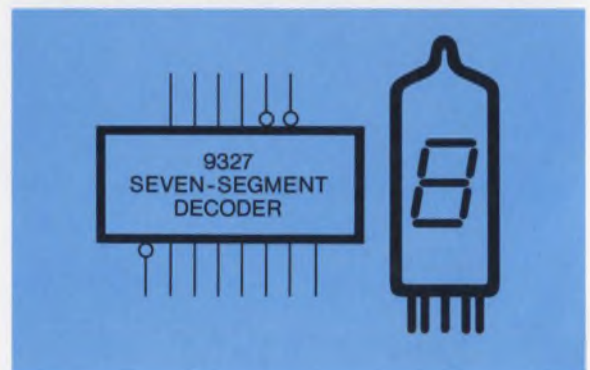
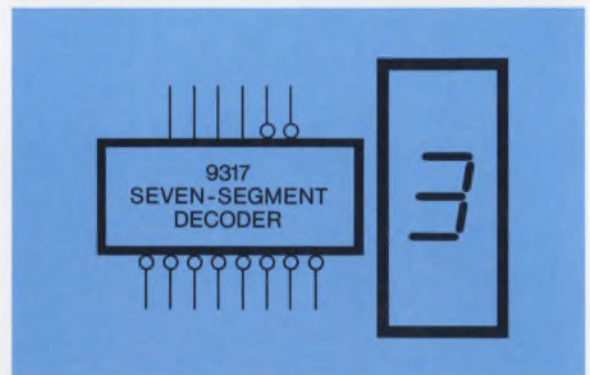
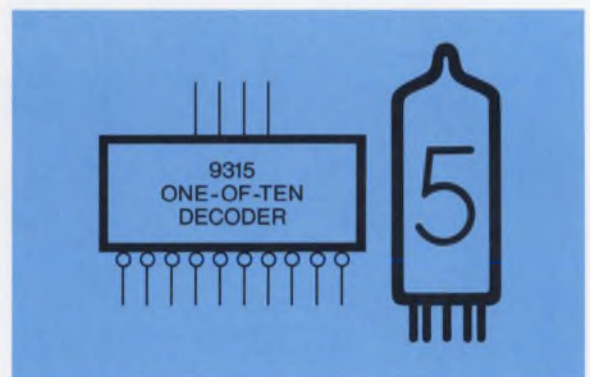
# To make Decoders that can drive every major display device,



Three Fairchild MSI decoder/drivers cover the requirements of every major military and industrial display device on the market. The 9315. The 9317. And the brand new 9327. Each device has a built-in driver stage—an important feature that means smaller, lower-cost systems with higher reliability.

**NIXIE**—The 9315 One-of-Ten Decoder/Driver accepts decimal inputs and provides ten mutually exclusive outputs which directly drive NIXIE\* tubes. Stable high-voltage output characteristics also make the 9315 ideal for driving relays, lamps and similar devices.

**SEVEN-SEGMENT**—Fairchild's 9317 and 9327 Seven-Segment Decoder/Drivers convert 4 inputs in 8421 BCD code into appropriate outputs for driving seven-segment numerical displays. The 9317 is designed for use with incandescent lamps, neon, electroluminescent and CRT displays, as well as light emitting diode indicators. The 9327 is used for DIGIVAC S/G\*\* vacuum fluorescent readouts. Both devices feature automatic ripple blanking, lamp intensity modulation, lamp test facility, and blanking output. Outputs are disabled by codes in excess of binary 9. Flags are removed on the 6 and 9, which reduces the number of ambiguous states.



\*NIXIE is a registered Trademark of Burroughs Corporation.  
\*\*DIGIVAC S/G is a registered Trademark of Wagner Electric Corporation.

To order these Decoder/Drivers, call your Fairchild Distributor or ask for:

PART NUMBER	PACKAGE	TEMPERATURE RANGE	(1-24)	PRICE (25-99)	(100-999)
U4L931551X	Flat	-55°C to +125°C	\$22.00	\$17.60	\$14.65
U4L931559X	Flat	0°C to + 75°C	11.00	8.80	7.30
U6B931551X	DIP	-55°C to +125°C	20.00	16.00	13.30
U6B931559X	DIP	0°C to + 75°C	10.00	8.00	6.65
U4L9317513	Flat	-55°C to +125°C	28.00	22.40	18.70
U4L9317593	Flat	0°C to + 75°C	14.00	11.20	9.35
U7B9317513	DIP	-55°C to +125°C	25.40	20.30	17.00
U7B9317593	DIP	0°C to + 75°C	12.70	10.15	8.50
U4L9327591	Flat	0°C to + 75°C	13.05	10.50	8.80
U7B9327591	DIP	0°C to + 75°C	11.90	9.55	8.00



# you have to get serious about MSI family planning.

We put together a family plan by taking systems apart. All kinds of digital systems. Thousands of them.

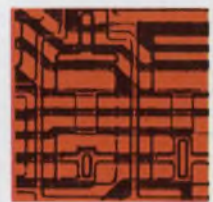
First we looked for functional categories. We found them. Time after time, in a clear and recurrent pattern, seven basic categories popped up: Registers. Decoders and demultiplexers. Counters. Multiplexers. Encoders. Operators. Latches.

Inside each of the seven categories, we sifted by application. We wanted to design the minimum number of devices that could do the maximum number of things. That's why, for example, Fairchild MSI registers can be used in storage, in shifting, in counting and in conversion applications. And you'll find this sort of versatility throughout our entire MSI line.

Finally, we studied ancillary logic requirements and packed, wherever possible, our MSI devices with input and output decoding, buffering and complementing functions. That's why Fairchild MSI reduces—in many cases eliminates—the need for additional logic packages.

The Fairchild MSI family plan. A new approach to MSI that's as old as the industrial revolution.

It started with functional simplicity, extended through multi-use component parts, and concluded with a sharp reduction in add-ons. Simplicity. Versatility. Compatibility. Available now. In military or industrial temperature ranges. In hermetic DIPs and Flatpaks. From any Fairchild Distributor.



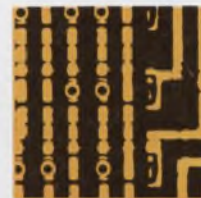
**OPERATORS**  
9304 - Dual Full Adder/Parity Generator



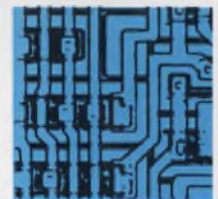
**LATCHES**  
9308 - Dual 4-Bit Latch  
9314 - Quad Latch



**REGISTERS**  
9300 - 4-Bit Shift Register  
9328 - Dual 8-Bit Shift Register



**MULTIPLEXERS**  
9309 - Dual 4-Input Digital Multiplexer  
9312 - 8-Input Digital Multiplexer



**DECODERS AND DEMULTIPLEXERS**  
9301 - One-Of-Ten Decoder  
9315 - One-Of-Ten Decoder/Driver  
9307 - Seven-Segment Decoder  
9311 - One-Of-16 Decoder  
9317 - Seven-Segment Decoder/Driver  
9327 - Seven-Segment Decoder/Driver



**COUNTERS**  
9306 - Decade Up/Down Counter  
9310 - Decade Counter  
9316 - Hexadecimal Counter



**ENCODERS**  
9318 - Priority 8-Input Encoder

**FAIRCHILD**  
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Shown actual size



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2. High sensitivity (300 mV DC fs) for transistor bias measurements, resistance measurements to 5,000 Megohms.
3. Hand-size with single selector switch and provision for attaching AC clamp-on adapter.



## MOS CLOCK DRIVERS

How many MOS devices can a clock driver operate? There is no hard and fast answer. Fanout is bounded by the driver's current and power ratings, but can vary greatly with drive requirements and with the way the driver itself is driven by the clock signal source.

Any of the drivers in the table might clock an MOS shift-register string with thousands of stages, for instance, but if that were the only consideration we wouldn't be producing a variety of types. All the drivers have the same basic function—translating a bipolar clock signal to MOS voltage levels and boosting the output current. They have similar output stages, whose operation was detailed in AN-18, "MOS Clock Driver."

What makes them tick differently is their input stages. The NH0007 includes an input AND gate and can be coupled directly to a TTL or DTL gate. The NH0009 is directly or capacitively coupled to a TTL line driver that provides at least 20 mA. To work at its full speed, the NH0012 requires direct-coupled, opposite phase inputs from a TTL driver. And the NH0013 is capacitively coupled to a TTL driver.

The NH0013 offers high fanout at lowest cost. It is most efficient because it does not have a built-in level shifter and the output duty cycle is lower than the input duty cycle. Essentially, it is the NH0009 without the Q1-Q2 input stages seen in Figure 1. However, the NH0013's output pulse width depends on the input drive circuitry rather than the input pulse timing. This is also true of the NH0009 when it is capacitively coupled.

When it is direct-coupled as shown in Figure 2 (most people use it capacitively coupled), the NH0009 will follow the input. That is, the driver output will remain at the MOS "1" level (near V<sub>2</sub>) for as long as the input is at the TTL "1" level. The output will be MOS "0" (near V<sub>3</sub>) while the input is at TTL "0". The NH0007 and NH0012 do the same.

In contrast, the NH0013 (or an NH0009 capacitively coupled) as shown in Figure 3 will produce an output MOS "1" level pulse during the period following the bipolar logic transition from the TTL "0" state to the "1" state. At all other times, the output will remain at the MOS "0" level. The width of the "1" output pulse depends on the cur-

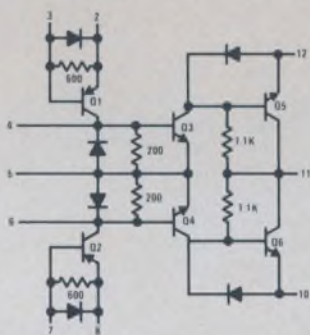


FIGURE 1. NH0009 Dual MOS Clock Driver

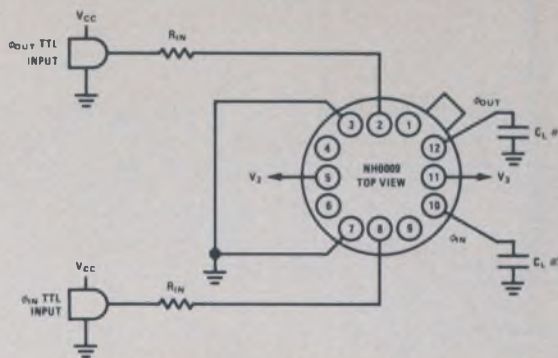


FIGURE 2. Directly Coupled Dual Driver

### Characteristics of National MOS Clock Drivers

TYPE	PACKAGE	OUTPUT PHASES	INPUT COUPLING	INPUT LEVEL TRANSLATOR	MAX REP RATE—MHz	MAX OUTPUT SWING—V	I <sub>OUT</sub> —mA	P <sub>MAX</sub> —mW @25°C/@70°C	P <sub>OFF</sub> mW
NH0007	TO-5	1	dc	Yes	5	30	±500	800/600	5
NH0009	TO-8	2	dc or Cap	Yes	3	30	±500	1500/1000	0
NH0012	TO-8	1	dc	Yes	10	30	±1000	1500/1000	20
NH0013	TO-8	2	Cap	No	5	30	±500	1500/1000	0

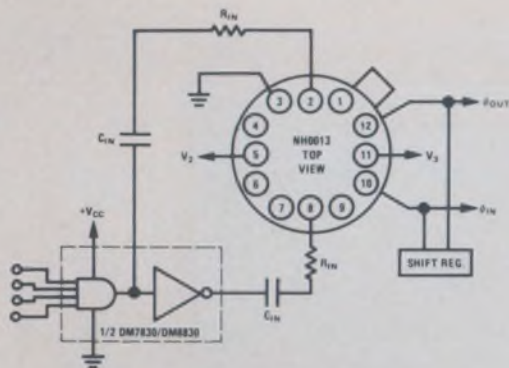


FIGURE 3. Capacitively Coupled Dual Driver

rent available from the TTL driver and the input capacitor (see Figure 4):

$$P.W. \propto C_{IN} \times V_{drive}/I_{drive}$$

As soon as the input rises about 0.5V, the output is driven to the MOS "1" level (V<sub>2</sub>). The output returns to the MOS "0" level (V<sub>3</sub>) when the input capacitor charges.

Capacitive coupling from the TTL driver to the NH0013 helps cut system power consumption and cost to the bone when used with other low duty cycle techniques. Low duty cycle driver efficiency is discussed in AN-18 and low frequency memory operation to reduce system power is discussed in AN-19, "Low Power MOS."

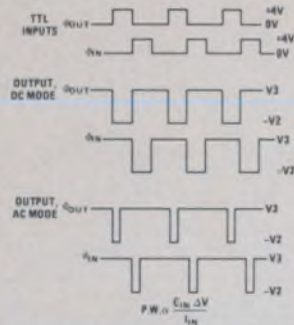


FIGURE 4. Waveforms, Each Half of Dual Driver

One point not covered in previous application notes is that capacitive coupling yields an additional fanout bonus by significantly reducing the power dissipation in the driver input (See NH0013 data sheet for more detailed calculations). Let's compare fanouts of half an NH0009 operating dc and half an NH0013 under the following typical conditions:

f = 2 MHz	V <sub>2</sub> = -16V
t <sub>r</sub> = 50 ns	V <sub>3</sub> = 0V
P.W. = 200 ns	T <sub>A</sub> = 70°C
V <sub>CC</sub> = +5V	

where t<sub>r</sub> is the rise time and P.W. the pulse width of the input signal.

One factor limiting fanout is P<sub>max</sub>, the package power dissipation. This is 500 mW for each half at 70°C, which covers both the internal dissipation P<sub>dc</sub> and the transient dissipation P<sub>ac</sub> involved in driving the load. That is,

$$P_{max} = P_{dc} + P_{ac}$$

The only significant P<sub>dc</sub> in National's two-phase drivers occurs during the "1" output, so P<sub>dc</sub> in half a direct-coupled NH0009 is

$$P_{dc} = \left[ (V_{CC} - V_2) I_{IN} + \frac{(V_3 - V_2)^2}{R_b} \right] \times \text{"1" duty cycle}$$

where I<sub>IN</sub> from the TTL driver averages 20 mA and R<sub>b</sub> is the output collector load resistor of 1.1 kΩ. Therefore,

$$P_{dc} = (21 \times 20 + 16^2 / 1.1) \times 0.4 \times 10^{-3} = 261 \text{ mW}$$

This allows P<sub>ac</sub> to be 239 mW in the NH0009.

In the NH0013, the input voltage component is only the TTL "1" level of about 4.0V, so its P<sub>dc</sub> is only 125 mW and P<sub>ac</sub> can be 375 mW. In all drivers,

$$P_{ac} = C_L f \times (V_3 - V_2)^2$$

where C<sub>L</sub> is the capacitive load presented by the MOS devices' clock inputs. Therefore, in this example each half of the directly coupled NH0009 would drive 467 pF worth of MOS devices, and the NH0013, 732 pF. The difference is more pronounced when the voltage swings are larger. In other words, each NH0013 could drive several more large MOS registers while dissipating the same power as the direct-coupled NH0009.

The two become equal when the absolute limit on fanout imposed by output current capability is reached. This is

$$C_{L(max)} = I \times t_r / V$$

where I is the output current limit and V the output voltage swing. These drivers will withstand transient currents of 600 mA, so C<sub>L(max)</sub> would be 1,875 pF at V<sub>2</sub> = -16V, V<sub>3</sub> = 0V and t<sub>r</sub> = 50 ns. Techniques such as lowering the duty cycle or making both V<sub>3</sub> and V<sub>2</sub> more positive can be used to work C<sub>L</sub> up toward C<sub>L(max)</sub>. But don't exceed it (a precaution that has sometimes been overlooked on the data sheets of rival devices).

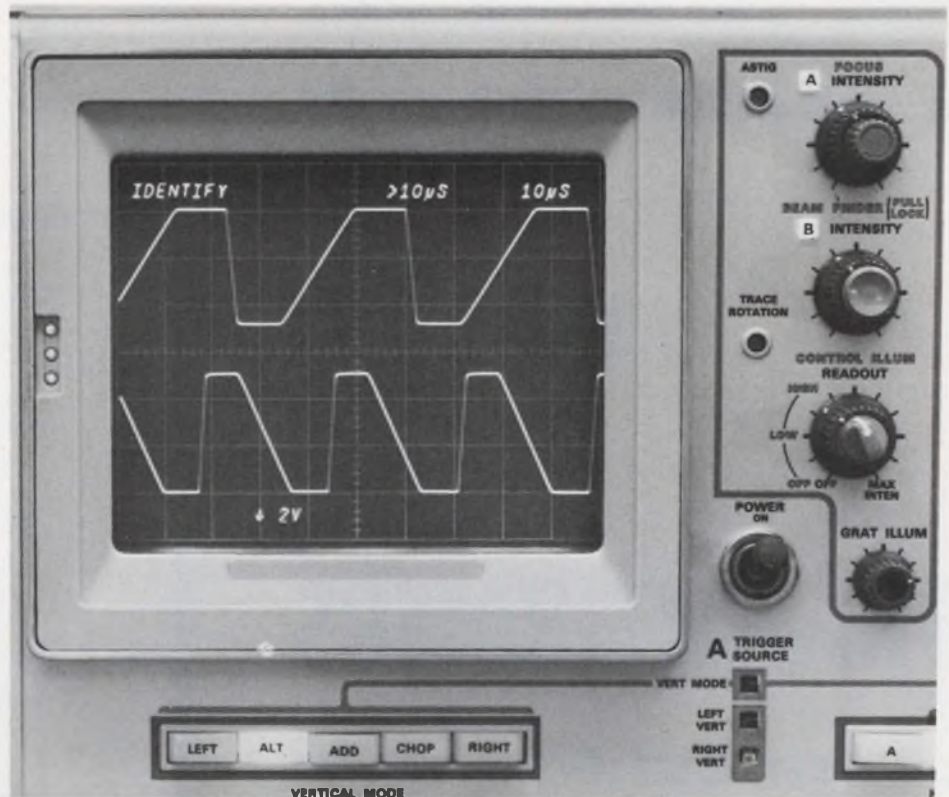
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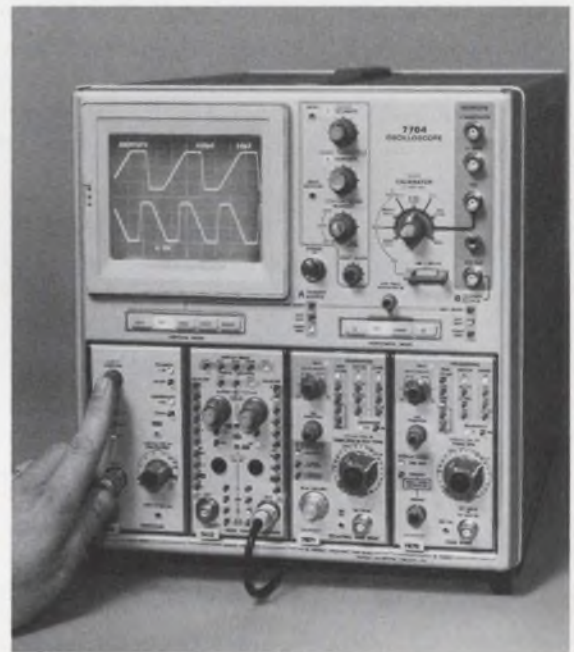
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7B70 Time-Base Plug-In . . . . .	\$ 600
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This breakdown-diode/transformer triggering circuit is a typical application for Type 11Z12 Trigate Pulse Transformers.

This unijunction-transistor/transformer triggering circuit is a typical application for Type 11Z13 Trigate Pulse Transformers.



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# Highlighting

THE ISSUE

PS Series	26.8-29.2	3-1
A6AY101	10-29.9	0.1
A6BY101	10-29.9	0.1
A6CY101R	10-29.9	0.1
A6DY101R	10-29.9	0.1
A6AY252	10-29.9	2.5
A6BY252	10-29.9	2.5
A6CY252R	10-29.9	2.5
A6AY502	10-29.9	5

Specifications for approximately 3500 power supplies made by 68 manufacturers are presented in convenient tabular form to assist you with your requirements. In addition, articles bring you up to date on technology in the field.

For convenience power supplies have been divided into 5 categories: high current, constant current, high voltage, laboratory type, and modular type.

**PAGE D1**



The medical electronics field is about to expand dramatically.

"When we installed our radiology department, we spent \$240,000," says Robert Heinlein, director of Overlook Hospital in Summit, N. J. "This year we are going to spend \$230,000 on new equipment alone."

Electronics is not only doing a critical job in hospitals, Heinlein says, but "physicians and nurses are now more sophisticated in their understanding of what electronic machines can do."

**PAGE 24**



Intended for use as a highly versatile bench instrument, a new four-digit multimeter with 100% overranging features a low cost of only \$795 in an instrument that is capable of measuring five functions in 30 ranges.

With 13 push buttons, the model DM414 integrating digital multimeter with a 100-ms response, measures ac and dc voltages, ac and dc currents, and resistances, all in very wide ranges.

**PAGE 97**

# Why NIXIE® tubes when we just developed SELF-SCAN™ panel displays?

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## Burroughs





# News Scope

## U. S. Budget for fiscal 1971; A mixed anti-inflation bag

The underlying theme in the \$200.8-billion U. S. budget request for fiscal year 1971 is the Administration's declaration of war on inflation, with austerity its chief weapon.

Money for defense is down, and funds for the exploration of space are at a new low. Showing a rise, however, are requests for funds to deal with the well-publicized airline traffic problems in the domestic skies and to fight crime.

In his first budget message to Congress, President Richard M. Nixon said: "For the first time in two full decades, the Federal Government will spend more money on human resource programs than on national defense."

Although the raw picture looks grim at a glance, closer scrutiny shows a number of programs continuing full blast and new ones opening up. The need for good market research this year has reached a high.

Out of the whole federal budget, defense gets only 34.6%—its the lowest percentage since 1950. Total obligation authority requested for 1971—new money plus unspent money from previous years—is down 14.8%. The figure for 1970 was \$85.6-billion; this year's request is for \$72.9-billion.

And the defense outlay—money expected to be spent—is down 12%, from \$81.6-billion to \$71.8-billion.

"There will be a 30% drop in procurement," a Defense Dept. spokesman told a pre-budget briefing. "There will be a reduction in contractor personnel from July, 1969, to July, 1971 of 640,000 employees, and there will be a substantial closure of military bases."

Money for strategic (global war) forces is up \$400-million. Minuteman III missiles will replace the older Is. For the Safeguard anti-missile system, \$1.5-billion is asked.

Short-range attack missiles for bombers will be bought, and \$100-million is being sought to start work on a new manned bomber, the B-1. A new over-the-horizon radar will be started, and Awacs, the long-delayed airborne warning and control system, is pegged for an \$87-million start.

Ship-building will hold its own at \$2.6-billion. And outlays for aircraft will be up, including funds for the F-15, F-14A and S-3A.

Some of the items that won't get as much this year as they did in 1970 include the EA-6B, the A-7E and A-7D, F-111, C-5A, nuclear aircraft carriers, nuclear guided missile destroyers, attack submarines and conversion of Polaris submarines to handle the bigger Poseidon missile.

NASA's planned expenditures of \$3.4-billion in fiscal year 1971 include roughly \$1.3-billion for electronics, based on an estimate by the agency's Administrator, Dr. Thomas O. Paine.

Although the lowest NASA budget request since fiscal 1962, the total may represent a nadir, says Dr. Paine. He discloses "an understanding" with President Nixon, obtained in late January, that the space agency will be supported at or above this level in succeeding years.

Dr. Paine firmly rejects a statement by a top White House official alluding to elimination of additional NASA centers. In a budget press briefing, Dr. Lee Dubridge, Presidential Scientific Adviser, indicated that more NASA research centers might be axed. But Dr. Paine says he has a Presidential okay to hold the existing NASA facilities together "as a national asset."

Losses to the electronics industry from the space budget will be compensated partly by marked in-

creases in funding for the Federal Aviation Administration and multi-agency expenditures for anti-crime research and Federal law-enforcement assistance.

A total of \$1.77-billion is being asked for the FAA—an increase of \$440-million over last year. Nearly \$240-million of this is for R&D and new equipment and facilities.

An additional \$292-million will be asked for airways and airport development—for radars, communications, and computer facilities—but this is dependent on separate legislation expected from the Congress this year.

For the reduction of crime, the Administration is asking \$1.26-billion—41% of it to assist state and local law-enforcement agencies, or nearly double the sum available last year.

### From machine tools to minicomputers

The Cincinnati Milling Machine Co., Cincinnati, Ohio, has announced its entry into the mini-computer market with two 8-bit models. The CIP/2000 is a micro-programmable, dedicated computer with a read-only memory that has 1024 instructions. The larger CIP/2100 has three read-only memories plus a 4K core memory that is expandable. The company is offering the two models to the OEM market, and it has not announced any plans for using the machines in conjunction with its machine-tool product line.

### Bell to test waveguide communications system

Bell Telephone Laboratories has announced plans for a 20-mile millimeter waveguide communications system that it expects to field-test in 1974. This system—reported by ELECTRONIC DESIGN in its issue of Sept. 13, 1969 (see "Dither Over Data," p. 30)—will carry 250,000 simultaneous phone conversations.

A spokesman for the Long Lines Div. of the Bell System says construction of the waveguide system will begin in 1973, with commercial service slated for the late 1970s.

The millimeter waveguide will consist of two-inch, copper-lined

steel pipe enclosed in a protective conduit four feet underground. The system is to operate at 40 to 100 gigahertz—a frequency band with a greater capacity than all of the lower radio frequencies combined.

Pulse code modulation will be used to convert all types of signals—voice, TV, Picturephone and data—for transmission through the waveguide.

In addition to its communication capacity, a major advantage of the millimeter wave system is that signals can travel about 20 miles before requiring amplification. Repeater stations with present coaxial systems are spaced two to five miles apart.

## Computers can spot offshore oil leaks

A new system has been developed that reduces the possibility of disastrous oil leaks, like the one off Santa Barbara, Calif.

Developed by Ocean Science and Engineering, Inc. of Long Beach, Calif., the system can operate up to 16 wells simultaneously in waters up to 1500 feet deep. The system, known as Deep Oil, includes a computer that monitors several performance parameters of the wells. According to W. Saxe Montgomery, western marketing manager for Ocean Science, the computer checks each well every three seconds.

"The system is fail-safe," says Montgomery. "Any failure noted in a valve or line pressure or oil flow rate will automatically shut the whole system off. No one need be around. The computer can be miles away. The computer's console has built-in diagnostic aids that show exactly where the failure has occurred. The Seafloor Oil Well Completion Unit (a submersible vehicle with robot-like arms) is then dispatched to the scene to make repairs."

Deep Oil eliminates the need for the Texas Tower type of structure

above ocean floor wells, since no one need be at the site. Wells are set in place by drilling ships with the help of the submersible vehicle.

This system was shown to attendees of the Marine Technology Society's Second Work in the Sea Symposium last month in Los Angeles.

## MIT Alumni Center attacks urban problems

In an effort to use its members' technical knowledge to solve urban problems, the Public Service Group of the MIT Alumni Center of New York has set up a clearinghouse to put interested alumni in touch with urban-improvement organizations. The alumni are acting as unpaid consultants to such organizations as the Urban Coalition, Applied Resources, Inc., Model Cities and the Interracial Council for Business Opportunity.

As William A. Loeb, chairman of the public service group, explains it, most of the projects in which the group has so far become involved fall into three major categories: housing, helping small businesses and job training. Several of the small businesses—usually run by minority-group businessmen—have been in the electronics area. A computer service bureau and a microelectronics firm are cited as examples.

## Belgian manufacturers set up New York office

To promote liaison between Belgian and American manufacturers in electronics and other industries, Fabrimetal, manufacturers' association of Belgium, has opened new offices at 50 Rockefeller Plaza, New York City.

Léon Félix, Fabrimetal's representative, will assist American firms in settling up licensing agreements and joint ventures.

## Job market dark for June EE grads

June graduates with advanced degrees are facing a "temporary

job market depression," Stanford's Director of Placement, Dr. Ralph Keller, believes.

The Placement Service records show that 58 major companies and seven government agencies that normally hire electrical engineers have already canceled their Stanford recruiting dates for January, February and March. Normally this is the peak period for visits by campus recruiting teams.

This includes firms in the "blue-book of American industry" that have never canceled before, Keller reported. In the past, cancellations have never amounted to more than a dozen, mainly from lack of student interest. More than 450 companies annually contact Stanford for recruits.

The whole spectrum—government, business, industry and education—is suffering a market slump, Keller said. However, the less defense-oriented the firm, the less it is suffering.

The problem is more acute for graduate students than for undergraduates, Dr. Lauress Wise, Associate Dean of the School of Engineering at Stanford, told ELECTRONIC DESIGN. The reason, he said, is that most undergraduates either go on to graduate school or enter military service. He pointed out that while the total number of job interviews for EEs is well below what it was this time last year, the salary amount of each offer actually made is some \$30 higher.

He said that MBAs with a BSEE have a higher probability of finding the job they want than MSEE's—but not better than PhDs in electrical engineering. He mentioned, however, that jobs for PhDs this year are harder to come by than ever before.

## Intelsat III starts commercial service

The new Intelsat III satellite stationed over the Atlantic began full-time commercial service earlier this month. It will handle communications between the U.S., Latin America, Europe, North Africa and the Mid-East. The satellite is the sixth in the Intelsat series. It was launched on January 14.



## Not everyone needs a multimeter that can measure the resistance of a piece of solder.

But you may be looking for a digital multimeter that will measure relay contact resistance. Or check cable continuity. Or handle other applications that require 100  $\mu$ ohm resolution without error caused by lead resistance. If that's the case, you may be looking for our 5500/135 DMM.

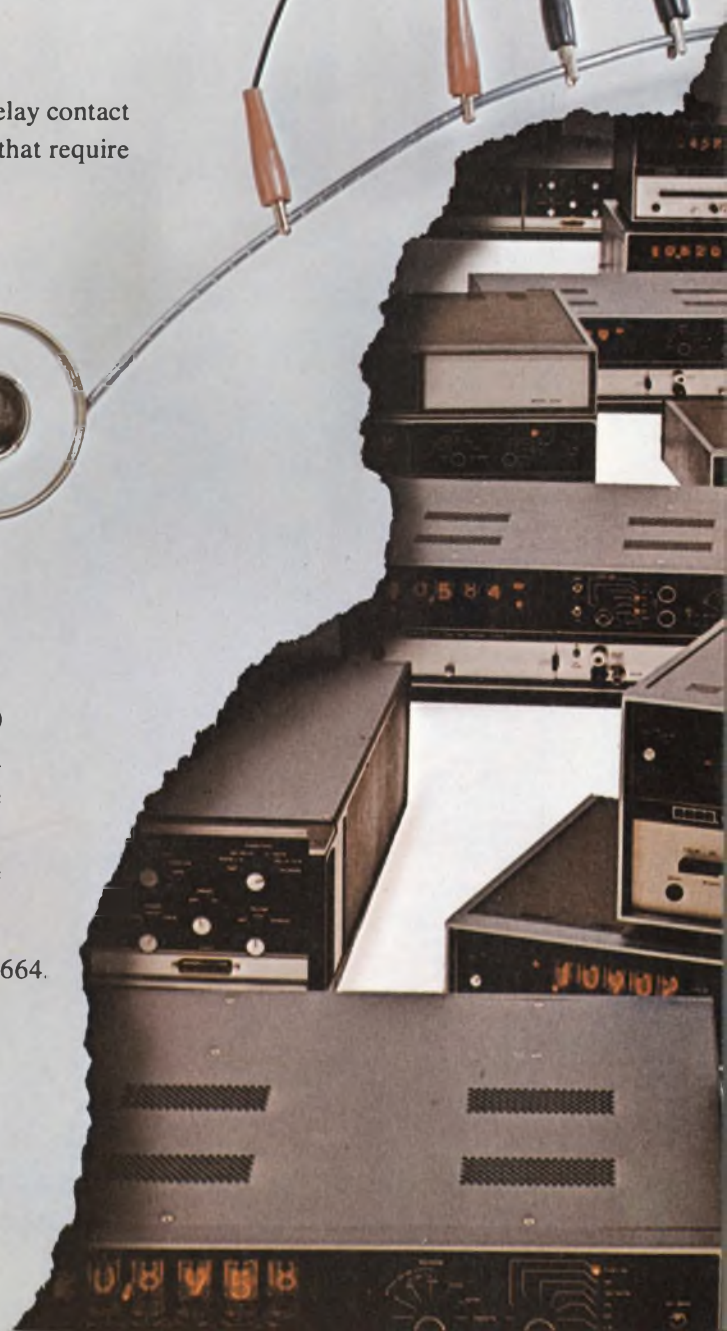
And it's more than an ohmmeter. You can turn it loose on dc volts, mV, dc/dc ratios, or square, triangular, sawtooth and sine waves. It will give you the true rms of an ac waveform, so accurately and distortion-free that we call it Computing RMS™ and have a patent pending on this revolutionary new technique.

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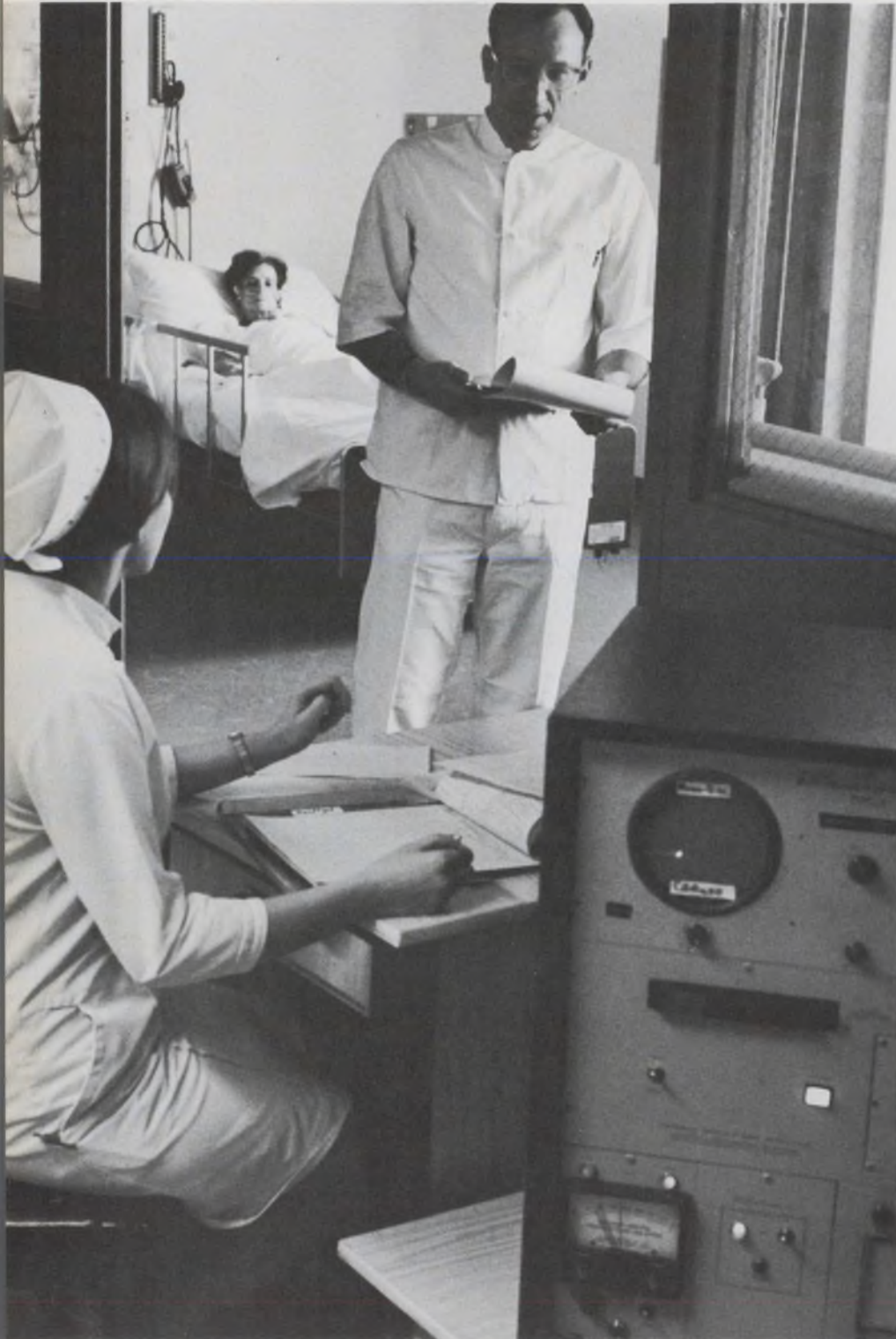
**DANA**



AN INSIDE LOOK AT HOSPITAL ELECTRONICS

# Where EE and MD

John N. Kessler, News Editor



The elevator doors open briskly on the ninth floor of Overlook Hospital, and a nurse and a therapist, moving at an efficient pace, wheel out a stretcher. The therapist is pumping an Ambu bag, a hand-held, balloon-like respirator that is used in emergency cases, and as the stretcher moves past the nurses' station on the floor, I can see through the window that it is a little girl.

She is Laurie, 6 years old, an auto accident victim. Her mother and grandmother, who were with her in the car, are already dead. The diagnosis on Laurie: severe brain-stem damage. She is motionless—unconscious.

"Put her in 924," the head nurse says.

## Machines sustain life

The girl is wheeled into Room 924—ICU, they call it at Overlook Hospital. The initials stand for Intensive Care Unit, an area where electronics is playing an increasing role in the care of patients.

Swiftly, attendants connect Laurie to a respirator that does her breathing. Nurses set up intravenous flows to keep her body fluids in balance and to maintain normal blood pressure. They also connect her body to a hypothermia unit to keep her temperature down.

Later an electroencephalogram is used to determine the extent of her brain activity. And an Echo-

**Hospital attendant John Kessler** gets his orders from a nurse in Overlook's Coronary Care Unit. Cardiac monitors have a 15-second memory loop and an adjustable pulsemeter alarm. An alarm in the patient's room automatically notifies medical personnel of any emergency and sets off a clock above the patient's bed.

# link up to prolong life

encephalogram is brought in to determine possible shifts in the midline of her brain.

The brain tests prove negative—indicative of severe damage and a possible shift in the brain. For three days, aided by electronic monitors and instruments, the staff watches and works over Laurie. She never regains consciousness. She dies on Jan. 23, 1970.

By now I have become nearly acclimated to the continual flowing and ebbing of life in a modern hospital. For I am just about at the end of a week's stint as a reporter-attendant in Overlook Hospital, a nonprofit, community institution in Summit, N.J. I wanted to find out how electronics is being used in American hospitals and where it is headed, so I took a job in a typical hospital right near my home.

I spent two days learning about the duties and responsibilities of a hospital attendant and then five days working in various areas of the hospital. I found that a broad range of electronic equipment is in use and is being planned for use: computer time-sharing, telemetry, cardiac monitors, communication systems, laboratory analytical instruments, closed-circuit TV and such instruments as respirators, which are just beginning to incorporate the sophistication that electronics affords.

## Major expansion likely

The medical electronics field is about to expand dramatically, I concluded.

"When we installed our radiology department, we spent \$240,000," says Overlook Hospital's director, Robert Heinlein, "This year we are going to spend \$230,000 on new equipment alone."

Electronics is not only doing a critical job in hospitals, Heinlein says, but "physicians and nurses are now more sophisticated in their understanding of what electronic machines can do."

ICU is a 14-bed intensive care unit. Each nurse on the 7 a.m.-to-3 p.m. shift is assigned two patients. Most patients here are listed as "critical," but they are considered to have a good chance of recovery. The unit is not used for "terminal" patients.

## Electronics in ICU

At least five types of electronic equipment are available in ICU, and each can have a significant bearing on whether or not a patient will recover:

- **Respirators.** These are breathing machines that have largely replaced the "iron lungs." Early respirators delivered a constant supply of air to a patient. But researchers found that in normal breathing a person sighs several times a minute—a natural reaction that keeps the lungs flexible and the airways open. Electromechanical respirators did not allow for such sighing, and doctors found this could lead to a breakdown of lung tissue. Now, an electronic counter can vary the total volume of air and oxygen delivered each minute, so that the patient is "sighed" automatically.

- **Hypothermia units.** These have taken the place of the hot water bottle and the ice pack. They raise or lower body temperature. Basically the unit consists of a cooling compressor, heating elements and pumps to circulate a heat-transfer liquid (20% alcohol in distilled water) from the unit to a vinyl pad. Pad temperature can be reduced from

105° to 40°F in about five minutes, depending on the size of the unit. Settings are usually accurate to  $\pm 1/2$  degree F. A thermistor probe for esophageal or rectal use provides a constant temperature readout.

- **Cardiac monitors.** These provide a visual readout of the electrical activity of the heart. There is a monitor at each bedside and a slave scope in the nursing station. A high-low alarm pulse-meter is set at 40 and 120 heartbeats per minute. It gives a signal when abnormal heart rhythm or speed occur. If an alarm does go off, a memory module automatically records the patient's EKG 15 seconds prior to the onset of the alarm. These tracings are taped to the patient's chart so they can be interpreted by a cardiologist.

- **Automatic rotating tourniquets.** These are cuffs (similar to those used for taking blood pressure). Placed on the arms and legs, they slow circulation of blood returning to the heart and the lungs. This reduces interpleural pressure, an important factor in treating patients with pulmonary edema.

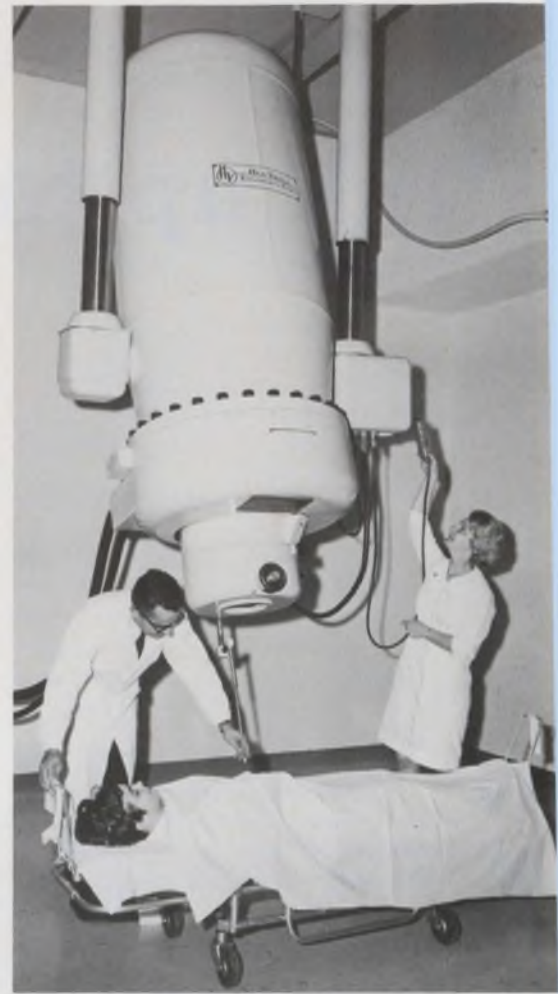
- **Communication systems.** These consist of an intercom between each room and the nursing station, telephones to the main switchboard, and four pneumatic tubes to carry written messages throughout the hospital and small medications from pharmacy to the ICU nursing station.

In Overlook's laboratory, a serum analyzer made by Technicon Corp.—the SMA 12/60—typifies the interdependence of chemistry and electronics in modern medicine. The Tarrytown, N.Y., company has programmed its Sequential Multiple Analyzer to analyze 12 constituents of blood serum. The chart on which these measure-

The operating rooms at Overlook all have anti-spark outlets, intercoms, cardiac monitors and fiber optic scopes. Electronics can aid in designing new types of scalpels, drills, cauterizers.



Two-million-volt Van de Graaff generator in the treatment room at Overlook. A TV camera and monitor is used to observe the patient undergoing radiation therapy.



ments are recorded shows those regions considered to be normal. It takes one minute to perform all tests and obtain a printout.

Jane Chatfield, chief technologist in Overlook's laboratory, says there has been rapid growth in the last four years in the development of electronic equipment for hospitals—"and it's possible to reduce costs." She points out that the analysis done by the SMA is considerably less expensive than would be the case if such tests were performed separately by hand under a microscope.

Overlook presently is tied into the computer bank of the New Jersey Hospital Association, which provides statistical information concerning financial aspects of hospital administration: accounts payable, personnel records, etc.

By early spring, the Medelco data communication system is slated to be installed. This will link Overlook with a large-scale computer in Princeton, N.J. Medelco, a division of Scam Instruments, Inc., Chicago, calls its program

THIS—Total Hospital Information System.

THIS will relay information from one section of the hospital to any other in 10 seconds. Small consoles will be set up at each nursing station.

Dr. Warren Nestler, director of medical education, emphasizes the need to speed medical orders, especially in emergencies. But the system will also handle a complexity of routine items that affect the care of each patient: orders to X-ray, changes in diet and medications, labels for pharmaceuticals and orders to the business office will be automatically printed out.

A small computer within the system will tie in equipment from Overlook's laboratory to all the nursing stations so test results will be available immediately. The cost of a time-shared program is expected to be substantially less than that of a full-scale computer within a hospital.

A third shared-computer program will be used to analyze the outputs of all equipment that

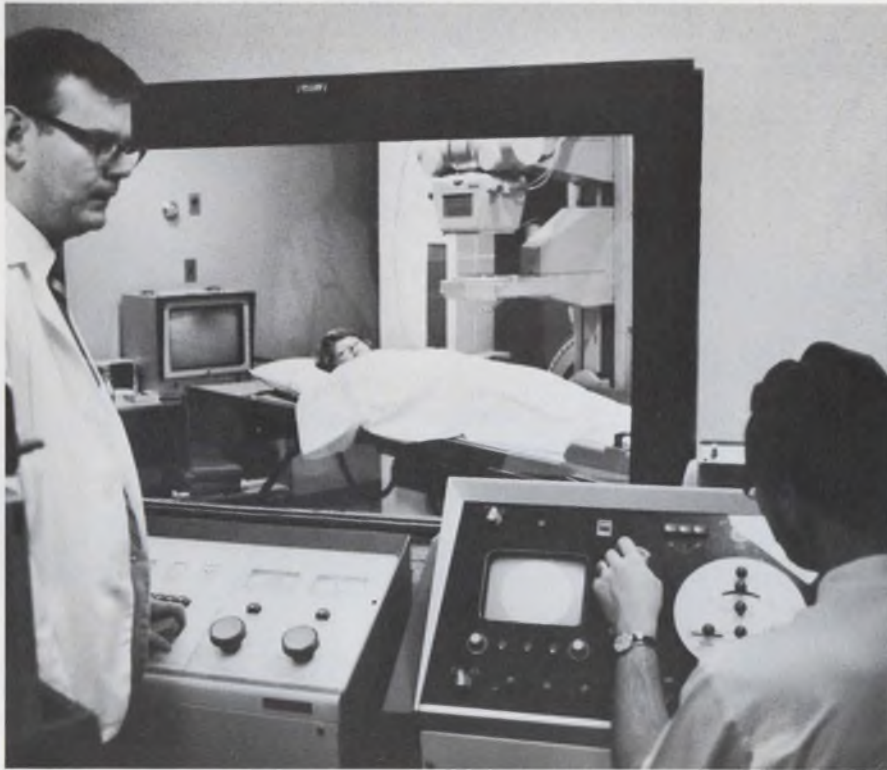
yields linear data.

Telemetry is another burgeoning area in hospitals. Four years ago Overlook had four cardiac monitors. Now there are 12 in CCU (the Coronary Care Unit) and six in ICU. The need for monitoring has become so great that Overlook will soon be installing a special ambulatory cardiac telemetry system. Recuperating coronary patients in need of constant monitoring will wear a small external transmitter over the chest. This will pick up basic EKG information and transmit it to a receiver at the nursing station. Patients will be able to move around and still be observed by EKG.

There are three X-ray units at Overlook equipped with remote-control TV. In the control room is a videotape recorder. All the X-ray and fluoroscopy equipment can be moved automatically. A videotape recorder enables a doctor to make a permanent record of fluoroscopic images.

In the X-ray therapy room, along with a 2-million-volt Van de

Remotely controlled X-ray unit is also equipped to video-tape fluoroscopic images. Overlook Hospital will spend \$230,000 on new radiological equipment this year.



Graaff generator, is a video camera. A monitor in the control room permits outside observation of a patient while he is under treatment.

#### The day starts at 7 a.m.

The typical day shift for the hospital attendant begins at 7 a.m., and a sampling from the diary I kept runs as follows:

**Jan. 15 at 7 a.m.** In all non-critical areas of the hospital, "the report"—the accounting by the nurse in charge of the status of her ward—is taped prior to the arrival of the new shift. In ICU and CCU the report is given orally by the head nurse:

"921: Robert Wilkenson, pneumonia acute MI (myocardial infarction) with congestive heart failure . . . 49 years old . . . has some chest pains, and he's had Demerol for that. Getting nasal oxygen continuously, and he is on a monitor with a regular sinus rhythm with an inverted T wave. EKG was done. He is alert.

"924—Frank George, post-pace-

maker of last night. Respiratory arrest, CVA (cerebral vascular accident) and tracheostomy. And this is the order of the attending doctor—he doesn't want any heroics. They did an EEG; it was flat. And an Echoencephalogram was negative for any localized findings."

The report drones on.

**Same day, 1:15 p.m.** An Echoencephalogram is wheeled into Room 924. This machine, made by Hoeffrel Instruments, Norwalk, Conn., can determine a shift in the midline of the brain.

Lorraine Gillard, cardio-pulmonary technician, holds the electrodes on both sides of Mr. George's head. A wave flickers across the screen. We see the peaks representing the sides of the skull, but nothing to denote a midline.

"We know where the main echo is, but we get it and lose it," says an assistant technician.

The problem here is not only to see the echoes, but to photograph them using a polaroid attachment to the scope. When Mrs. Gillard says "Now!" I step down

twice on the foot pedal to trigger the shutter. The camera cannot be triggered automatically.

**Jan. 21 at 7 a.m., 10th floor.** Here are Overlook's 11 operating rooms. All have Grouse-Hinds, three-pin anti-spark outlets. Each room has an intercom to the nursing station.

Much of the equipment is electric, but in need of the advances that electronics can provide. A sampling includes:

- A metal locator—a pencil-shaped probe that uses hysteresis and eddy-current effects to pinpoint embedded metal particles.

- A Dermatone for cutting precise layers of skin for transplant to another area of the body.

- An electrocoagulator—a forceps-and-scalpel device used for cauterizing as a cut is made.

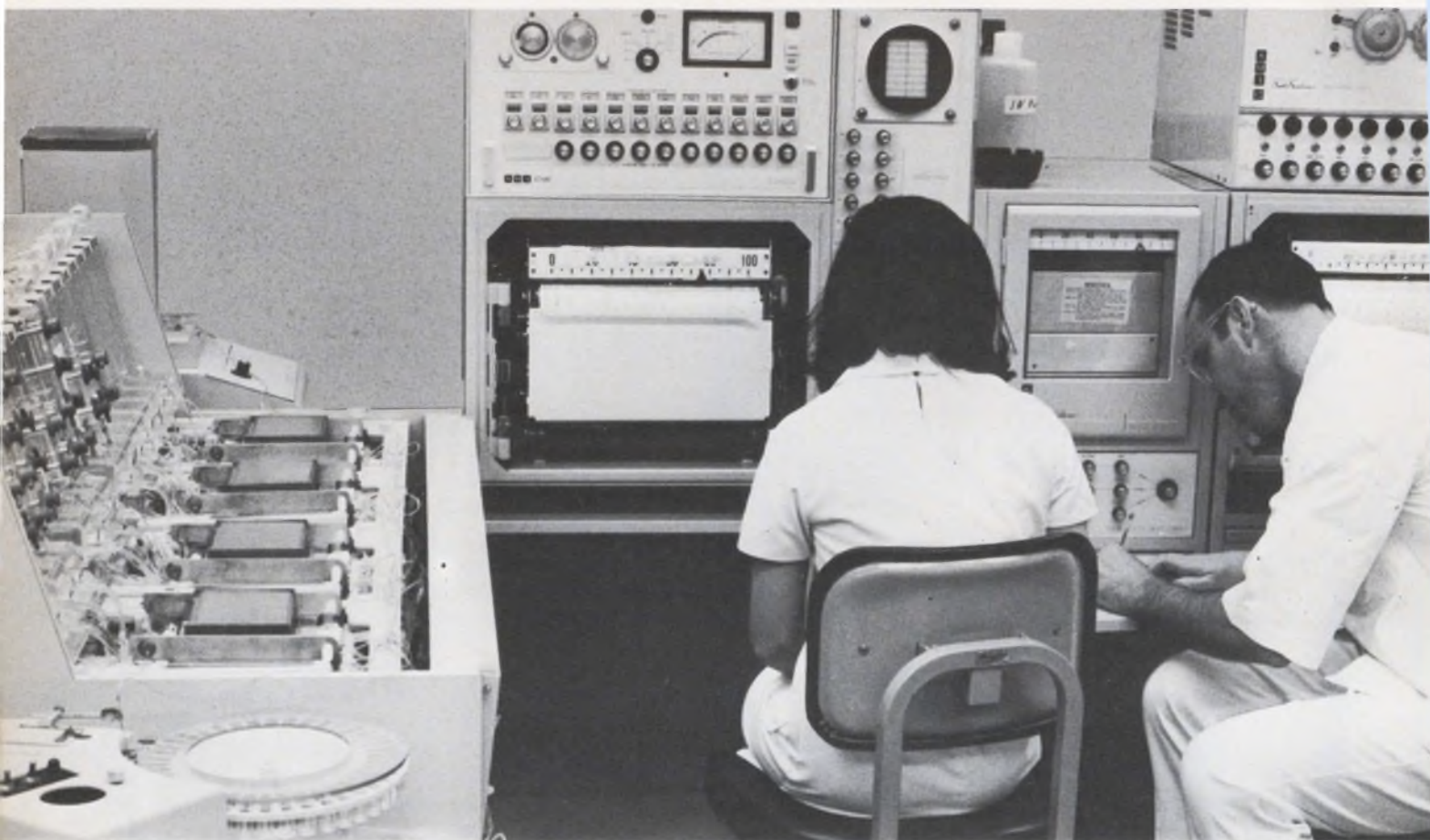
**11 a.m.** Next to one wing of operating room is a small dark-room. Joseph Barefoot, chief inhalation therapist, is developing a paper roll containing an EKG and a phonocardiograph. Both tracings are made by light beams scanning photosensitive paper. "Light beams—rather than a pen recorder—are used," says Barefoot, "because light will respond to higher frequency inputs."

The EKG picks up electrical impulses produced by the heart muscle itself. The phonocardiogram is a visual record of the sounds the heart makes as it contracts and expands. "With this," says Barefoot, "we can pick up such things as murmurs and calcified valves."

What about the future of electronics in inhalation therapy?

"Electronics in medicine in general, especially in inhalation therapy, hasn't even scratched the surface," Barefoot says. "We've just begun to see machines coming out with printed-circuit boards. We have many crude instruments. In inhalation therapy, we're not doing what is physiologic at all.

"A person normally breathes in. He creates a vacuum in his chest—lower pressure in the chest



**Blood serum analyzer** can measure the 12 constituents of blood in one minute. A new, time-shared computer

program will route such reports from Overlook's laboratory to any nursing station in 10 seconds.



**Phonocardiogram**, used to obtain a visual image of the sounds of the heart as it pumps, is demonstrated by Lorraine Gillard. The equipment detects murmurs and other heart disorders.

than outside. But with a respirator, you are creating a pressure on the outside of the patient and blowing air in. This is physiologically unsound. It works; we can do the job. But we must sample arterial blood gases three or four times a day."

Barefoot looks to the day when "we can tie a computer directly into the respirator and monitor the arterial blood gases at a reasonable price: If the oxygen goes down, the machine automatically gives the patient more oxygen; if the CO<sub>2</sub> goes up or down, it adjusts the respirator accordingly."

Jan. 22. Tomorrow my career as a hospital attendant will be over. I have learned that machines can sustain life—prolong it, even in hopeless cases. Electronics is making this equipment more compact, more sophisticated. But there is room for improvement, for major advances through ingenious design.

3 p.m. Sitting in the office of Overlook's director, I talk with

Heinlein about the role of electronics in hospitals. He is very much concerned about possible hazards. Procedures in handling equipment have been carefully worked out at Overlook to avoid the danger of electric shock.

"But," says Heinlein, "we're not biomedical engineers. We have a difficult time evaluating equipment. The purchase of new electronics is decided on by a committee of doctors and nurses who will be using it.

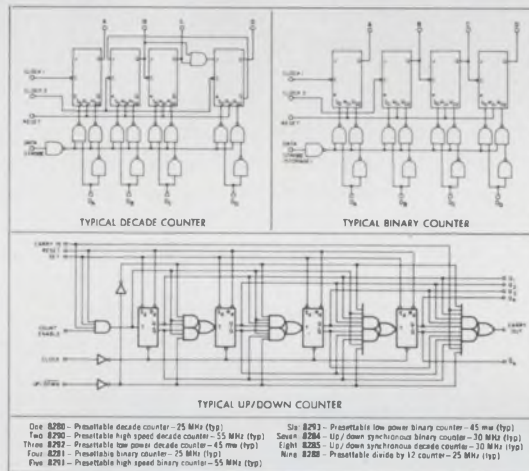
"We have some built-in standards. We buy only equipment that is Underwriters or similarly approved for safety. We consult people who have used the equipment, and then we ask to use it here on a trial basis. This is the best practice—not only from the standpoint of safety but from the standpoint of use."

"Why not hire electrical engineers as part of the hospital staff?" I ask.

Heinlein smiles. "That's in the works," he says. ■■



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INFORMATION RETRIEVAL NUMBER 16

# Breaking the laser communication barriers

## Modulation and power problems are expected to be solved in system NASA will test in 1972-73

David N. Kaye  
West Coast Editor

Laser communication in space, while highly desirable, has been stymied up to now by two major barriers: lack of an efficient way to modulate the beam and lack of adequate power in a small laser. But Aerojet-General Corp. of Azusa, Calif., expects to overcome these problems in a communications system it is developing for NASA.

The system will employ CO<sub>2</sub> lasers. The output power of the transmitter laser will be 547 mW at a transmitter wavelength of 10.6 microns (P-20 line). A 5-cm GaAs piezoelectric crystal in the laser cavity will be used to modulate the laser. The modulation will be fm, with a signal bandwidth of from 30 Hz to 5 MHz.

If the system is successful, it will make possible the first broad-

band, point-to-point laser communication in space. The target date for a start on experimental operation is early 1972.

NASA has given Aerojet-General a \$5-million contract for the developmental work, and the company has awarded a subcontract to RCA, Ltd., Montreal, for the CO<sub>2</sub> laser subsystem.

"CO<sub>2</sub> lasers were chosen," says Alexander W. Belikow, manager of advanced engineering project research at Aerojet-General, "because of their efficiency and the advanced state of the CO<sub>2</sub> laser art."

Dr. George L. Clark, chief scientist on the experiment for Aerojet-General, points out that laser communication on earth is not practical because weather conditions can upset transmissions through the atmosphere. But in space, laser communication requires equipment that weighs less and is smaller than that in microwave sys-

tems. In addition the bonus of greatly increased bandwidth may one day enable deep-space transmission of live television pictures over millions of miles.

According to William F. Funnell, project engineer for the opto-mechanical portion of the experiment at Aerojet-General: "The capability of the first package will be a 5-MHz communication bandwidth. This is enough for a single channel of television."

In the future, laser communication is expected to yield much larger bandwidths than 5 MHz.

The Aerojet-General system will be on board the Applications Technology Satellite-F when the latter is launched in early 1972. The first communication experiments will be conducted between a transportable ground station in the Mojave Desert and the satellite, weather permitting. The satellite will be in a synchronous orbit over the United States.

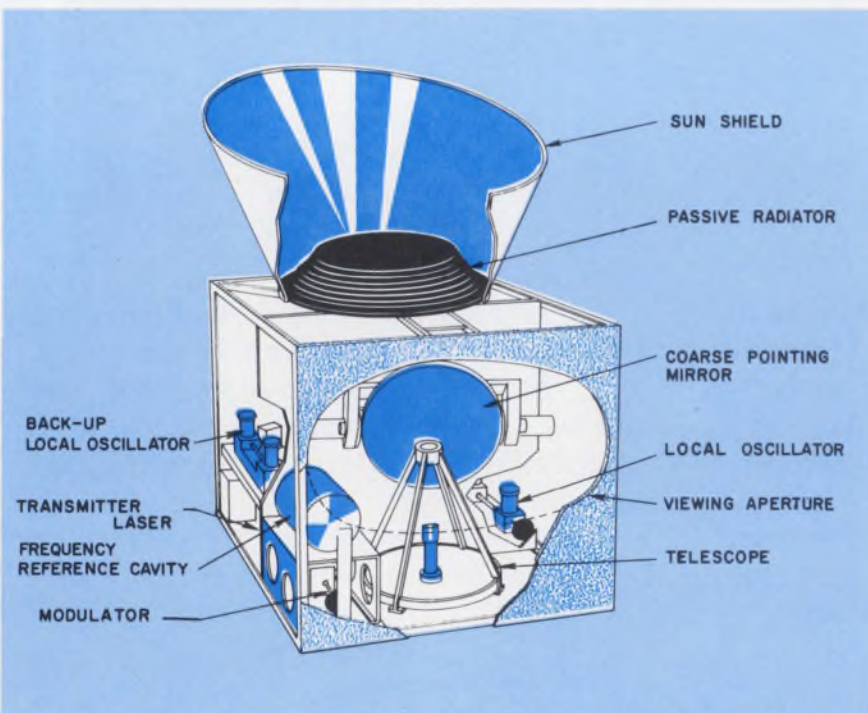
Early in 1973 a second package will be carried into synchronous orbit over India on board the ATS-G satellite. This will permit experiments in point-to-point communications between the two ATS satellites.

### Three lasers planned

In addition to the transmitter laser, the system will have a local oscillator laser and a back-up local oscillator laser. The local oscillators will be of sealed ceramic platinum electrode construction, as will the transmitter laser. They will put out 22 mW and be on the 10.6-micron wavelength, P-18 line. (Fine gradations of wavelength are denoted by P lines.)

Reception of signals will be through use of an Hg Cd Te photovoltaic detector. The detector and other receiver parts are being supplied by the AIL Div. of Cutler-Hammer Corp., Melville, N. Y.

The sensitivity of the receiver will be 10<sup>-12</sup> W in a 10-MHz bandwidth. The receiver signal-to-noise ratio will be 23 dB. ■■



Laser communications package will be on board the Applications Technology Satellite F scheduled for launch in early 1972.

## New radar will solve mysteries of storms

A new doppler radar technique will, for the first time, permit meteorologists to obtain a three-dimensional view of the swirling interiors of severe storms and other turbulent weather conditions.

Developed by Dr. Robert Lhermitte, a physicist at the Environmental Science Services Administration in Boulder, Colo., the system will consist of an array of three portable doppler radars, strategically stationed for a multiple, simultaneous probe of the weather phenomena under study, and a high-speed digital computer.

Lhermitte's doppler radars, two of them already built, work on a pulse and range-gate principle.

Like any other radar, they transmit a signal, which reflects from the target (in this case small precipitation particles) and returns to the antenna. The range or distance to the target is determined by the time it takes for the radar signal to make the round trip. The radar beam actually penetrates the storm cloud, but it is partially reflected by any precipitation along the penetration path. Scientists can select the part of the penetration path they want to examine by opening an electronic "gate" at precisely the right time to let in that reflection and no other.

In their present form Lhermitte's dopplers simultaneously observe a series of 24 points in range along each radar beam. The gates open once for each pulse but at a slightly different time for successive pulses, so that they receive reflections from progressively deeper penetrations. Thus radial velocity data is received for precipitation particles at the 24 points from front to rear of a storm.

Every two seconds the antenna automatically shifts to a new direction and observes another 24 points. Working under simultaneous digital control, the three radars complete a total-volume scan in a few minutes. By repeating the scan every few minutes during the storm's lifetime, Lhermitte believes he can observe the air circulation and structural dynamics of the storm system. ■■

# World's first.

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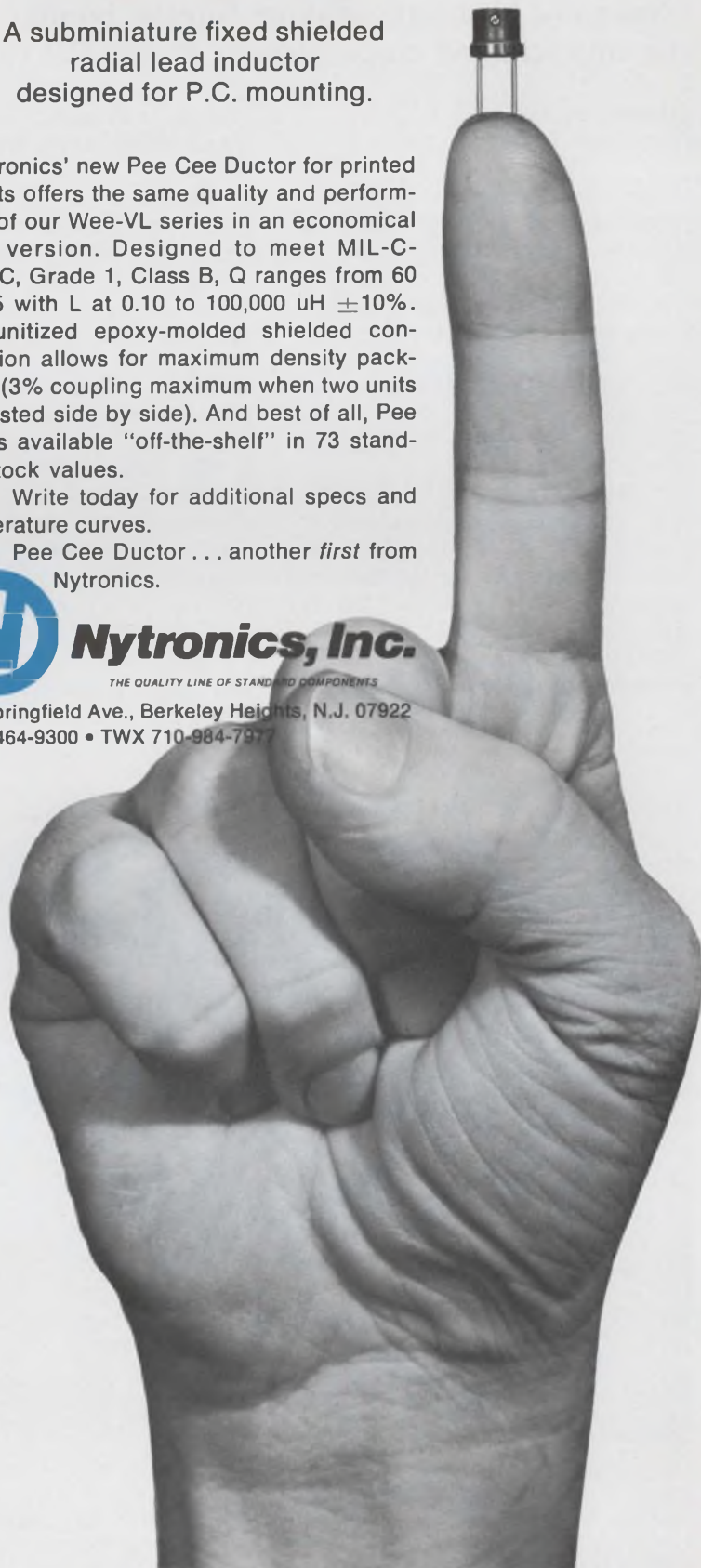
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# How to cut semiconductor memory costs

## Instead of hermetic sealing, Intersil bonds the unpackaged chips directly to the PC card

Elizabeth de Atley  
West Coast Editor

For years, designers have been predicting that ferrite cores in computer main frame memories will be replaced by semiconductors. But how do you package the semiconductors to hold down the cost?

Intersil of Cupertino, Calif., believes it has one solution to the problem. It attaches the unpackaged chip directly to the printed-circuit card.

"Doing it this way," according to Donald Rogers, vice president of marketing, (who has since left the company) "we can get the finished product down to a price that is competitive with cores."

The conventional way to package a semiconductor memory, explains

Rogers, is to put it in a hermetically sealed multi-lead package, which may cost the semiconductor company as much as \$2. Die attaching, bonding, sealing and other steps can add another \$2, he points out. "And that doesn't count the \$2 packages you throw away because of mistakes in assembly," he adds.

Every package must be individually tested, not only by the semiconductor company but usually by the systems company as well.

"When you add to all this the expense the systems company must undergo to assemble these costly packages onto PC cards," says Rogers, "it's not surprising that they usually stick with cores."

Intersil's method cuts package and assembly costs and eliminates

duplication of effort by systems and semiconductor companies.

How does Intersil produce a reliable system without using hermetically sealed packages?

"First we passivate the chips by silicon nitride techniques," explains Frank Todd, senior packaging engineer. "Then we attach the die face-up to a gold island on the PC card, using a conductive silver paste rather than a high-temperature die attach, which would heat up the board. We run wires from the chip to the gold trace on the PC card and weld them ultrasonically."

The chips and wires are then encapsulated in a viscose silicone compound. "We use silicone rather than the traditional epoxy," says Todd, "because epoxy and aluminum are not compatible and aluminum tends to decompose."

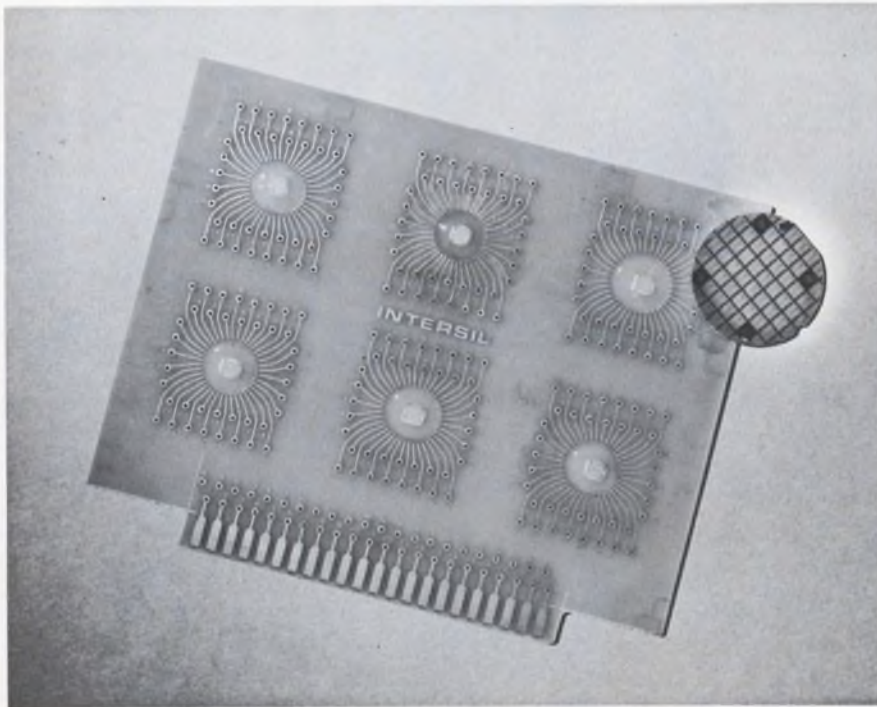
A packaged system of this type has to be custom, says Rogers, because every customer has different system needs. To produce it at the lowest possible cost, Intersil works with its systems customers from the early conceptual stages.

"It has to be a common venture from the beginning," Rogers points out, "because at that point we can control the final system cost. We get together with the customer and with him decide how to design the memory and how to package it as a final system."

"We use N-channel MOS for most of our memories," says Rogers, "because the speed is three to five times faster than that of a comparable P-channel device, and power dissipation is only slightly greater."

For example, he points out, Intersil's new  $256 \times 1$  N-channel read-write random-access memory has an access time of 350 ns. A comparable P-channel device would be roughly 1 microsecond.

The reason for the higher speeds obtainable with N-channel devices, he explains, is that N-type material has higher carrier mobility and therefore higher transconductance than P-type. ■■



**Unpackaged chips** are attached directly to the printed circuit board in Intersil's semiconductor memory. The chips shown above are N-channel MOS  $256 \times 1$  random-access read-write memories with full decoding on the chip. The silicon in the photo is clear, but normally it would be opaque to protect the chips from light.

**Integrated  
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# IDEAS

FROM  
SYLVANIA

## How SUHL circuits improve avionics systems.

Computer family uses our ICs and functional arrays to obtain powerful, compact, airborne navigation package.

A small, lightweight, computer using Sylvania SUHL circuits has been selected for use in the navigation system of the new Lockheed TriStar passenger jet. The computer is a member of Micro-D family designed and developed by the Arma Division of Ambac Industries. Both computers in the family depend on SUHL logic for high-speed operation and design flexibility.

One of the computers, a serial type, is being used in inertial navigation systems, airborne loran receivers and cockpit displays for area navigation systems. The computer uses 342 Sylvania SUHL circuits of 10 different types. Arma selected SUHL TTL circuits for their design because they offered high noise immunity, excellent fan-out/fan-in capability and high reliability. On the latter point, Arma is assuring a MTBF of 10,000 hours on every computer.

The computer operates at 1.5 MHz clock speed, weighs 5.7 pounds and occupies less than 0.1 cubic foot of space. An optional high-speed clock provides a 50% increase in computation speed.

Packaging of the computer uses nine multilayer circuit boards that plug into a multilayer mother board. The memory stack and associated electronics occupy five of the nine boards, three boards are used for logic and control operations, and the last includes clock and timing circuitry. The rugged package can withstand 35 g's in all three axes. *(continued on next page)*

### This issue in capsule

#### MSI Applications

Read-only memory features on-chip decoding.

#### IC Specifications

Where we stand on MIL-STD 883.

#### IC Applications

Interface family solves transmission-line noise problems.

#### LSI Developments

Uni-Cell LSI flies high in airborne computer.

#### Manager's Corner

Where will the next price break come in ICs?





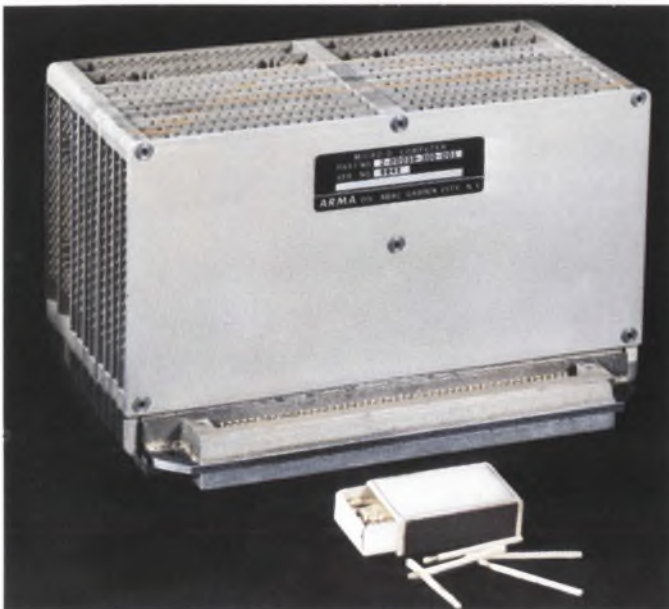
The second SUHL equipped Arma computer is an 18-bit word, parallel-organized system that weighs in at 9 pounds and takes up 0.2 cubic foot of space. This is the computer selected for use in the area navigation system of the new Lockheed L-1011 TriStar passenger jet. This computer uses 495 SUHL circuits of 9 different types, including a number of functional arrays. Again, Arma selected SUHL TTL circuits for their high noise immunity, fan-in/fan-out capability and high reliability.

According to Arma, the liberal use of Sylvania functional arrays provides an extra measure of flexibility in speed and architecture. The multiplicity of flip-flops and gates in the MSI packages permits compact packaging without compromising reliability and economy.

The central processor contains 13 registers for manipulation of instructions and data. Two 18-bit registers form a double-length accumulator to provide double precision computation. Three 15-bit registers are also available to insure efficiency of programming and memory conservation.

Like all of the SUHL TTL circuits used in these computers, both systems are available off-the-shelf.

CIRCLE NUMBER 300



## Read-only memory features on-chip decoding.

Single-chip 256-bit device has typical access time of 35 ns.

Sylvania's new SM-320 read-only memory has a 256-bit capacity arranged in 32-word x 8-bit format. All decoding is done directly on the chip. The outputs have free collectors, thus making it easy to parallel devices to expand system capacity. A 5-bit address code enables the selection of any one of 32 8-bit words stored in the memory.

The SM-320 read-only memory is shown in block diagram form in Fig. 1. The input address gates and chip enable gate are located in section A, the address decoder matrix (5 bits for 32 words) is located in section B, and the memory storage area (256 bits) is located in section C. Section D contains the output transistors which have open collectors to facilitate feeding data onto a common bus. Pull-up resistors can be added externally.

Operation of the memory can be seen from Fig. 2. Selection of any one of the 32 8-bit words stored in the memory is implemented by 32 5-input emitter selector transistors. Only one word may be selected at a time. The chip enable signal controls selection or inhibition of all words in the memory.

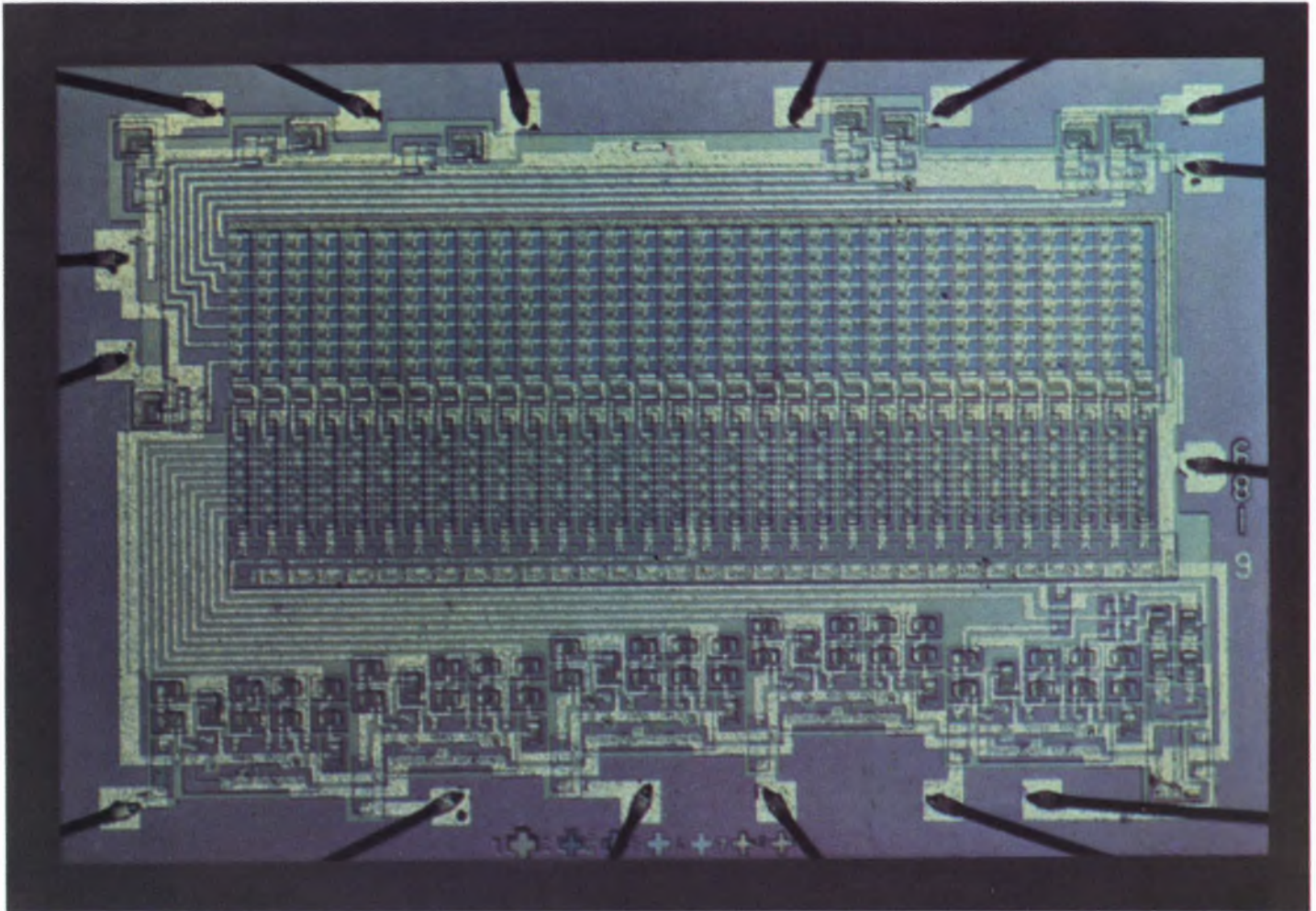
In a larger system using more than one device, the chip enable can be used to select individual units or groups of units. In this manner, for example, data in multiples of 8 bits can be sequenced onto a serial bus line. Decoding of appropriate units, as in character generation, can also be implemented in this manner.

The 5 emitters of each selector transistor accepts appropriate inputs from the address gates. In the unselected state, at least one emitter on all 32 decoding transistors will be at logic "0" due to the chip enable inhibiting that particular address bit. If, for example, the network  $Q_1, Q_2, Q_3$  is considered, the emitter of  $Q_1$ , which has a logic "0" presented to it, will allow current to flow through it to ground. This insures, through the  $V_{BE}$  drops of  $Q_1$  and  $Q_2$ , that  $Q_3$  is turned off. Therefore, no current will flow in any of the 8 emitters of  $Q_3$ . Thus, transistors  $Q_4$  through  $Q_{11}$  will be turned off, causing a logic "1" condition to appear at the outputs. In the "selected" state all 5 emitters of  $Q_1$  would go to a logic "1" condition by appropriate application of input signals and by the chip enable line enabling the address gates. This causes  $Q_3$  to turn on, allowing current to flow in all 8 emitters. In turn, transistors  $Q_4$  through  $Q_{11}$  turn on, setting all 8 outputs to the logic "0" state.

This condition would be true, however, only if all 8 emitters of the word selected are connected to their individual bit lines. If any emitter is not connected, no current will flow into the base of its corresponding output transistor. That transistor will not turn on and a logic "1" will appear at the output. Thus, to set up a logic "1" in any of the 8-bit positions in a word, the appropriate emitter connection must be broken or etched away. A logic "1" is obtained by breaking the connection between the emitter and the bit line, and a logic "0" is obtained by allowing the linkage to remain intact.

The SM-320 read-only memory has a typical access time of less than 35 ns and provides an output current of 10 mA at 450 mV. Input load current is typically 1.4 mA. The SM-320 comes in a 16-lead dual in-line package using ceramic or CerDip construction.

CIRCLE NUMBER 301



SM-320 read-only memory

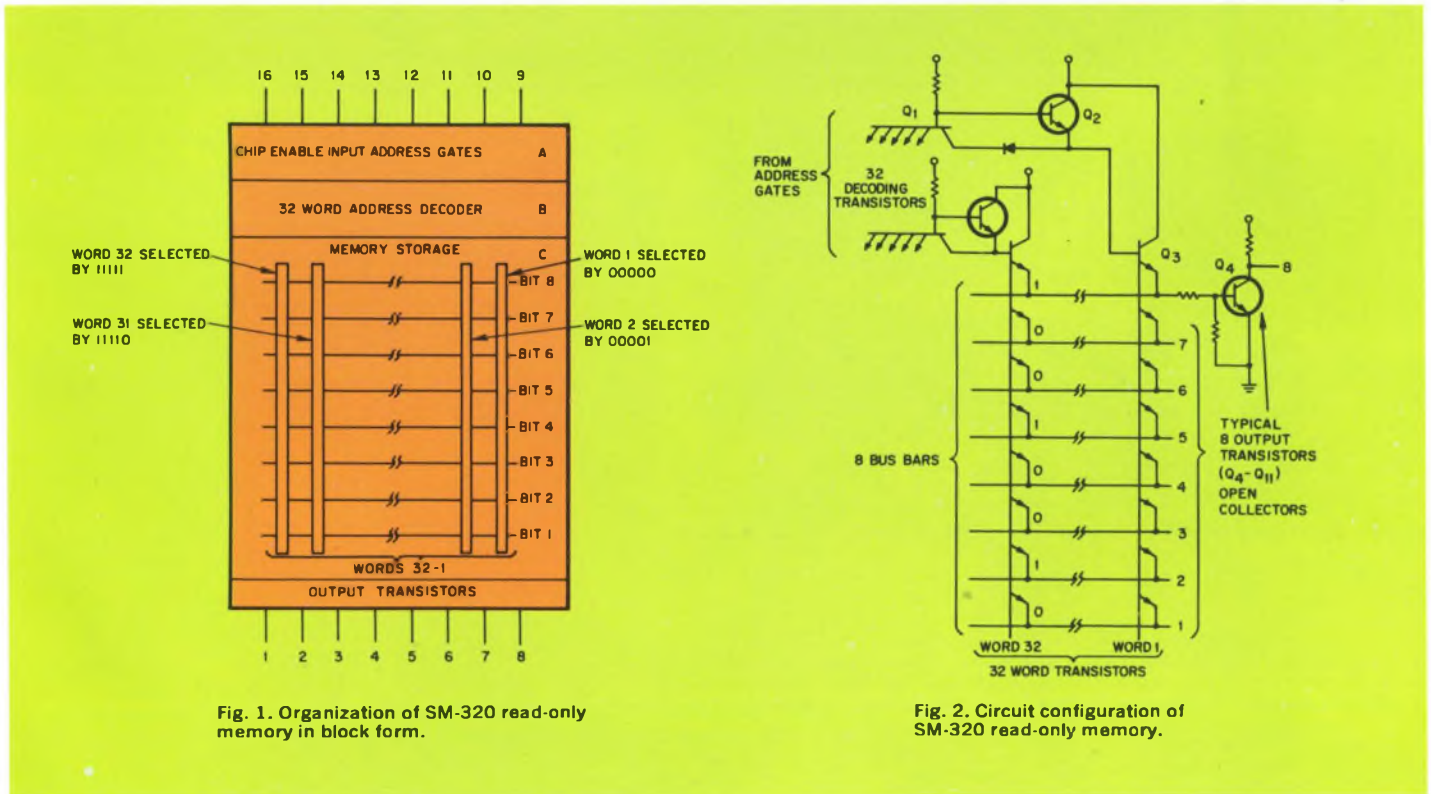


Fig. 1. Organization of SM-320 read-only memory in block form.

Fig. 2. Circuit configuration of SM-320 read-only memory.

## Where we stand on MIL-STD-883

There has been a lot of confusion about MIL-STD-883. Here's a chart that will clarify Sylvania's position on this important document.

Like its predecessors, MIL-STD-883 contains a wide variety of options as to stress levels and methods of testing. The chart shown here gives Sylvania's standard reliability specifications for the three reliability levels called for in

MIL-STD-883. The five-digit numbers shown in many of the boxes refer to specific sections of Sylvania's standard reliability manual where full test procedures are detailed.

Of the three levels of reliability, option A is the most stringent and is designed for circuits to be used where repair is difficult or impossible and where high reliability is imperative. Option B circuits are intended for applications where repair is less difficult to perform but high reliability is still required.

The standard reliability level is actually the test procedures applied to all off-the-shelf Sylvania SUHL logic circuits. These circuits should be selected where repairs can readily be made but high reliability is desirable.

CIRCLE NUMBER 302

**Table 1. General Reliability Specification**

I. Production Screens	Option A	Reliability Level Option B	Standard Sample	Remarks
Pre-seal Visual Inspection	100% (91-928)	100% (91-917)	(91-910/91-913)	91928 identical to 883 Method 2010 Test Cond. A except for 1 level 75X mag.
Stabilization Bake	48 hours (91-176)	24 hours (91-176)	16 hours (91-176)	All 200°C
Temperature Cycle	20 Cycles (91-205)	10 Cycles (91-205)	5 Cycles (91-144)	All -65 to +200°C 10 cycles 91-205 meets 883 Method 1010 Cond. D
Constant Acceleration	30K 6's; Y1 and Y2 (91-194)	30K 6's; Y1 only (91-194)	None	Meets 883 Method 2001 Cond. E
Electrical Screen	DC, (Go/No-go at temp. extremes)	DC, (Go/No-go at temp. extremes)	Specified DC, & AC Go/No-go tests	Per test spec. sheet for appropriate type
Burn-in	RL to simulate 15 (RL—270 ohms) 168 Hrs., 125°C (91-929)	RL to simulate 7 (RL—470 ohms) 96 Hrs., 125°C (91-929)	None	Same as 888 Method 1015, Cond. D (flip-flops) or Cond. E (gates) except no. of gates not limited to 21 in Cond. E
Electrical Screen	DC, Go/No-go at temp. extremes; AC at 25°C	DC, Go/No-go at temp. extremes; AC at 25°C	None	Per test spec. sheet for appropriate type
Fine Leak Screen	5 x 10 <sup>-8</sup> cc/sec. (91-163)	5 x 10 <sup>-8</sup> cc/sec. (91-163)	None	Meets 883 Method 1014
Gross Leak Screen	(91-162)	(91-162)	(91-162)	Same as 883 Method 1014 except omit Step 1 & vacuum sequence

**Table 2. Product Acceptance Tests**

Inspection	Acceptance Criteria LTPD/a (max)*			Remarks
	Reliability Level			
	A	B	Std.	
Electrical Verification DC at 25°C AC at 25°C DC at High Temperature DC at Low Temperature	5 / 2 5 / 2 10 / 3 10 / 3	10 / 3 10 / 3 Not Required Not Required	10 / 3 10 / 3 Not Required Not Required	Conditions and limits on test spec sheet for appropriate type
Mechanical Verification	5 / 2 (91-908)	10 / 3 (91-908)	10 / 3 (91-908)	Meets 883 Method 2009
Fine & Gross Leak Verification	10 / 1 (91-911)	Process Control	Process Control	883 Method 1014 (See Table 1)

**Table 3. Design Assurance Tests (for information only)**

Test	Acceptance Criteria per Subgroup LTPD/a (max)*			Remarks
	Reliability Level			
	A	B	Std.	
88-200 Group B	10 / 3	10 / 3	10 / 3	Individual tests per appropriate methods in 883
88-200 Group C	10 / 3	10 / 3	10 / 3	

**Table 4. Traceability**

Reliability Level		
A	B	Std.
Lot travel card from pre-seal visual inspec.	Lot travel card from pre-seal visual inspec.	Date code

\*LTPD = Lot tolerance percent defective  
a (max) = Maximum acceptance number



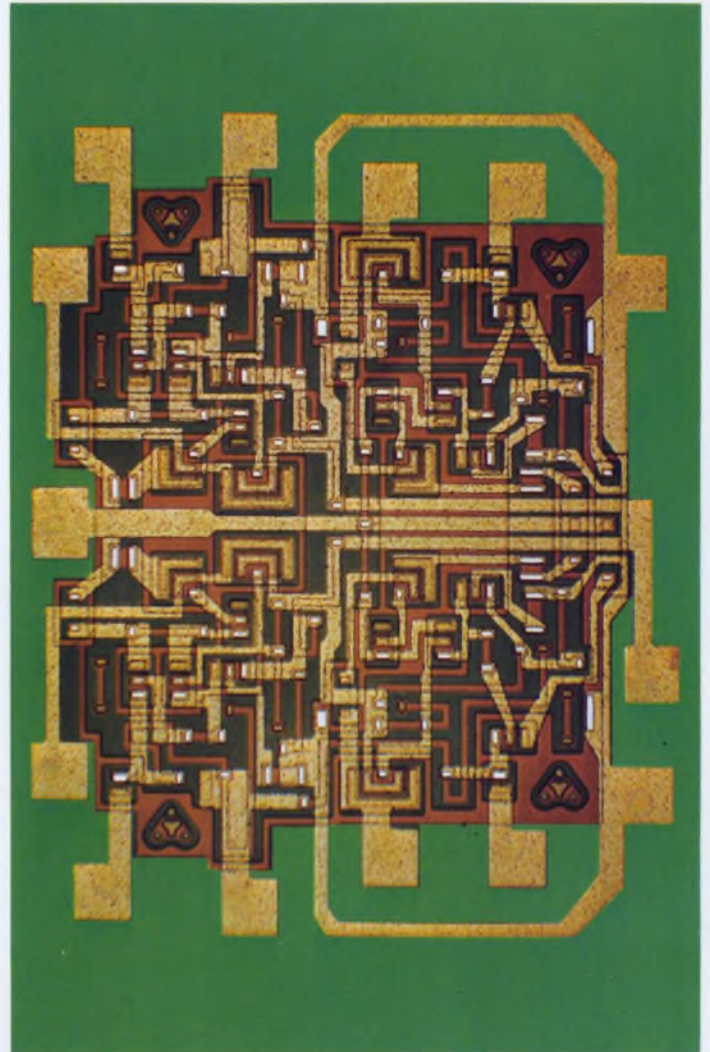
## Interface family solves transmission-line noise problems.

Line driver and two receivers are completely compatible with SUHL logic and other types of TTL.

Here is a family of circuits specifically designed for digital data transmission in high-noise environments. The family consists of a quad logic-level driver to transmit digital signals and two types of receivers. One receiver is a quad single-ended type and the other is a dual differential receiver.

When used together, these devices provide high system noise immunity due to an increased logic "1" level of the driver and increased thresholds of the receivers.

The two receivers feature diode decoupling of the inputs



SS-342 series quad high-threshold logic receiver.

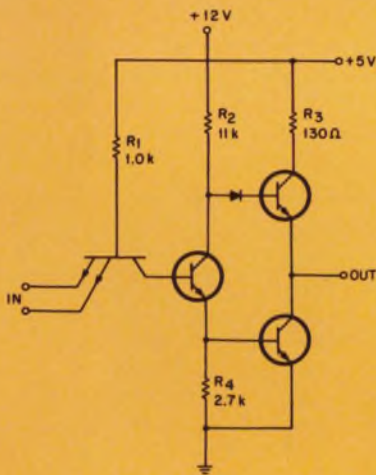


Fig. 1. Single transmitter unit of quad logic-level driver.

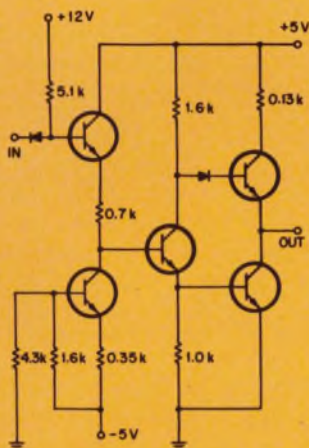


Fig. 2. Receiving element used in quad logic-level receiver.

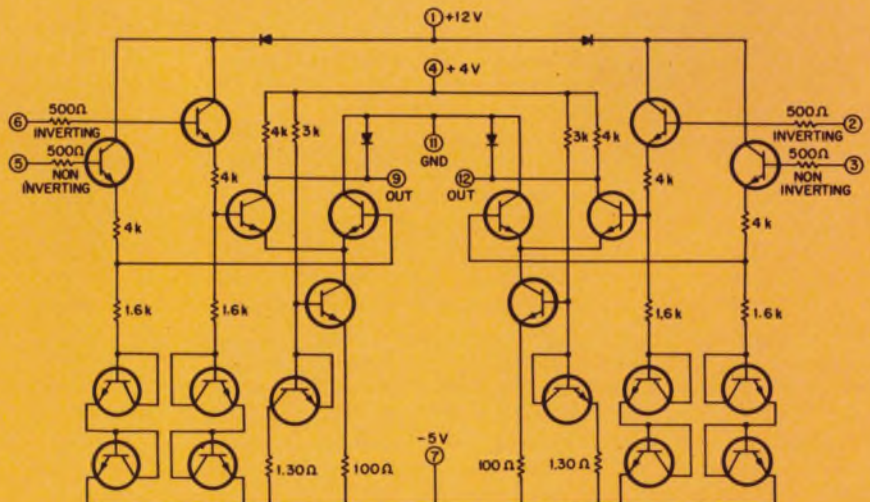


Fig. 3. Complete circuit of dual differential receiver.

to protect against power-down conditions. Thus, if driver power is turned on before receiver power, the devices will not be damaged by transmitted levels of up to +11 V referenced to receiver ground.

The SS-207/-208 logic-level driver, shown in Fig. 1, consists of four identical inverters integrated on one monolithic chip. The main advantage of this driver over a typical TTL integrated-circuit gate is that it has a high logic "1" level, allowing greater system noise immunity.

Each inverter is capable of driving six single-ended receivers or four differential receivers while maintaining a logic "1" level of 4.5 V. Input loading of each device is equivalent to four SUHL I gates and is typically 4.0 mA at logic "0" and 160  $\mu$ A maximum at the logic "1" level.

Although the input threshold of the logic-level drivers is approximately the same as SUHL I, the output logic "1" is about 1 V higher than TTL logic. This is achieved by two variations from conventional TTL circuitry. First, the base of the upper cascode is returned to +12 V through  $R_2$ , resulting in a high static logic "1". Second, the ratio of collector-to-emitter resistor is about 5 to 1 virtually eliminating the "1" level sag observed in typical TTL logic.

The logic-level receiver package, SS-209/-210, contains four independent single-ended receivers. (Fig. 2) When used with SS-207/-208, logic-level driver, this design allows  $\pm 1.5$  V of noise rejection. Output circuitry of the receivers is similar to SUHL I circuitry and displays the same basic

characteristics. The input circuitry is a departure from TTL design that provides higher thresholds. Basically, the input threshold is established by a current source which is compensated to obtain a stable transfer characteristic over the temperature range. The receiver is designed to drive directly SUHL logic and other types of TTL.

The design of the SS-194/-206 dual differential receiver allows for large shifts in ground and  $V_{cc}$  levels between the line driver and receiver. The input of each of the two independent differential switches can swing from +11 to -5.25 V, referenced to receiver ground. The differential receiver is normally driven by two complementing logic signals. These could be derived from the Q,  $\bar{Q}$  outputs of a flip-flop, the input and output signals of a NAND gate or the input and output of a logic-level driver.

The output of the receiver will go to a logic level "1" when the non-inverting input voltage is at least 1.5 V more positive than the inverting input voltage, within specified input voltage limits. Conversely, a logic "0" will appear at the output when the inverting input is at least 1.5 V more positive than the non-inverting input voltage. Thus, the receiver responds to the difference between the two input signals rather than their absolute magnitudes. This is especially valuable in high-noise environments.

All three devices in our interface family come in 14-lead flat packs and are available in both commercial and military temperature ranges.

CIRCLE NUMBER 303

## Uni-Cell LSI flies high in airborne computer.

Adaptive four-bit shift register replaces 28 standard ICs in compact lightweight system.

Sylvania's approach to LSI, Uni-Cell, got its first real test in Raytheon's new AS-80 airborne computer. And it came through with flying colors.

The compact computer uses a Sylvania-designed adaptive four-bit shift register. Using only three control lines, the register can shift right or left, count up or down, clear, hold, read-in paralleled data and complement.

Raytheon designed the AS-80 computer to make use of the latest state-of-the-art LSI and MSI circuits. The result is a small, high-speed fourth generation machine.

The unit is a high-speed 16-bit parallel processor incorporating a 32-word 100 ns scratchpad memory, programmed input-output channel and a convenient repertoire of 25 instructions. The unit weighs only 10 pounds and occupies 0.3 cu. ft. of space.

The four-bit shift register made for the Raytheon computer consists of 20 Uni-Cells—the equivalent of 80 logic gates. This LSI package replaces 28 discrete ICs and reduces external connections from 292 to 28. Inside the device, the reduction of wire bonds from 586 to 56 enhances system reliability. Other advantages gained over the use of discrete

ICs are a reduction in clock interval from 125 ns to 60 ns, a decrease in power from 1.4 W to 0.75 W, and a speed-power product lowered from 175 ns-W to 45 ns-W.

Sylvania's Uni-Cell design is a highly flexible approach to LSI. A typical uncommitted Uni-Cell wafer is shown in Fig. 1. Each basic Uni-Cell element contains the equivalent of four gate functions and a sufficient number of components to permit metallization of any one of eight different logic functions.

When you use the Uni-Cell approach, all you have to do is define the logic function you want, partition the system and deliver the functional logic diagrams to our semiconductor facility at Woburn, Mass. We'll take it from there.

Our engineers will convert your diagrams into Uni-Cell groups and determine the minimum array size. Then they will prepare the metallization patterns. The first layer of metallization interconnects the Uni-Cell components to define the lowest sub-logic to be performed. The second layer metallization (Fig. 2) defines cell interconnections in the horizontal direction. The third metallization layer (Fig. 3) defines the signal paths in the vertical direction and brings terminal points to bonding pads for connection to package leads. A typical Uni-Cell device mounted in a 28-lead package is shown in Fig. 4 ready for testing and capping.

If you think LSI is the way to go in your next project, show us your logic diagrams and we'll show you what Uni-Cell can do for you.

CIRCLE NUMBER 304

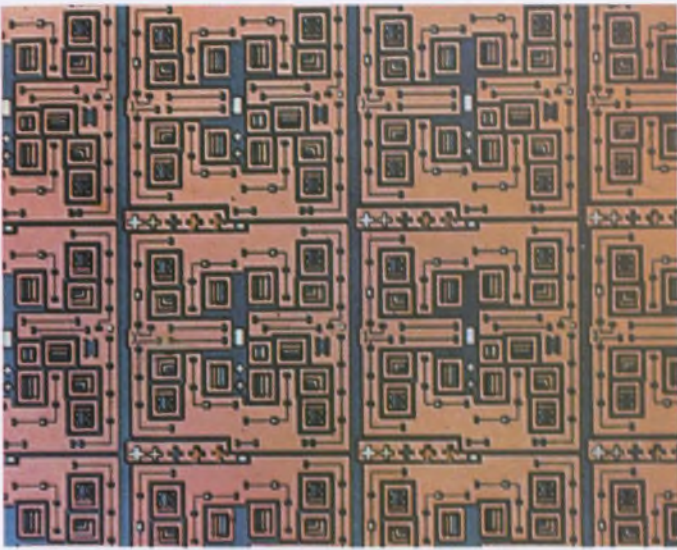


Fig. 1. Section of an uncommitted Uni-Cell wafer ready for metallization.

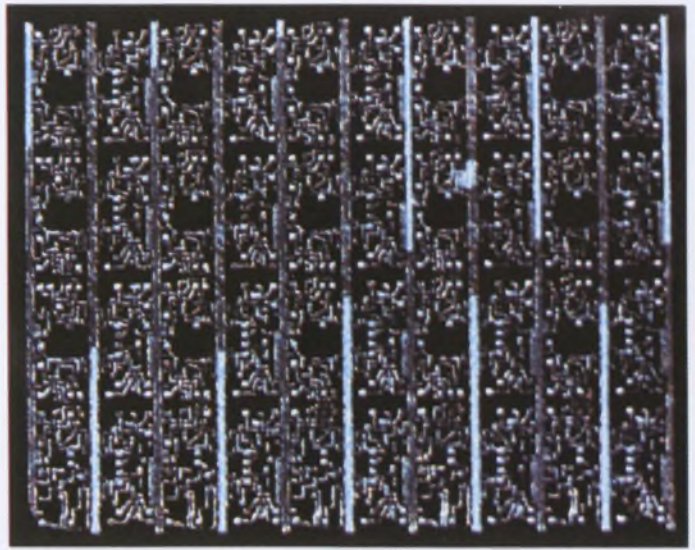


Fig. 2. Uni-Cell wafer with first and second metallization steps completed.

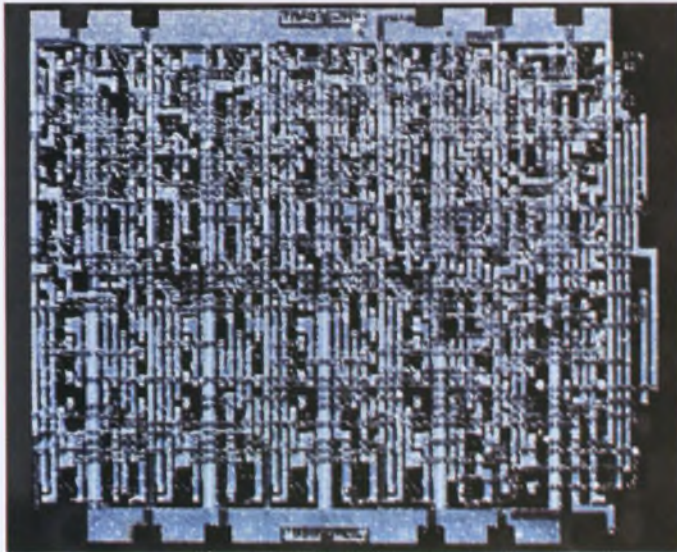


Fig. 3. Third metallization step brings connections out to bonding pads.

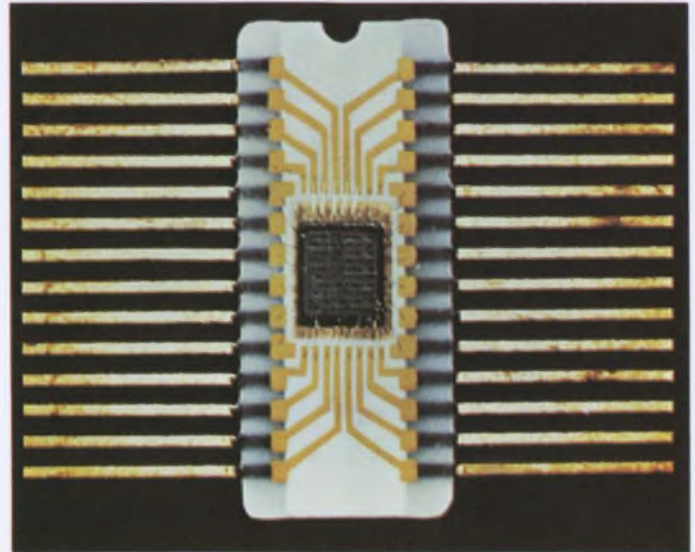


Fig. 4. Completed Uni-Cell circuit mounted in 28-lead package ready for testing and capping.



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## MANAGER'S CORNER

### Where will the next price break come in ICs?

Higher yields and improved technology have been instrumental in knocking down the prices of integrated circuits to their present low levels. But, there is a limit as to what can be done in these areas to further improve the price picture.

One of the key cost factors remaining in the present state of the IC art is the cost of connecting the chip to the outside world.

In the vast majority of circuits produced today, thermo-compression or ultrasonic bonding techniques are used. Both of these methods involve high labor cost because of the skill required by the operator and the fact that each pad on the chip must be connected individually.

The fact that many manufacturers use overseas plants in low-cost labor areas indicated the importance of this step in the overall IC cost picture.

Obviously, the area of chip mounting and bonding is ripe for technological advances. And there are a number of these advances now in the development stage. Among these techniques are flip-chip, spider bonding and beamleading.


All three methods place some restriction on the layout of the chip and all three are only suitable for high-volume production.

Beamleading promises to be one of the most effective approaches to the problems of lower device cost and greater design flexibility.

Unlike flip-chip, beamlead devices are mounted face-up thus making testing easier. Beamleads also have a limited degree of flexibility that permits bonding to surfaces that are not perfectly flat.

Because of advanced masking techniques and the perfection of batch processing methods, it is easier to attain exacting precision with beamleads than with spider bonds.

Sylvania has been working on the beamlead process for over three years and has developed many special pieces of equipment for handling and mounting these devices. We see beamleading as a major answer to lower costs in automated high-volume production runs.



H. K. Ishler  
Director, Integrated Circuit Engineering

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## and no one but Cimron can make a claim like that stick

Here's the first and only 4-digit instrument that you can take with you and hook up for full multimeter performance anywhere. Cimron, the Customer Concern Company, puts your needs first. That's why this new Cimron 6453 is just one more the competition will have to catch up with.

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# Device is an adaptive filter or transformer

## RCA develops tiny, ferroelectric/piezoelectric unit for memory and remote-control applications

**Jim McDermott**  
East Coast Editor

Scientists at RCA Laboratories in Princeton, N.J., have developed a tiny "adaptive" device with ac signal characteristics that can be set at any number of discrete levels by applying 100 to 300-V pulses. The ferroelectric/piezoelectric device, which comes in two versions—an adaptive resonant filter and a broadband transformer—is expected to find wide use in consumer and industrial memory and control applications.

Pulses can be applied by simply pushing a button or by using relatively sophisticated circuits. Practical applications considered include simplified kitchen appliance controls for blenders, mixers and fans. For example, multibutton blender speed controls could be replaced by a single pulsing button that, when pressed, could control an infinite range of speeds.

Or the unit might be connected to a remote control designed to turn night lights up to a desired level of brightness upon command from the night table.

Because the devices are low powered and purely electronic they could be used for remote control of almost anything to which wires are connected; without wires, operation by radio or ultrasonic links is possible.

### Both are sandwiched

The two versions of the device were developed by Dr. Stuart S. Perlman and Joseph H. McCusker of the Laboratories.

One is an adaptive resonant filter, with an effective "Q" of 100 at zero-center frequencies from 100 Hz to 10 MHz. The other version—to be described by Dr. Perlman at this month's International Solid State Circuits Conference in Philadelphia Feb. 18 to 20—is a broadband transformer or non-resonant electronic attenuator that passes signals from 10 Hz to 40 kHz, with essentially zero phase shift.

Both devices are of sandwich construction, similar to the familiar Bimorph phonograph cartridge element, and they should

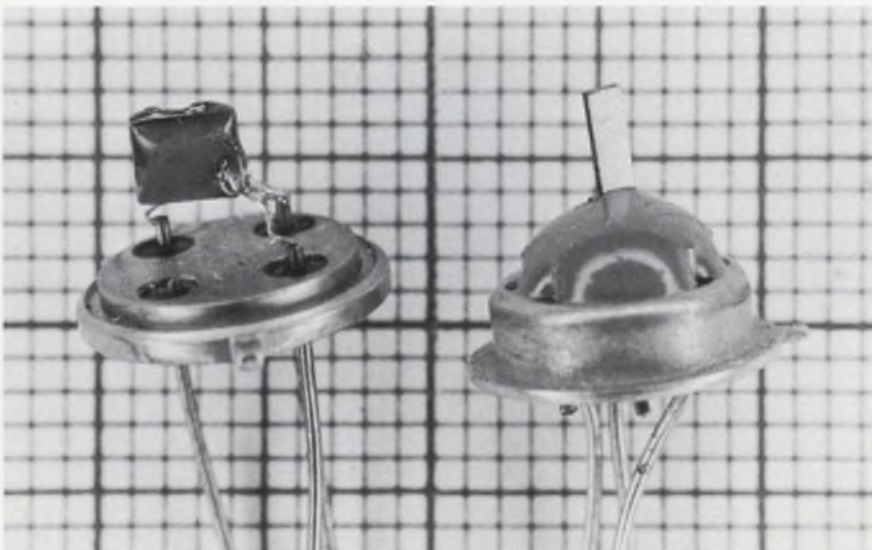
sell for less than a dollar when eventually produced in quantities, according to RCA.

These adaptive units are small, in the order of 20 mils thick, and they utilize a unique combination of piezoelectric and ferroelectric phenomena. They are fabricated as a tiny sandwich of two wafers of PTZ-5 type of ceramic lead-zirconate/lead-titanate materials, bonded together on a center electrode. The input signal is applied to one wafer, and is taken from the second (see Fig. 1.)

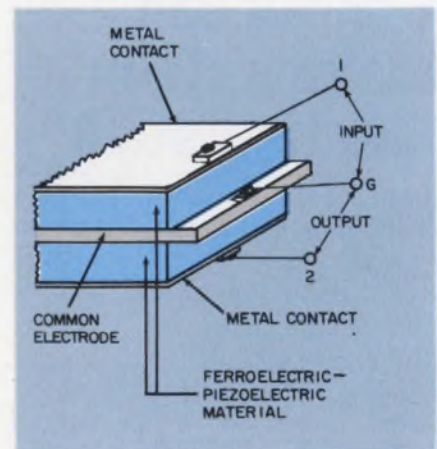
When a signal is applied to the input wafer, it vibrates because of its piezoelectric properties, and these mechanical vibrations are transmitted to the second wafer, which converts them back to an electrical output signal.

The way in which the output is controlled is this: If the material is highly polarized, it produces maximum vibrations in response to an input signal; or in response to vibrations, it gives a maximum output signal. Thus, piezoelectric activity of the wafer is controlled by the degree of ferroelectric polarization.

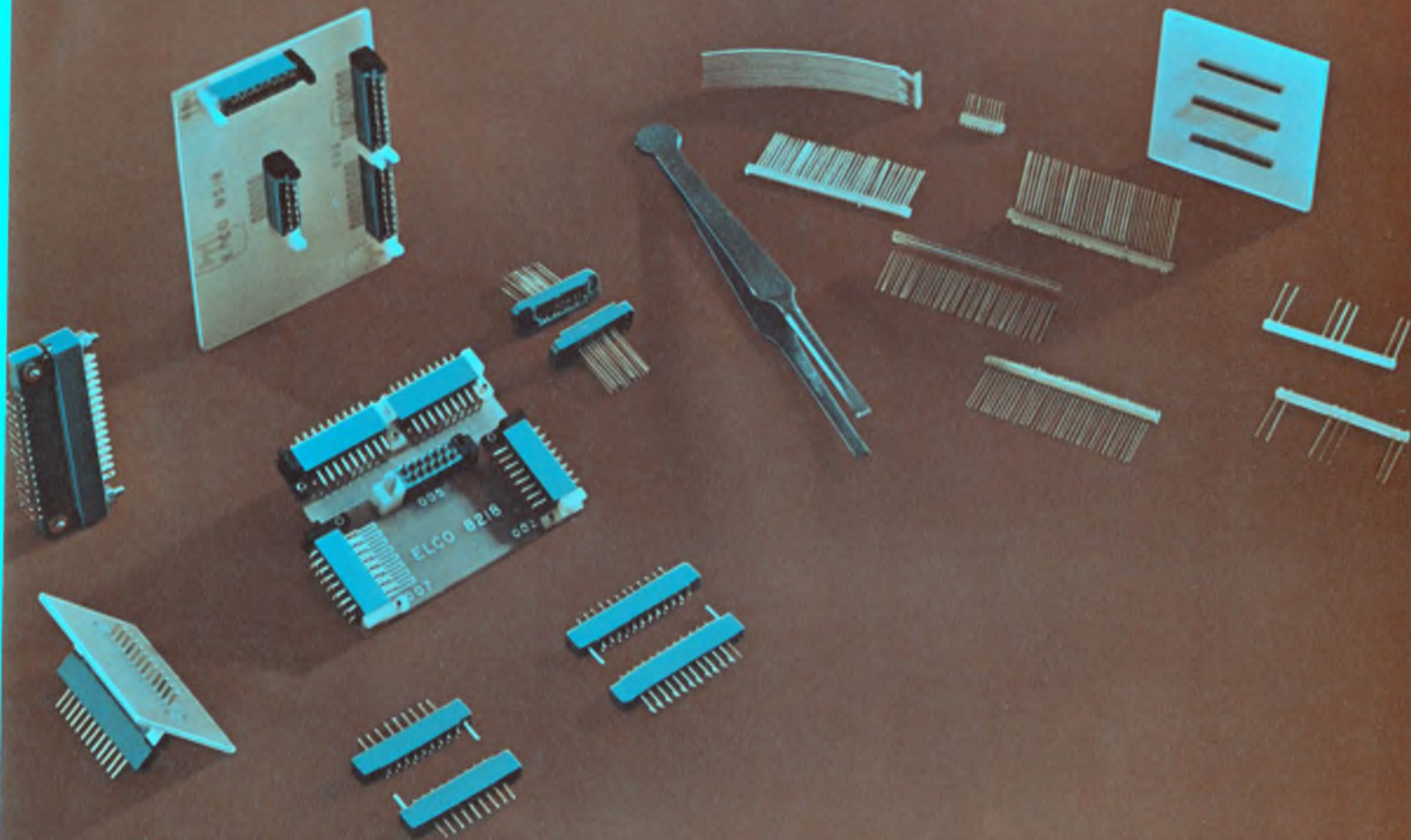
But polarization of this type of material can be changed by apply-



An adaptive transformer, at left, and adaptive filter, at right, are mounted on transistor headers. One-millimeter squares in background show the relative sizes of the components.



1. New adaptive device uses sandwich construction. Input signals produce piezoelectric vibrations that are transferred to the output side. At the output, vibrations are converted back to electrical signals.



## Miniature, subminiature connectors, yes.

### Miniature, subminiature contacts, no.

Microelectronics can give you a pain in the tweezers. You have to be perfect. And you have to be perfect in places so small that a flea would have trouble scratching his back.

Actually, the electronics part isn't too hard, what with piezoelectric this's and thin-film that's to work with.

But, inevitably, there comes the day when all the this's and that's have to be put together. It's a problem. Mechanically. Electrically.

You don't want to put a big fat plug on a skinny little mini-circuit.

So you need miniature or subminiature connectors. Those we have. By the catalogfull.

But you sure don't need undernourished contacts. You need all the strength you can get, all the contact area you can get, all the hang-togetherness you can get.

Those we give you. Every miniature in our catalog is made with our patented Varicon™ contacts (you probably already know about them). Our newer sub-miniatures are made with Bi/Con™ contacts (which

is sketched at the left).

See the four mating surfaces?

Four mating surfaces, coined so that they're exceptionally hard and smooth.

Four mating surfaces, held together snugly by the spring-like action of the design. And by the innate characteristics of the phosphor-bronze.

Four mating surfaces, strengthened by a reinforcing web.

Four mating surfaces, on a contact that floats in its insulator to make sure that the four mating surfaces mate.

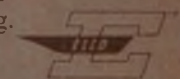
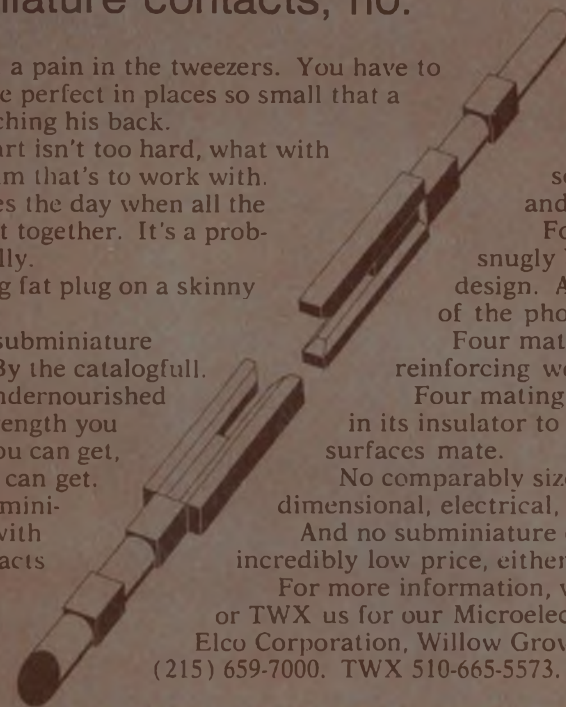
No comparably sized contact can match the Bi/Con's dimensional, electrical, and mechanical characteristics.

And no subminiature contact can match the Bi/Con's incredibly low price, either.

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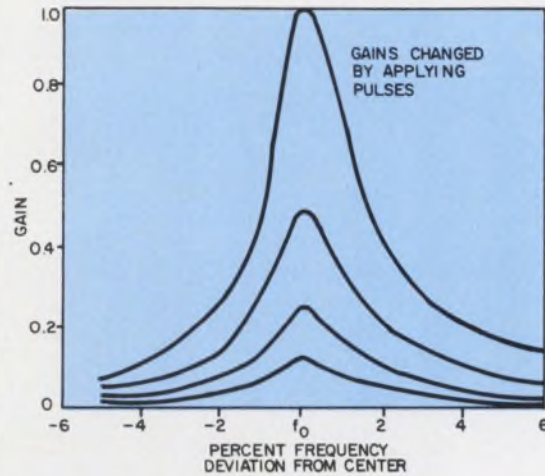
**ELCO** Varicon® miniatures  
Bi/Con® subminiatures

**(adaptive device, continued)**

ing 100 to 300-V pulses. For one polarity of the pulses, the polarization is increased, while reversing the pulse polarity reduces the polarization. By pulsing either the input or the output side (or both) of the wafer, the gain of the device can be set to either maximum or minimum attenuation or anywhere in between (see Fig. 2).

The acoustical coupling mechanism provides stable characteristics, and once a given level is set, it will maintain that level indefinitely. As a result, these adaptive devices are essentially an analog memory element potentially useful in computer memory circuits, learning circuits, adaptive logic circuits, system control, and remote-control circuitry.

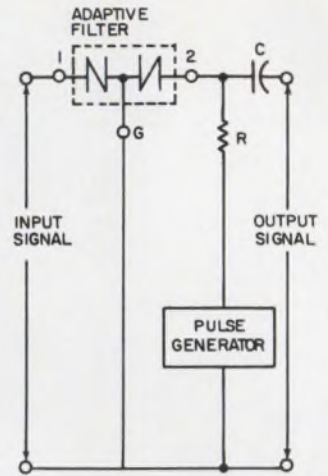
The maximum input signal to the resonant filter is 1 V rms. The application of the adapting pulses



2. Gain of adaptive filter is changed by output of pulse generator. The

is cumulative. According to Dr. Perlman, the output signal can be varied in analog fashion over a dynamic range of 60 dB in 100 microseconds, or as long as 10 minutes, depending upon pulse voltage and length.

In the transformer-type device,



higher the voltage, the greater the change. The effect is reversible.

there is a minimum 10% loss, with a maximum of 60-dB attenuation. In essence, this unit is a resonant filter operated substantially below its resonant frequency.

The impedance presented to the circuit by both devices is capacitive. ■■

## Portable terminal keeps computer on call

For the man on the road—whether he be an engineer, salesman or insurance agent—IBM has developed a portable terminal to enable him to talk to the home-office computer from any standard telephone.

A product of the company's center in Research Triangle Park, N.C., the audio terminal is built into an attache case. Users can enter alphabetic and numeric information into an IBM System/360 (with audio response capability) and get computer-compiled spoken responses to their inquiries.

The terminal is expected to find wide use among engineers and students, insurance agents and at manufacturing plants. "It can go anywhere a businessman goes and be used wherever a telephone is handy," notes Howard G. Figueroa, marketing vice president of IBM's Data Processing Div.

The handset of the telephone fits into the terminal's acoustic coupler, a cradlelike connecting

device.

The user would query the computer, using the unit's keyboard. The computer's reply is heard over the terminal's built-in speaker, or through an earphone. The spoken words are selected by the computer



Portable terminal in an attache case will permit users to "talk" to a computer from any standard telephone.

from its audio response unit.

The terminal has 60 keys—26 letters, 10 numerals and 24 special characters and controls.

To prevent unauthorized access to data stored in the computer, each 2721 can be assigned an identification code.

The terminal operates continuously for at least eight hours on rechargeable batteries, or can be plugged into any 110-volt ac line. It has a battery charge indicator and an automatic charger.

The unit measures 16 × 9 × 4 inches and weighs less than 10 pounds.

IBM's elastic diaphragm switch technology—flat, prewired switches that eliminate mechanical key linkage, keeps maintenance to a minimum, according to Figueroa.

The terminal communicates with all of the System/360 Models through an IBM 7770 audio response unit. It can be purchased for \$600 or will rent for \$20 per month. ■■



# Our 5-band carbon comps are cats of a different stripe



Okay, so the other leading brand is also great on military specs. But our Speer resistors have still more to offer.  They provide superior soldering characteristics. They're backed by the first and most sophisticated on-line computerized resistor quality control system. They're delivered in an exclusive foil pack.  And they're accompanied by written documentation.  Another helpful note—both our 1/2-watt and 1/4-watt types qualify under the new Established Reliability Specification at the S level.  Our 4-band carbon comps are something special, too—particularly now. They offer all of our traditional quality features—plus competitive prices.  To learn more about our resistors—and the reliable customer service that backs them up—write AIRCO SPEER ELECTRONIC COMPONENTS, St. Marys, Pennsylvania 15857.  Five "stripes" or four—you may even decide we're a whole new breed.

The passive innovators at **AIRCO** Speer

Speer resistors  Resistor and conductor paste  Jeffers JC precision resistors  Jeffers JXP precision resistors and networks  Jeffers inductors  Jeffers capacitors  PEC variable resistors and trimmer potentiometers.



# We make components for guys who can't stand failures.

Everybody hates failures in their electronic gear. It's just that some guys hate failures a little bit more than others.

These are the guys that we try to please.

At Corning, we make our resistors and capacitors to perform like your whole system depended on them, because many times it does. We build an extra measure of performance into all our components to let you build extra reliability into the equipment you design.

Take our precision tin oxide resistors, for example. They're the best of the metal film class. Because the resistive tin film is completely oxidized and molecularly bonded to the glass substrate, our tin oxide resistors are impervious to moisture and environmental degradation. No other resistor can deliver the same stability and reliability over load life. They offer guaranteed moisture resistance across all ohmic values to set a standard of reliability that can't be matched by metal film, wire wounds, carbon comps or metal glaze resistors.

After a recent 56-day-long heat

test in an environment of extremely high humidity, our tin oxide resistors showed a resistance change of just 0.2 per cent. And in an ambient temperature test—now in its ninth year—not one of the 600 tin oxide resistors being tested has exceeded a resistance change of 1.5 per cent.

Take our glass capacitors. The U.S. Air Force has found that our glass capacitors have much better stability and much higher insulation resistance than the ceramic, mica and the other capacitor types they tested. That's why glass capacitors are designed into so many major aerospace and missile projects.

And we've got something to offer when economy and value are the prime considerations. We've developed the Glass-K™ capacitor to give you the volumetric efficiency and economy of monolithic ceramic capacitors, but with the much improved stability and reliability that only a glass dielectric can add. In resistors, our tin oxide resistors already offer long term economy over metal film, precision wire wound and metal glaze resistors.

Our new C3 resistors, in addition to giving you a small case size, compete costwise with carbon comps.

Another important Corning development is the flame proof resistor. These resistors can withstand overloads of up to 100 times rated power without any trace of flame. And because they open under overload, they provide protection for the rest of the system.

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INFORMATION RETRIEVAL NUMBER 21

# NASA's relay satellite faces a wobbly future

## Spinning orbit delays tests with ATS-V, and the opposition of fishermen may force system redesign

C. D. LaFond, Chief  
Washington News Bureau

A NASA program to test the effectiveness of a relay satellite in long range communications and navigation has run into complications, a satellite malfunction and opposition by commercial fishermen.

The first could cause delays of up to a year in the ground-satellite-aircraft experiments; the second may result in redesign of future satellites, a NASA official says.

The satellite effort involves the PLACE (Position Location and Aircraft Communications Equipment) concept and is being directed by the Goddard Space Flight Center, Greenbelt, Md. Initial tests were to begin late last year, using L-band relay and ranging techniques through Applications Tech-

nology Satellite-V. Launched last summer into stationary orbit, the satellite failed to stabilize with its antenna aimed earthward and is now spinning rapidly, the space agency reports. Goddard hopes to work around the spin problem by late this year.

But conceptual disagreement with PLACE arose last year during a two-week conference in Europe with potential user organizations, says William Gould, assistant chief of the Application Experiments Branch at Goddard. Position papers are still being analyzed, he discloses, but the argument centers largely on fishing-fleet operators, who ultimately would use the system to determine their positions at sea.

They want a passive system—one that will avoid revealing their position to others. Commercial fishing is a highly competitive busi-

ness, dependent for its success on locating exclusively those areas of the ocean where the fish are abundant. PLACE is designed for cooperative (two-way) position-location techniques.

The U.S. must now take another look at the existing active time-division multiplex scheme, as opposed to some form of passive, continuous earth-coverage mode, Gould says.

Comprehensive testing of PLACE had been scheduled for 1972 with the more complex, but not yet built, ATS-F (the letter designation changes to VI after launching). Some redesign may be required to test passive location techniques, Gould suggests.

### L-band to be used

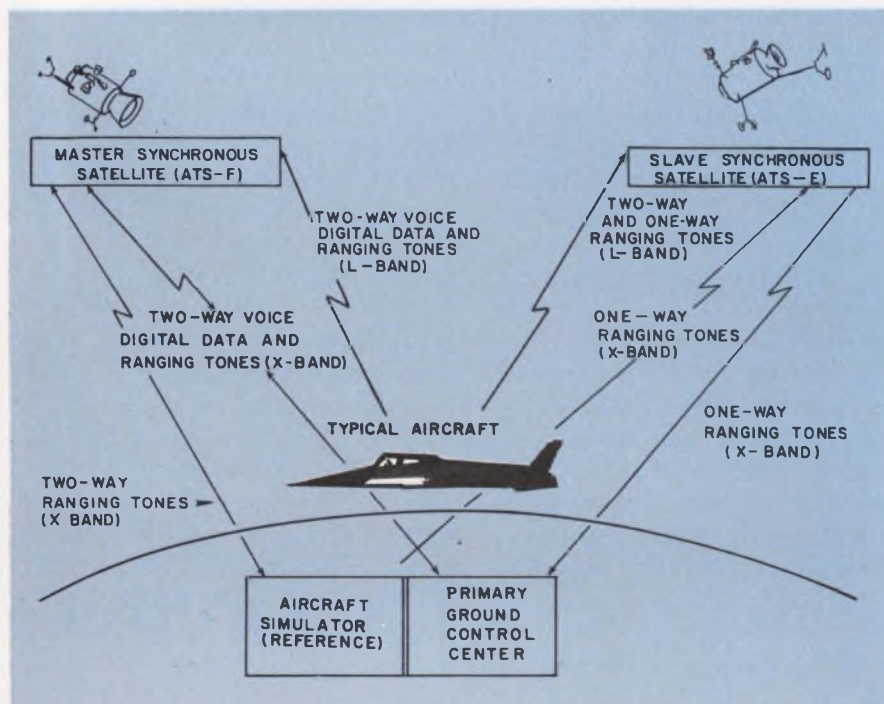
The PLACE experiments will link aircraft through ATS-V (and later ATS-VI) to a principal ground control center at NASA's Rosman, N.C., tracking facility. A backup NASA station at Mojave, Calif., and a mobile facility also will be used.

Communications relay tests between airliners and ground stations have been successfully performed in the past two years, using ATS-I and ATS-III with standard vhf (118-136 MHz) voice and data.

Goddard officials describe the next steps in the program as follows:

With ATS-V, the ground-satellite link will be via C-band (4-6 GHz); ATS-VI will use X-band, (possibly 10-14 GHz). The satellite-aircraft links for both satellites will use the aeronautical radio navigation frequencies in L-band (1550-1650 MHz) for the first time. Ground stations also will receive the L-band transmissions.

The Rosman tracking station will perform the measurements and transmit back all position data to the aircraft. The aircraft will be equipped with sensors and a telemetry channel to transmit altitude and velocity vector informa-



**Experimental PLACE system configuration.** First full-scale tests of an air-traffic-control system that uses satellite relay is scheduled to begin in 1972 with Applications Technology Satellite-F.

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tion to ground via the satellite.

Both the satellite transponder and the aircraft transceiver will employ similar frequency synthesizers. An independent oscillator in the Rosman station will serve as the system frequency standard. Thus the satellite will lock onto frequency and phase of the carrier component transmitted from Rosman; the aircraft, similarly, will lock onto the signal frequency and phase from the satellite.

The synthesizers will generate all frequencies required by either craft, and the aircraft subsystem will provide a gross Doppler correction in transmission paths.

The C-band (or X-band) transmissions from the satellite to ground will be used by the control center to determine positional information for all aircraft using the system and for the communications links. L-band transmissions between aircraft and satellite also will be received at the ground stations for monitoring and control purposes. The control center will use the L-band signals to provide range and range-rate measurements between it and the satellite.



**ATSS-V during final tests** at Hughes Aircraft Co., El Segundo, Calif. Prior to launching on Aug. 12, 1969. The rectangle with a dozen small circles at the upper right section of the satellite is the antenna portion of an L-band communications and navigation system.

ATSS-V has a 3.5-foot effective aperture planar-array antenna, with a receive gain of 32 dB and a transmitting half-power gain of 19 dB. ATSS-VI will carry a 30-foot-diameter deployable dish with a 28-dB gain. The ATSS-V ground-aircraft transponder will produce a 40-W output; its aircraft-ground transponder will have an output power of 4 W. The aircraft antenna has an effective gain of 25 dB and a transmit power output of 50 watts.

### Position determined on ground

PLACE designers at Goddard believe the system, with a single satellite, will be able to locate and keep track of up to 200 aircraft at any given time. Gould estimates aircraft location will be determined to within 1-mile accuracy.

Transmissions required for location will be automatic, and all signal processing will be performed at Rosman. Position will be determined by the intersection of three spheres derived by the ground computer, Goddard engineers say.

The first will be developed by the aircraft altitude. The second by ranging measurements between the satellite and aircraft. A circular line of position, on which the aircraft is located, will result from the intersection of the two spheres. The third sphere, obtained by a ranging measurement from the aircraft with the help of the Navy's Omega vlf (10-14 kHz) navigation transmission, will establish the aircraft position at the point it intersects with the circular line of position.

### Spin problem under study

NASA scientists are now working out an answer to the spin problem encountered with ATSS-V. Gould is optimistic that some valid PLACE tests may still be performed. The original goals were to evaluate and characterize three parameters: ocean multipath, the background noise environment and the positioning accuracy obtainable at L-band in an operating environment.

At present, the NASA engineer discloses, the craft can be used only 5 per cent of the time. It is

spinning at 80 rpm, and communications with it must be synchronized with the rotating antenna. NASA is now preparing to try rudimentary time-division multiplex tests that will use data only, not voice, says Gould. This would permit position determination and provide some propagation information, the engineer predicts.

Both the satellite ranging at L-band and the aircraft ranging at vlf will be performed with sidetone measurement techniques, originally developed for the Goddard range and range rate tracking system, the center says. To determine range, propagation times or phase delays in a multi-tone signal will be measured and compared as they traverse both radio paths from ground-to-satellite-to-aircraft.

A basic tone will be used for fine range resolution, a set of sidetones will be used for ambiguity resolution. Similar measurements will be made between the ground station and satellite, and then subtracted to obtain the necessary range calculation from satellite to aircraft, the tracking experts say.

Range accuracy will vary with errors introduced by the transmission medium and the signal-to-noise ratio maintained over the radio path. Other small errors will be added by the dual transmissions involved and the two-to-three mile error that may occur with use of the Omega system. (The Goddard tracking system was designed for a theoretical range accuracy to within 15 meters.)

If the plans had called for a second satellite to be used, the Omega system would not have to be employed. Because of the several-minute delay in obtaining data from the Navy system, it probably will not be used in an operational navigation satellite system, space officials indicate.

PLACE will employ a secondary method of ambiguity resolution called Satellite Inertial Navigation Determination. Position will be determined with the use of satellite-to-aircraft sidetone ranging, aircraft altitude and the aircraft velocity vector telemetered from on-board accelerometers. A fourth factor, aircraft range rate relative to the satellite, must also be determined. ■■



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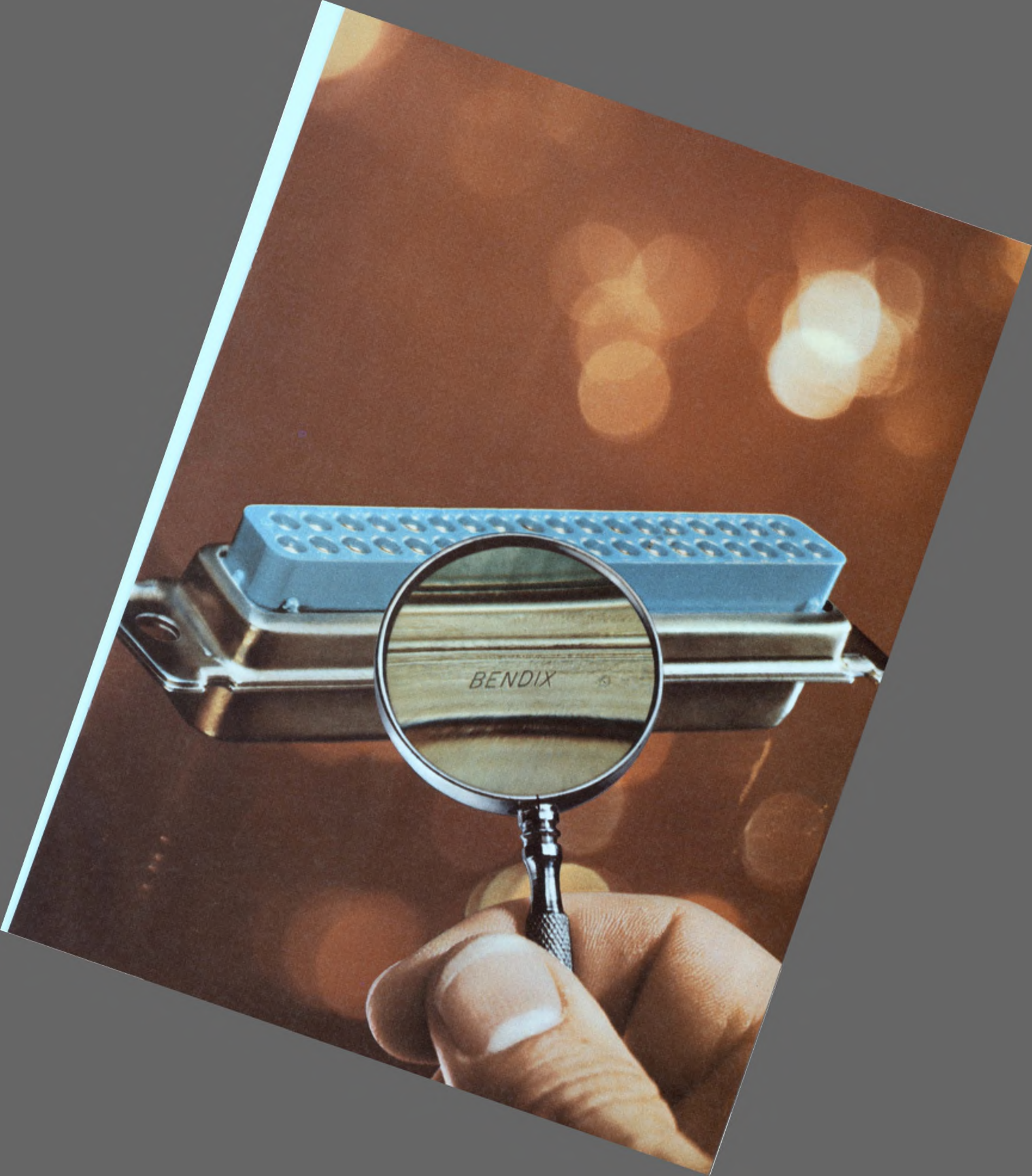
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# Washington Report

CHARLES D. LA FOND, WASHINGTON BUREAU

## More higher-altitude spy satellites expected

Washington aerospace industry informants predict an increasing reliance by the Dept. of Defense on high-altitude (polar orbit and synchronous) surveillance satellites during the 1970s. Launchings of the short-lived, low-altitude spacecraft have declined in the last two years.

The spy satellites provide recoverable photo and electronic intelligence packages. No official statements on their operation are ever issued by the Pentagon. Based on leaks of information, however, it is believed that the Air Force is now looking toward a sophisticated, multi-spacecraft approach to high-altitude surveillance. Industry informants say three systems ultimately may be combined into an expanded early-warning system.

One is Project 647 (previously Project 949), an integrated early-warning satellite surveillance system under development by TRW Systems, Inc. It would employ an infrared, long-range optical system, operating in the 2.3-micron range, to detect enemy missiles from launching through final propulsion burnout. A second system, under study by TRW and Philco-Ford, is for a mid-course satellite surveillance system. This would employ infrared tracking in the 8 to 14-micron range to follow the missiles after propulsion burnout and in low-altitude orbit. Project 313 would complete the network. It would be employed for satellite-to-satellite data relay. Studies are under way by TRW and General Electric for a wideband, narrow-beam, millimeter-wave satellite relay system.

## A less-expensive Main Battle Tank is the new goal

The long-awaited decision by Deputy Defense Secretary David Packard on the future of the controversial Main Battle Tank has been made, but it's not likely to end the controversy. High costs were at the root of the dissent by some Congressmen, so Packard, in a secret report to Congress, has recommended continuation of the MBT-70 program, but with greatly reduced costs and a funding policy that would end joint development of the tank with the Federal Republic of Germany. Present plans are to build the tanks for about \$500,000 each—\$200,000 less than original estimates.

But an Army program official, who admits not having seen the report to Congress, says he cannot envision at this time how the armored-vehicle design can be altered sufficiently to produce such a cost saving."

## Domestic-satellite recommendation pleases carriers

"For five years we've had indecision, and now that the White House has given direction on future domestic satellite policy, I believe it has unnerved the whole industry," says one pleased top-official of a principal common carrier. "It was not a decision I had expected."

This about sums up the response here by industry to the recent White House recommendation that ownership and operation of U.S. domestic communications satellites be opened to competition. The nod had been expected to go to Comsat.

The Executive recommendation is contained in a report to the Federal Communications Commission by a Presidential committee headed by Dr. Clay Whitehead. The FCC chairman, Dean Burch, has promised that the recommendation will receive the "highest priority." An FCC decision is expected by the end of this month or early March.

## **Prospects rosy for international weather satellites**

Chances are very good for a cooperative international weather satellite system, says David S. Johnson, director of the National Environmental Satellite Center, but he offers no timetable. Discussion with many countries for such an effort has been in progress for several years, says this official of the Environmental Science Services Administration, and he expects this collaboration to continue.

Under the proposed U.S. plan, says Johnson, a global geostationary satellite system employing at least four spacecraft would be equispaced around the equator. The U.S. would provide at least one spacecraft with one backup for the system, and other nations, either jointly or individually, would provide the remaining satellites.

## **Federal law enforcement assistance climbs**

The impact of funds available for equipment and research from the Law Enforcement Assistance Administration of the Justice Dept. is only now becoming discernible. Sen. John L. Fannin (R-Ariz.) recently noted short-term increases in funding under the national program within his own state. In fiscal 1969, the Arizona State Justice Planning Agency obtained nearly \$500,000 in block grant funds, plus participation with other states in two discretionary grants of \$600,000 and an additional \$70,000 in college grants for law-enforcement students. In fiscal 1970 the same agency will receive \$228,000 planning funds, plus over \$1.5 million in action funds for crime-program improvements.

A summary list by the Senator reveals that 11 states in 1969 were either expanding or improving their command and control communications and information networks. These include Alaska, Colorado, Florida, Nebraska, Nevada, New Jersey, Rhode Island, Texas, Vermont, Wisconsin and Wyoming.

## **Electronic clothing tags aim to reduce shoplifting**

A new industry may be burgeoning: rf-excited electronic warning devices for store theft prevention and industrial security. A pioneer in the field is Knogo Corp., Westbury, N.Y., which is now arranging franchises to market its systems throughout the country. The first franchise arrangement was instituted in the Washington area last September with the establishment of Knogo of Washington. Six franchises now exist, and up to 50 is the goal of Knogo's president and system inventor, Arthur J. Minasy.

The anti-shoplifting system uses a transmitter-receiver to radiate a signal through a cluster of loop antennas around an exitway. This field generates a very low-level rf response from the passive Knogo printed-circuit tags attached to apparel, according to Robert Burch, president of the Washington franchise. The printed circuit is contained within a patented plastic wafer, which includes an unusual connecting device that penetrates and locks onto fabric. "It can be removed, without destroying the fabric, only by a special tool," Burch asserts.



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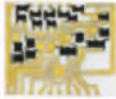


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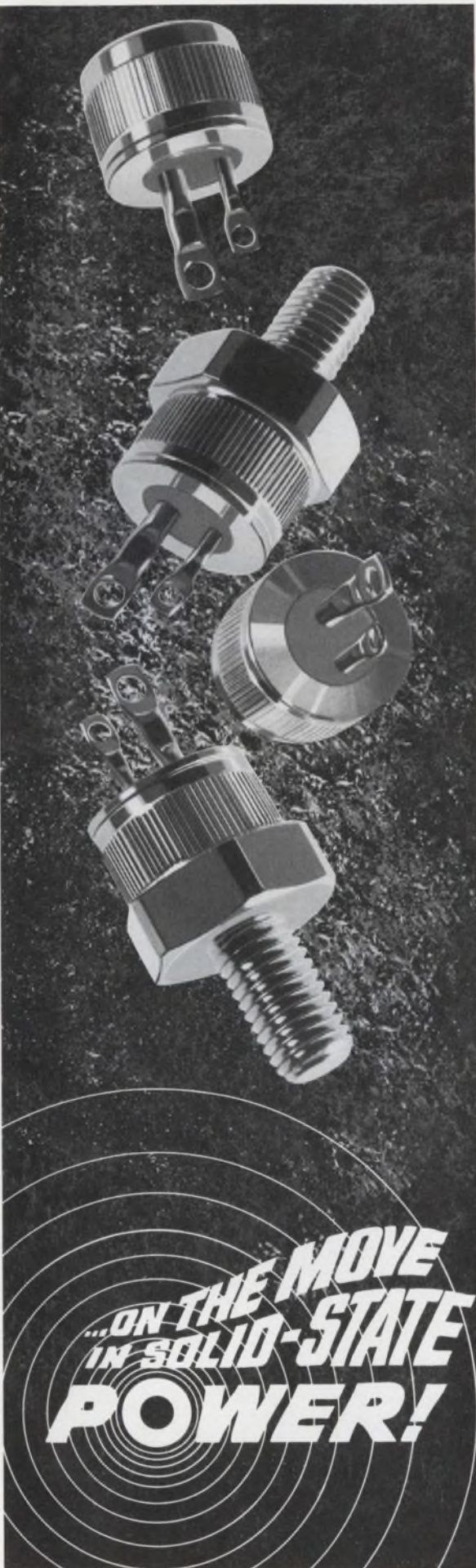
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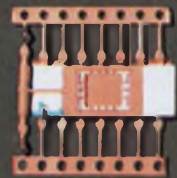


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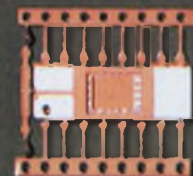


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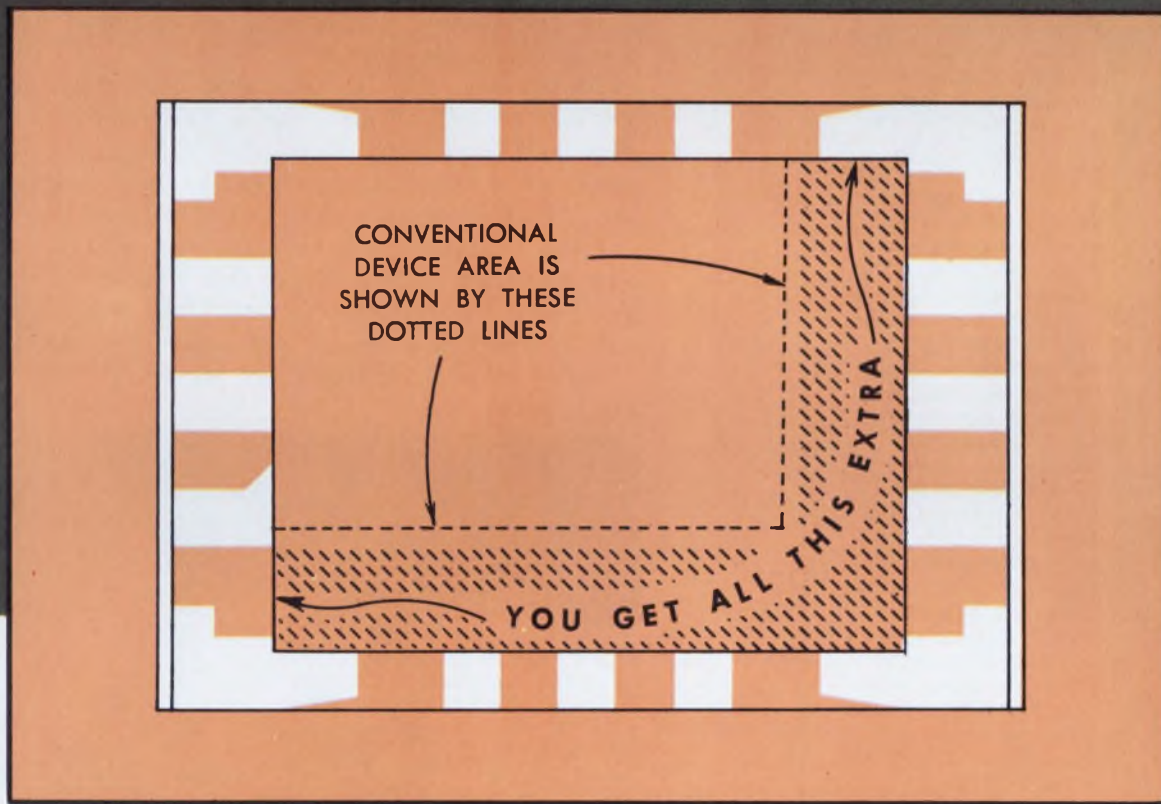


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INFORMATION RETRIEVAL NUMBER 29

## SIDELIGHTS

### From editor to hospital attendant

Because his wife, a registered nurse, got tired of hearing reports that medical-electronic equipment was hazardous, Jack Kessler, *ELECTRONIC DESIGN* news editor, found himself getting up at 5 a.m. to work as an attendant at Overlook Hospital in Summit, N.J., to observe some of the devices firsthand.

"I could have visited six university hospitals with the most advanced electronic equipment and spoken to the directors and department chiefs responsible for its purchase and operation. Instead, I decided to experience the things I would write about," he says.

He applied at the nursing office at Overlook because it was near his home. The hospital agreed to hire him for seven days and arranged a schedule that allowed him to work in those areas where electronic machines were most used. He became part of the nursing team. He saw the machines that control body temperature, respiration and circulation. He found out how patients are chosen for intensive-care units. He saw how blood gases and electrolytes are analyzed and how the pulmonary system is evaluated.

During his stay at the nonprofit, fully accredited 438-bed hospital—which has a 300-member staff, 1100 employees and more than 200 volunteers—Jack saw plenty of the human as well as the technological side of life: "I saw how an electric pulse restored human heart rhythm to a patient who otherwise would have died, how electronics can probe inside the heart, the brain, and define the boundary between life and death for an auto victim whose organs were up for transplant."

Jack's article, reporting on his week's observations, begins on p. 24.



Flat on his back in Overlook Hospital, but not a bit worried, is Cliff Gardiner, *Electronic Design's* art director, on hand to supervise the picture-taking for the medical-electronics story. That's News Editor Jack Kessler to the left of him.

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A-B resistor  
enters the

exclusive  
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Here's the latest Allen-Bradley resistor—the Type BB 1/8 watt—to meet the requirements of MIL-R-39008 Established Reliability Specifications at the highest level—the S level. Now, A-B provides this "peak" performance in all four ratings—the 1 watt, 1/2 watt, 1/4 watt, and 1/8 watt. A clear demonstration of the type of leadership you've come to expect from Allen-Bradley.

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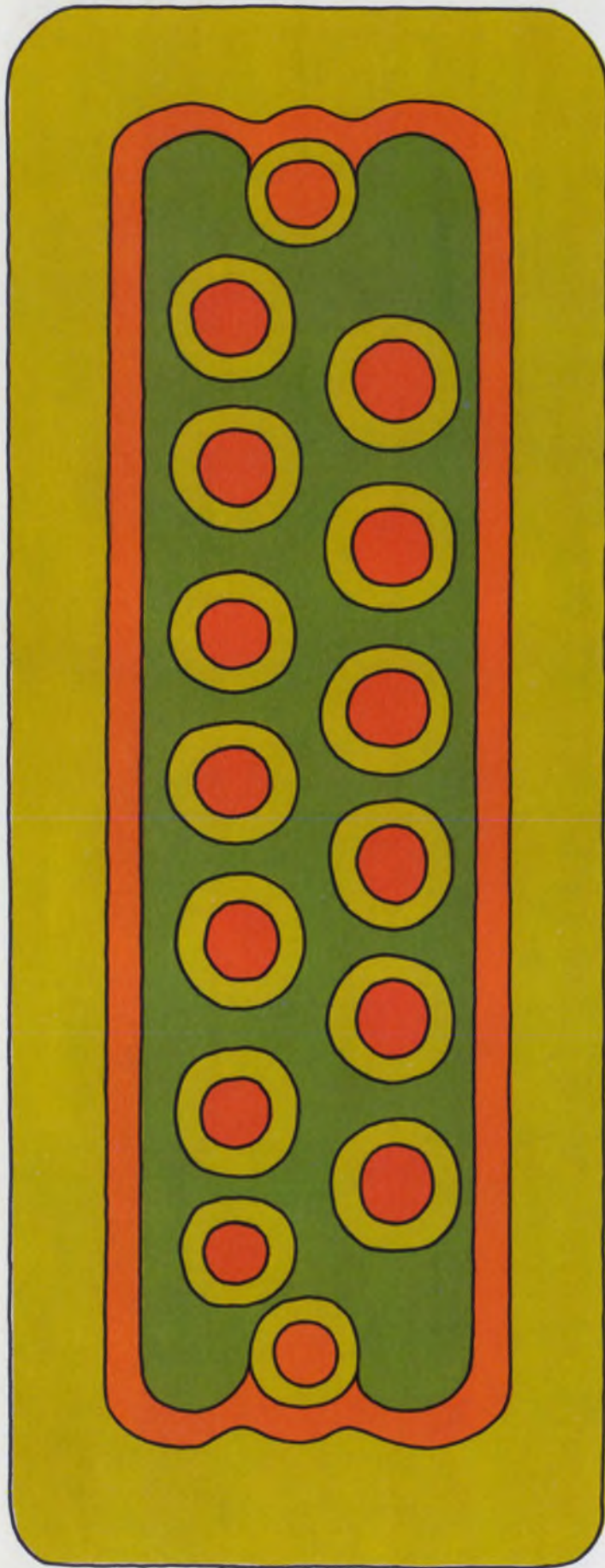
For immediate delivery at factory prices, call your authorized A-B Industrial Electronics Distributor. For technical specifications write Marketing Dept., Electronics Div., Allen-Bradley Co., 1201 South Second Street, Milwaukee, Wis. 53204. Export Office: 1293 Broad Street, Bloomfield, N. J., U.S.A. 07003. In Canada: Allen-Bradley Canada Limited.

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A-B hot-molded fixed resistors are available in all standard resistances and tolerances, plus values above and below standard limits. Meet MIL-R-39008 at S level for all values from 2.7 ohms to 22 megohms, except Type BB which is from 10 ohms to 22 megohms. Shown actual size.



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## EDITORIAL



## Electronics . . . it follows you everywhere nowadays

Never sick a day in your life, and yet here you are being wheeled into the coronary-care unit of the local hospital. "Myocardial infarction" was the term the doctor used.

How about that. You—a heart attack. And Joe always said you'd live to be a hundred. That's probably how long it would take to move into his slot as chief engineer. He isn't going anywhere, even though he is a darn good engineer. He just doesn't know a thing about company power politics.

What a heck of a time for this to happen. Those new op amps are due in next week, and you just know that they won't be tested properly. It's not Sam's fault. As a technician, he's not responsible, although by now you'd think he would know enough. Ed's the problem. It's his project—but you'd never know it the way he operates. He lets vendors get away with murder. You keep telling him he better keep on top of them and maybe even throw a scare into them periodically, just to keep them honest. But he won't listen. The frustrating part is that his projects generally result in good designs, completed on schedule. It doesn't seem possible, though, for his luck to hold out forever.

What are you *doing*? Here you are flat on your back in bad shape, and all you think about is work. Don't worry—they'll manage without you.

How long will you be here in the hospital? A week, a month? What will you do to pass the time? Write a technical paper, that's what you'll do. At least you'll be able to write it in peace and quiet. Not like those other ones that you always seem to be writing at the dining-room table, with the kids hollering and your wife accusing you of work, work, work.

Maybe she's right. You haven't taken her on a vacation in four years. Wait a minute—that's wrong. You took her to Wescon with you two years ago.

Oh well! Things will be different when you get out of here. No more carrying the ball all by yourself at work. They pay you to be a group leader, and that's what you'll be. Fifty-hour weeks and 800-mile overnight trips are out. More time with the family. That's what you're going to do.

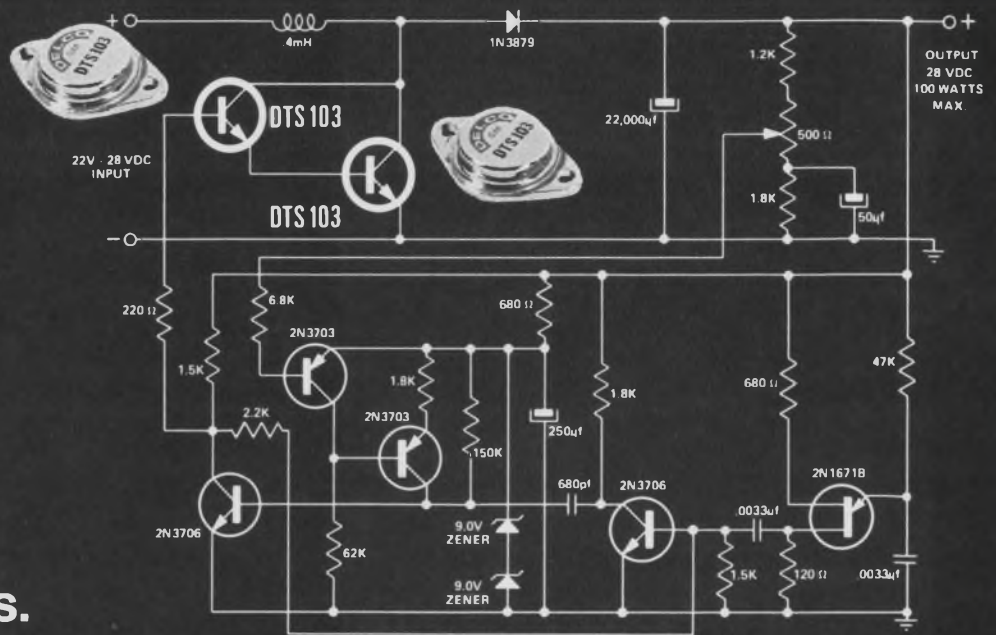
Hey—what's that. Oh, it must be the display and monitoring panel for the coronary unit. Look at that. Modular amplifiers, CRTs, strip-chart recorders—the works. This really must be a growing field.

Wonder what the chances are for a small-time company that could design components for these systems? When you get back on your feet, you could use your savings and operate out of your garage. Of course, at least for a while, you'd keep your job and just do this evenings and weekends. And then you could . . .

*Now turn to page 24 for an inside look at medical electronics from the hospital's point of view.*

FRANK EGAN

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high energy  
silicon power  
transistors.  
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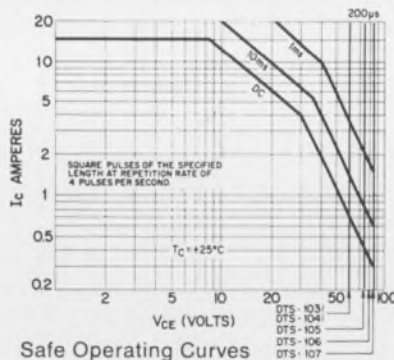
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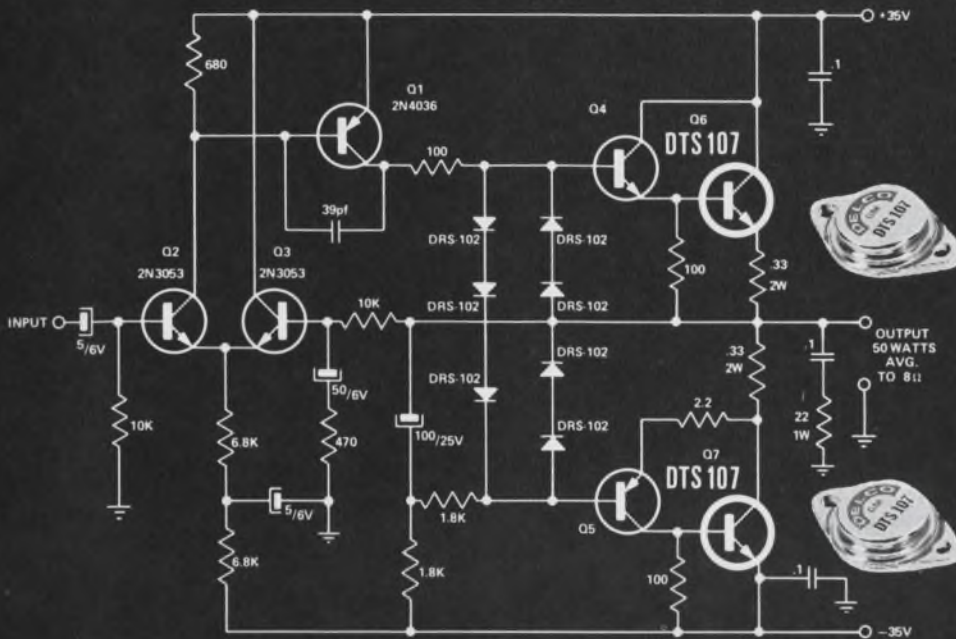
energy reliability that's needed for very tough switching jobs—resistive or inductive. The 28-volt shunt regulator above, for example, is amply handled by the DTS-103 ( $V_{CEX}$  of 80 volts). For complete data on this circuit, ask for our application note No. 42.

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Our solid copper TO-3 package provides maximum thermal capacitance to absorb peak power pulses. Its low thermal resistance (0.75°C/W Max.) assures the extra reliability you expect from Delco.

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DTS-103	15	20	80	60	60	20-55	5	1.8	4	125
DTS-104	15	20	80	60	60	50-120	10	1.5	4	125
DTS-105	15	20	100	80	75	20-55	5	1.8	4	125
DTS-106	15	20	110	90	80	20-55	5	1.8	4	125
DTS-107	15	20	120	100	85	20-55	5	1.8	4	125

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**2 Are you eating your way to heart attack?**

You may be if your diet is too rich in saturated fat and cholesterol.

**3 Is your blood pressure high?**

Ask your doctor. The higher your blood pressure, the higher your risk of heart attack.

YES NO

**4 Do you smoke cigarettes?**

If you smoke more than one pack of cigarettes a day, your heart-attack risk could be 2 to 3 times greater than a non-smoker's.

**5 Are you physically fit?**

Regular, moderate exercise improves circulation, strengthens the heart.

**6 Do you dodge your doctor?**

Don't. See him regularly. Let him help you cut your risks.

Another way to reduce your risk is to help expand the life-saving programs of your Heart Association.

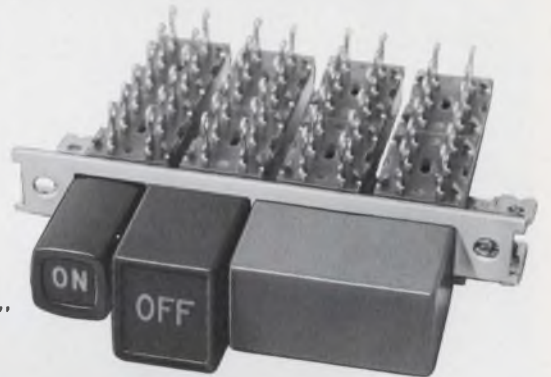
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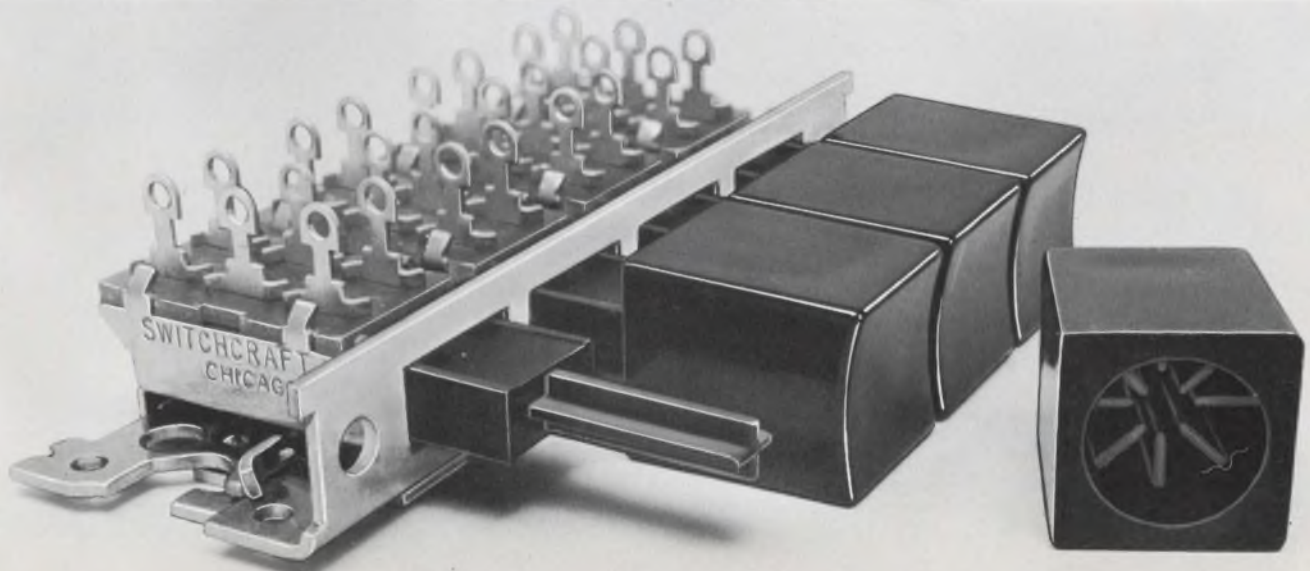
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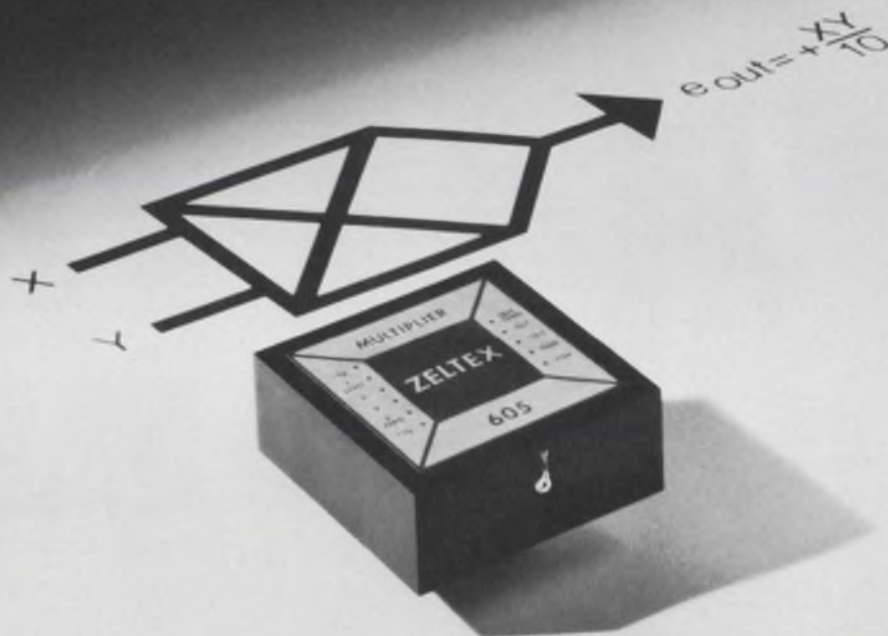
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# The more complicated it gets...

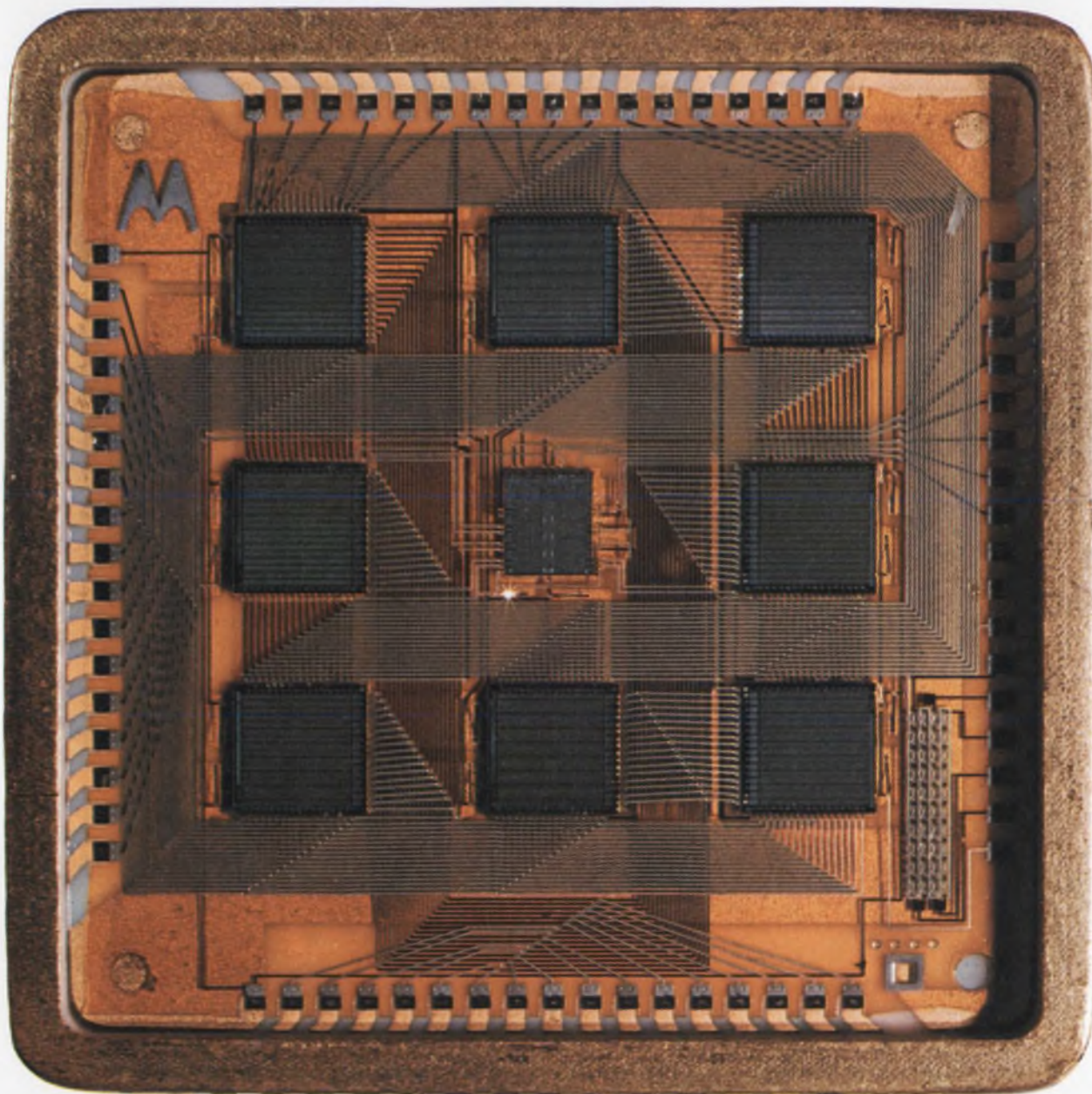


Photo courtesy of Motorola Semiconductor Products Inc., Phoenix, Arizona

# The more engineers control your market

**COMPLEXITY AND DESIGN** To the layman, even the simplest electronic device seems complex. But, to engineers, complexity is commonplace. They thrive on it. Faced with an evolving technology that can pack 2,500 circuits in the space of a thin dime, who but the engineer can speak the language? Yet, the staggering intricacies of the IC, MOS, and MSI generations bring with them a clear message to marketers: *The more complex and sophisticated the product or system becomes, the more OEM buying power is placed in the hands of engineers and engineering managers.*

**EXPLODING A MARKETING MYTH** Some publications would have you believe that the electronic OEM is fragmented—that buying power has become scattered—moved away from its engineering base. This is not substantiated by the facts. Your market is *not* fragmented, it is *concentrated!* It is increasingly engineer-dependent. Now, more than ever, the prime responsibility for product development lies with design engineers and engineering managers—the men who select and specify.

**NEW PROOF SUPPORTS OUR CLAIM** The engineer-dependence of your market shows up clearly in a 1969 study conducted by Dr. James J. Mullen, President, University Research Associates, Chapel Hill, North Carolina. Buying practices were examined for 25 product categories in 87 representative plants.

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## Electronic Design

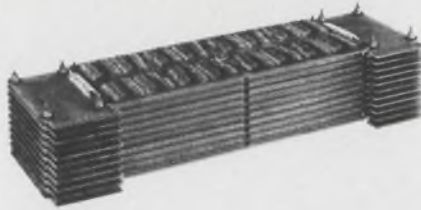
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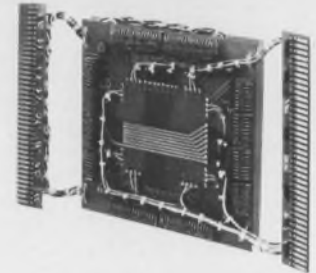
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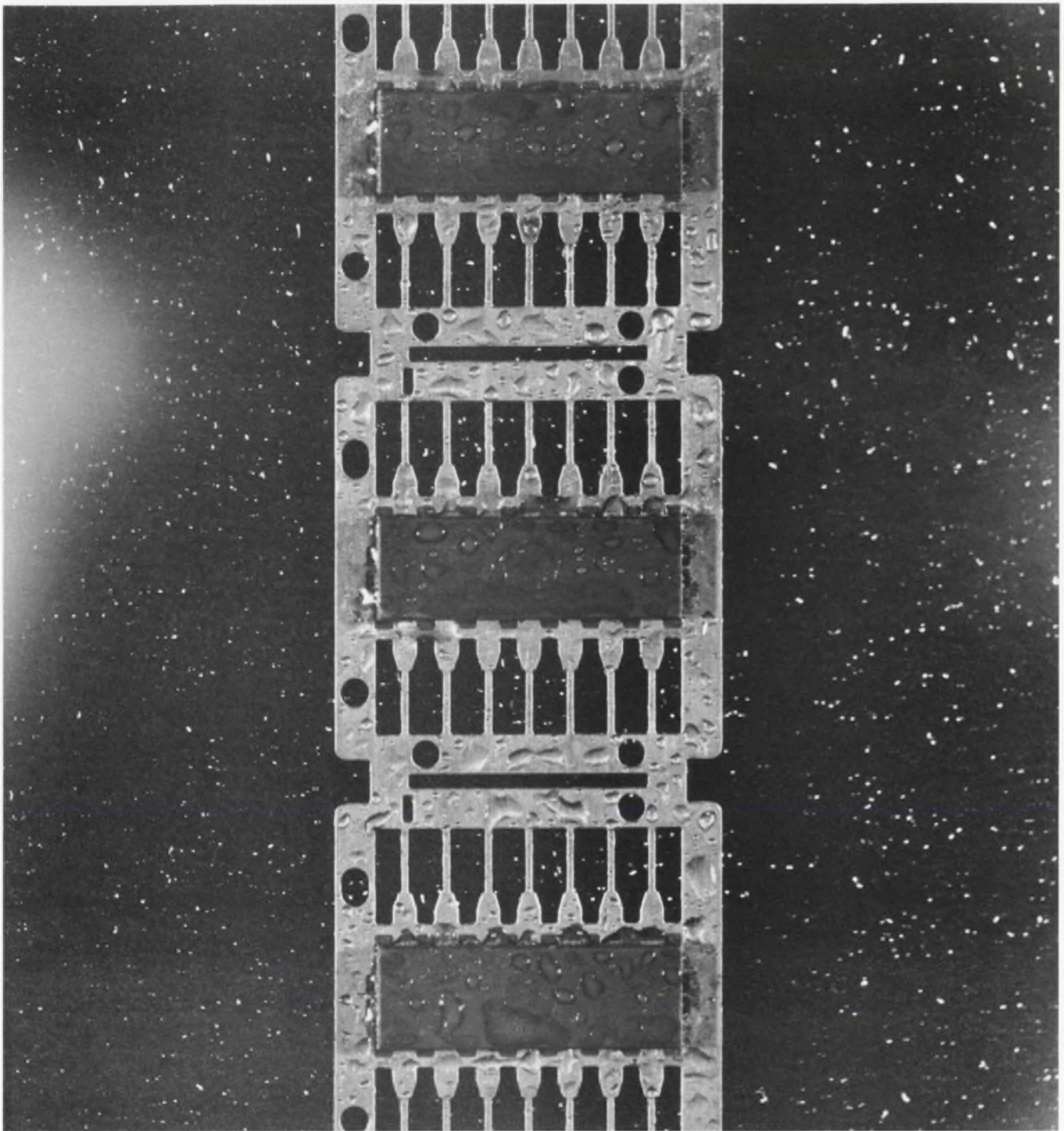
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LOW-NOISE HIGH CMRR	Extremely low noise, high common mode rejection ratio.	5-40	5-15	100	500	15 (10 Hz) 10 (1 kHz)	0.1	$I_D = 200 \mu A$ $V_{DG} = 20 V$	2N5520- 2N5524	CDNS01*
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BALANCED MIXERS		—	100	—	5,000	30 (10 kHz)	20	$I_D = 5 mA$ $V_{DG} = 12 V$	U257	CDNZ01*

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# Need a low-voltage dc converter?

Use this solid-state multiplier circuit. It operates from sources as low as 0.1 V.

Multiplying low-level dc voltages is often a headache. All conventional solid-state rectifiers have forward voltage drops, under any appreciable current, of 0.3 to 0.6 V, and if the source voltage to be multiplied is under one or two volts the problem looks insurmountable. But it isn't.

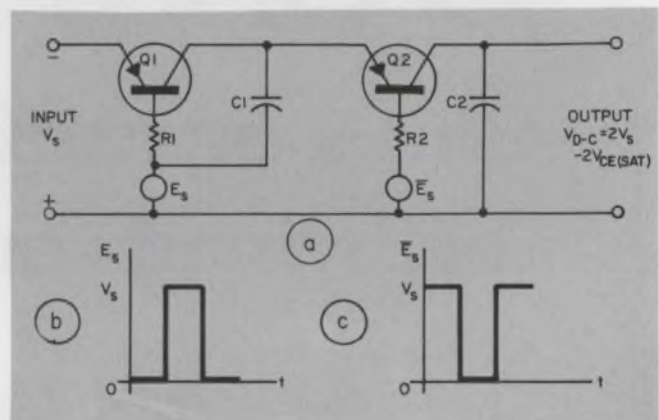
Bipolar transistors, with their low (50-mV) collector-to-emitter saturation voltages make excellent rectifiers for low-voltage multipliers. Connected in a special multiplier circuit, and driven by solid-state clocking circuitry, they can multiply dc sources as low as 0.1 V. And at source voltages of 1.35 V, with a load current of 1.25 mA, efficiency has been measured at 55%. An added plus: the new circuit can easily be built in hybrid form.

A basic doubler circuit, which uses bipolar transistors operating in the saturation mode as rectifiers, is shown in Fig. 1. The switching voltages  $E_s$  and  $\bar{E}_s$  are 180° out of phase, and have a peak value equal to the supply voltage  $V_s$ . With  $E_s$  at 0 V, capacitor  $C_1$  charges to  $(V_s - V_{ce1(sat)})$ . With  $E_s$  equal to  $V_s$  and  $\bar{E}_s$  equal to 0 V, the voltage at point A reaches  $(2V_s - V_{ce1(sat)})$ , and  $C_2$  charges to  $(2V_s - 2V_{ce1(sat)})$ , assuming equal saturation voltages. Actual circuits, built with transistors having saturation voltages of 10 mV, have achieved output voltages of 2.68 V using a supply voltage of 1.35 V.

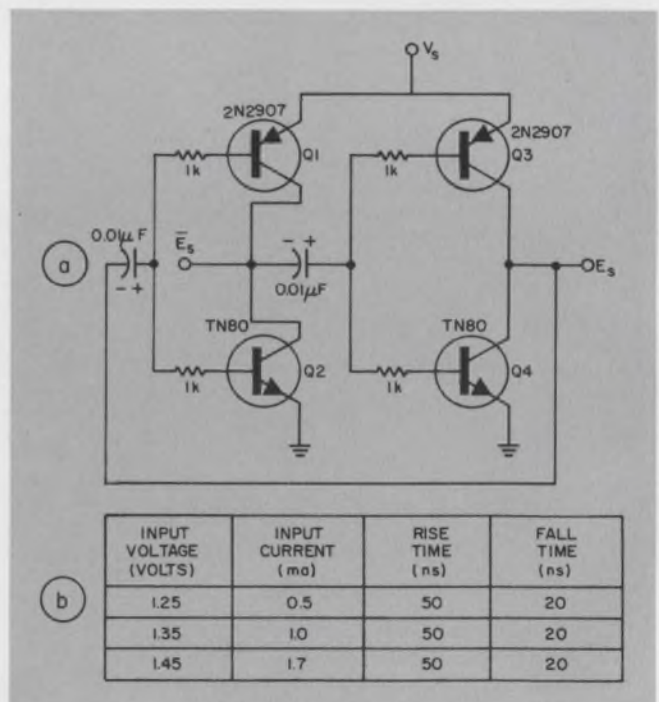
## The clock is the key

The key to the successful operation of the circuit of Fig. 1 is generating the clock voltages  $E_s$  and  $\bar{E}_s$ . A clock circuit designed for this purpose is shown in Fig. 2.

The clock circuit operates basically as an astable multivibrator. The 1-kΩ resistors have been selected so that  $Q_1$  and  $Q_3$  saturate for low values of  $E_s$  and  $\bar{E}_s$ , whereas  $Q_2$  and  $Q_4$  saturate for large positive values of  $E_s$  and  $\bar{E}_s$ . Since  $E_s$  and  $\bar{E}_s$  are 180° out of phase, this means that for

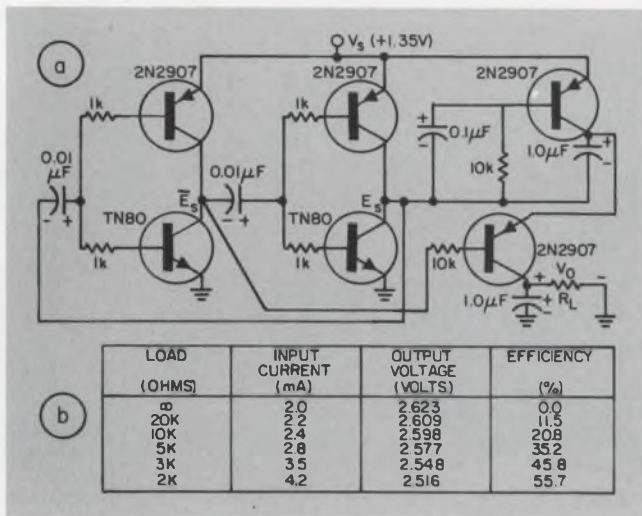


1. A simple low-voltage doubler circuit uses pnp transistors as rectifiers (a). The forward voltage drop across each transistor is  $V_{ce(sat)}$ , roughly 15 mV, and the circuit can work well with source voltages as low as 100 mV. Voltages  $E_s$  and  $\bar{E}_s$  [(b) and (c)], vital to the operation of the doubler, are obtained from a special clock.



2. The clock circuit is an astable multivibrator (a), which can achieve rise and fall times of 50 and 20 ns on a 0.5-mA supply current (b).

N. Poirier, Research Associate, and B. L. Cochun, Associate Professor, Northeastern University, Boston, Mass.



3. A complete doubler for a 1.35-V source (a) achieves a load voltage of 2.52 V at 1.25 mA and an efficiency of 55.7%. Efficiency falls to 20.8% for a load current of 0.26 mA (b), and open-circuit output voltage rises to 2.62 V.

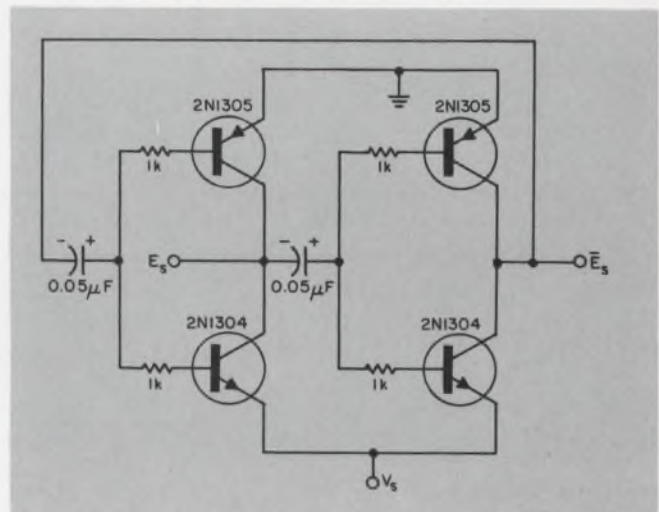
one-half of a cycle of the square wave both  $Q_2$  and  $Q_3$  will be in saturation with  $Q_1$  and  $Q_4$  cut off, and the reverse will be true for the other half of the cycle.

The capacitors charge and discharge through the saturation resistances of the pnp and npn transistors, respectively, thereby achieving excellent rise and fall times for the square-wave output waveform. For the values shown in Fig. 2, for example, rise and fall times of 30 and 20 ns respectively are achieved with an input current of 1 mA.

A complete doubler circuit operating from 1.35 V is shown in Fig. 3. The table lists the characteristics of this particular circuit. Noteworthy is the efficiency, which is 55.7% for a load current of 1.25 mA and a load voltage of 2.52 V.

Voltages of higher output can be obtained, of course, using additional stages, with each additional stage requiring one additional resistor, capacitor and transistor.

The doubler circuits shown are not limited



4. A germanium transistor clock operates on 0.1-V supplies, and will enable multiplication of 0.4-V nuclear sources when they are available. The polarities shown are for a negative output doubler, and the rise and fall times of the circuit are both 0.8  $\mu$ s.

to 1.35-V cell sources. With slight redesign, they can accommodate sources as low as 0.1 V.

#### Multiply sources as low as 0.1 V

Nuclear sources, for instance, expected to be available in the near future, will have terminal voltages of 0.4 V. If nuclear sources are used with this doubler configuration, it will be necessary to redesign the clock circuit to use germanium transistors, with their lower junction voltages.

The redesigned, 0.4-V clock circuit is shown in Fig. 4. There is no fundamental difference between this clock circuit, of course, and that of Fig. 2. The polarities shown are necessary if the clock is to be used for a negative output doubler.

Operation of the circuit of Fig. 4 is possible from supply voltages as low as 0.1 V. With  $V_s = 0.3$  V, the rise and fall times of the output square wave are both 0.8  $\mu$ s, with an input current of 0.31 mA.

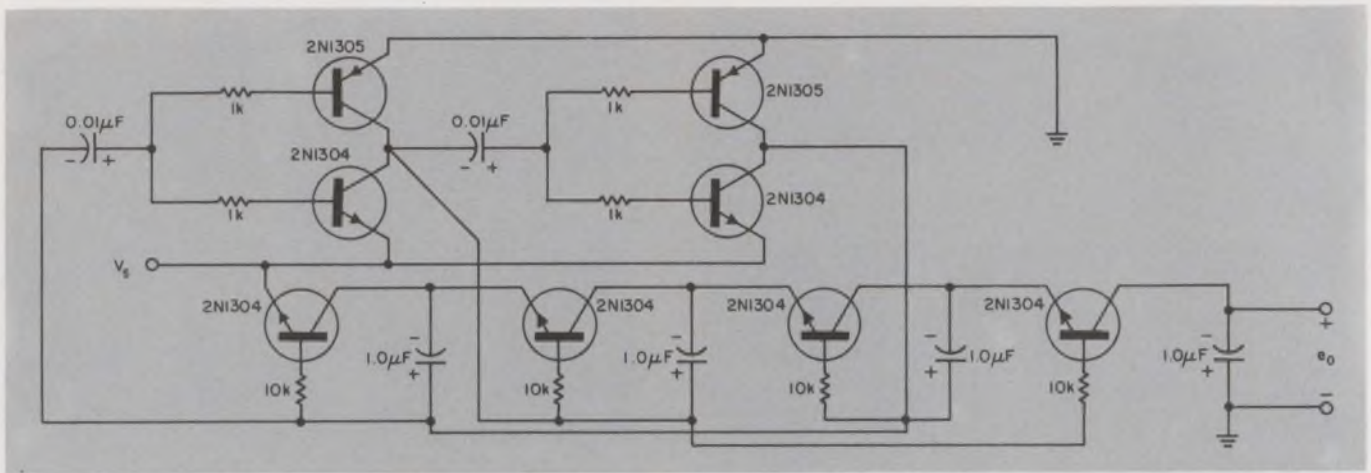
## Instrumentation needs low-voltage multipliers

There is a rapidly growing need for small power sources—especially in biomedical and instrumentation work—which will provide enough voltage to drive solid-state circuitry.

Simple series-connected cell supplies are usually too bulky for these applications, and single cells (mercury cells, for instance) supply only up to 1.5 V. But the junction voltages of bipolar transistors and the pinch-off voltages of junction FETs are in the order of 0.3 to 0.6 V, and direct coupling in the amplifier usually re-

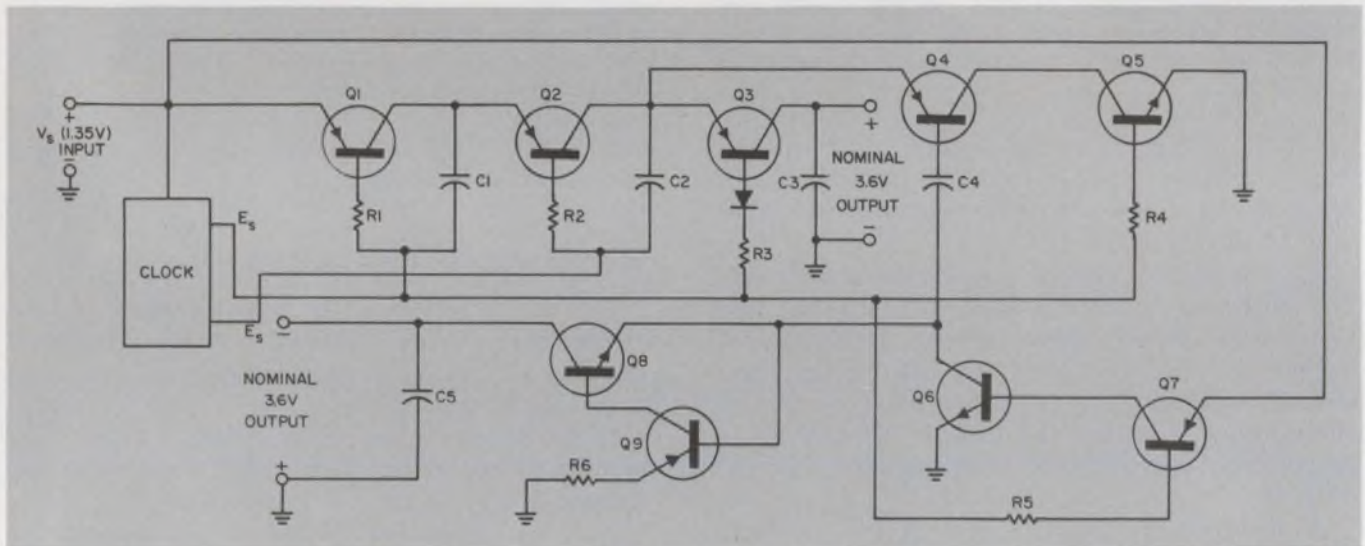
quires dc level shifting. The result is a requirement of at least a 2.6-V supply for proper amplifier operation. Some means of boosting the voltage of a single cell is needed.

Transformer multipliers are out, obviously, because they are far too large. And the use of conventional diodes in a doubler circuit has greatly limited effectiveness because, with any appreciable current, the junction voltages approach 0.3 to 0.6 V. But bipolar transistors offer a way out of the dilemma.



5. A four-stage multiplier yields  $-1.29$  V at an output current of  $1.1$  mA, from a  $0.4$ -V source. Used with a

nuclear source it can mean miniaturized sources, equivalent to mercury cells, with ratings of mA-years.



6. A voltage tripler configuration with dual-polarity output uses the same circuit techniques. It supplies a

nominal  $\pm 3.6$  V from a  $1.35$  V source and is ideally suited to hybrid construction.

A complete four-stage multiplier circuit using the clock circuit of Fig. 4 and giving a negative output voltage is shown in Fig. 5. With  $V_s = 0.4$  V and an input current of  $1.1$  mA, the output voltage of this circuit is  $-1.29$  V. This circuit, when used with a  $0.4$ -V nuclear power source, would become an equivalent mercury cell with a rating of mA-years rather than mA-hours.

An extension of these ideas makes possible converters with dual-polarity output voltages derived from a single-polarity input voltage.

A dual-polarity tripler circuit is shown in Fig. 6. The block labeled CLOCK is the clock circuit of Fig. 2.  $Q_1$ ,  $Q_2$ , and  $Q_3$  make up the positive output tripler circuit which generates an output voltage of  $3.6$  V. Assuming negligible values for  $V_{ce(sat)}$ ,  $C_1$  is charged to  $3.6$  V through  $Q_1$  and  $Q_2$ , since with  $E_s$  equal to  $0$ ,  $Q_7$  will bias  $Q_3$  into saturation. With  $E_s > 0$  and positive,  $Q_1$ ,  $Q_2$ , and  $Q_7$  are open and  $Q_5$  is in saturation. Transistor  $Q_5$ , in saturation, grounds the positively

charged side of  $C_1$ , which effectively shunts the collector  $Q_3$  and the base of  $Q_1$ , with  $-3.6$  V.

These multiplier circuits are ideally suited to hybrid construction. Minimal difficulty should be encountered with single-polarity outputs, since only two pnp units are required for the clock circuit. These could be two beam-leaded chips. For dual-polarity outputs, with their greater number of both types of devices and more complex circuitry, the approach could involve individual monolithic structures for the pnp and npn groups of devices. It should be possible to achieve a final package that would be smaller than the currently projected size of  $0.4$ -V nuclear cells. ■■

#### References

Cochrun, B. L. and Rochefort, J. S., Report Number 2, NASA Research Grant NGL 22-011-024, Sept. 1, 1968.

#### Acknowledgment

This work was sponsored by NASA-ERC under NASA Grant NGL 22-011-024.

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# Decipher the Gray code.

Convert it into binary or decimal equivalents or use it directly in arithmetic computation.

The Gray code, a modified binary code, is distinguished by the fact that there is a change in only one bit in any transition between consecutive numbers. This characteristic is used to speed operation in shaft encoders and counters and to minimize instantaneous error. Numbers written in Gray code, however, are not as easy to work with or to recognize as those in the more familiar binary or binary-coded decimal (BCD).

The techniques for the conversion of Gray to binary or decimal and vice versa are not widely known. There are the paper and pencil conversion of a number in Gray to a recognizable number in binary or decimal, and the physical conversion using gates and clocks to perform some computation.

In addition, there are techniques for carrying out computations in Gray code without converting to a more familiar form.

## Gray code speeds counting

In a conventional counter, there are many transitions in which most bits are inverted. For example, if binary 127 (01111111) is incremented by one to 128 (10000000), every bit is inverted. Since some binary elements are faster than others, large instantaneous errors can exist. A delay equal to the settling time of the slowest element is used to prevent these errors from having adverse effects. This slows machine operation. The Gray-code restriction to only a one-bit change minimizes this problem.

"Unit distance," "cyclic,"<sup>1</sup> and "reflected" are other designations for this type of code. The most common, though, is the Gray<sup>2</sup> which is illustrated in Fig. 1 with binary and decimal equivalents for comparison.

Note that except for leftmost column in Fig. 1 the number of transitions in a given Gray column is one-half the number that appears in the equivalent binary column.<sup>3</sup> This feature of Gray code permits a given size of shaft encoder to contain twice the information that could be con-

tained in binary.

The relationship between binary and Gray is defined as follows:

$$G_i = B_{i+1} \cdot \overline{B_i} + \overline{B_{i+1}} \cdot B_i = B_{i+1} \oplus B_i \quad (1)$$

where the symbol  $\oplus$  means exclusive OR. The parallel mechanism for this is shown in Fig. 2a, using NAND logic.

Another way of regarding Eq. 1, convenient for paper and pencil conversion, is that each bit immediately to the right of a binary 1 is inverted to obtain the equivalent Gray bit. The serial mechanism of this is shown in Fig. 2b. The serial train must be received MSB (most significant bit) first, and the flip-flop must be in the reset condition prior to receiving the first bit.

## Convert Gray to binary

The relationship between Gray and binary<sup>3</sup> is defined as follows:

$$B_i = B_{i+1} \cdot \overline{G_i} + \overline{B_{i+1}} \cdot G_i = B_{i+1} \oplus G_i \quad (2)$$

This equation implies that not only the Gray bits but also encoded binary bits must be used in the logic. The parallel circuit for this is shown in Fig. 3, using NAND gates. Another way of regarding Eq. 2 is that the binary output changes only at each Gray 1 position.

Figure 3 also illustrates the serial realization of Eq. 2, using NAND gates and a J-K flip-flop. The serial train must be received MSB first, and the flip-flop must be in the reset condition prior to receiving the first bit.

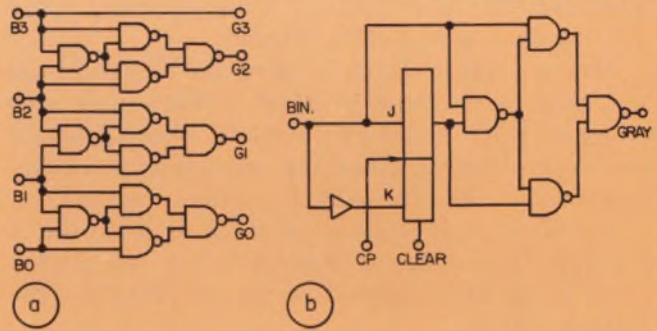
It can be seen that the parallel binary-to-Gray and Gray-to-binary circuits in Fig. 2 and 3 are quite similar. The same circuit configuration and number of gates are used for each encoded bit. The only difference between the circuits is that the binary-to-Gray uses the  $n$ th input bit as an input to the  $(n-1)$ th encode gate, while the Gray to binary used the  $n$ th output bit as the input to the  $(n-1)$ th encode gate. By logically selecting this gate input, a reversible binary-to-Gray or Gray-to-binary converter is possible.

The serial binary-to-Gray and Gray-to-binary<sup>4</sup> circuits shown in Fig. 2 and Fig. 3 are also quite similar. The only difference between the two cir-

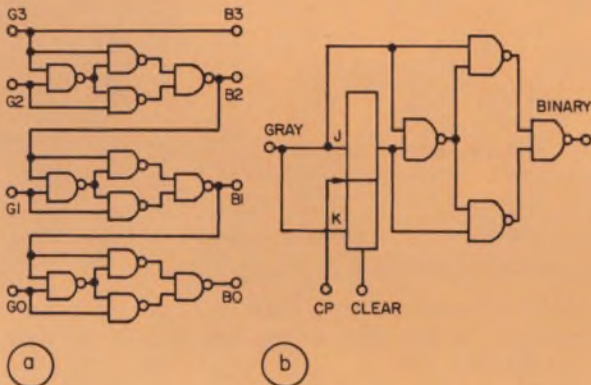
Monty Walker, Digital Manager, Instrumentation Division-Gertsch Operation, The Singer Co., Los Angeles, Calif.

GRAY				DECIMAL	BINARY				DECIMAL
D	C	B	A		8	4	2	1	
0	0	0	0	0	0	0	0	0	0
0	0	0	1	1	0	0	0	1	1
0	0	1	1	2	0	0	1	0	2
0	0	1	0	3	0	0	1	1	3
0	1	1	0	4	0	1	0	0	4
0	1	1	1	5	0	1	0	1	5
0	1	0	0	6	0	1	1	0	6
0	1	0	1	7	0	1	1	1	7
1	1	0	0	8	1	0	0	0	8
1	1	0	1	9	1	0	0	1	9
1	1	1	0	10	1	0	1	0	10
1	1	1	1	11	1	0	1	1	11
1	0	1	0	12	1	1	0	0	12
1	0	1	1	13	1	1	0	1	13
1	0	0	0	14	1	1	1	0	14
1	0	0	1	15	1	1	1	1	15

1. The Gray-code counting sequence differs from binary. Gray with decimal equivalent is on the left; binary is on the right.

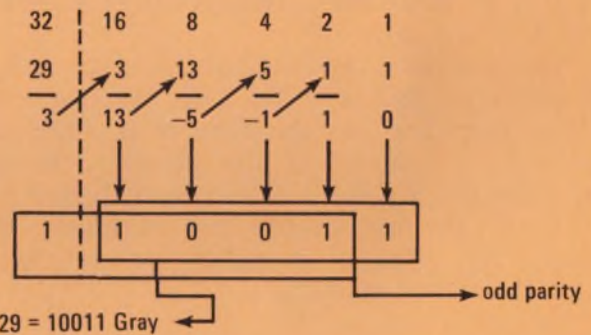


2. Binary can be converted to Gray by using parallel or serial methods. A 4-bit parallel converter is shown in (a) and the serial version in (b).



3. Gray-to-binary conversions can also be parallel (a) or serial (b). The circuit of (b) differs from Fig. 2(b) only in the uninverted K flip-flop input.

Convert decimal 29 to Gray



4. Decimal can be converted to Gray on paper. The least significant bit is 1 because the remainder is 0 and the parity to that point is odd.

circuits is the K input to the flip-flop. In the binary-to-Gray conversion, the K input is equal to the inverse of the J input ( $K = \bar{J}$ ). In the Gray-to-binary conversion, the K input is equal to the J input ( $K = J$ ). If the K input is selected to invert or not invert upon command, the same circuit can be used for either conversion.

### Make Gray-decimal conversions on paper

For pencil and paper methods it is convenient to be able to convert directly from decimal to Gray and Gray to decimal.<sup>5,6</sup>

To convert directly from decimal to Gray, refer to Fig. 4 and proceed as follows:

1. Subtract the decimal number (n) from the power of two next greater than n.
2. Subtract successively the absolute value of the remainders from the descending powers of two.
3. Positive remainders are Gray 1, and negative remainders are Gray 0. A 0 remainder is Gray 1 if the parity (total number of bits) to that point is odd, and Gray 0 if parity to that point is even.
4. The Gray number is the converted bits after the first subtraction.

The reverse conversion, Gray to decimal, is shown in Fig. 5 and in the following rules:

1. Write powers of 2 above the Gray number, starting with 2 above the least significant bit (LSB).
2. Add an even parity bit to the Gray number. This bit is added below decimal 1 to the right of the LSB. A 1 is entered for the parity bit if the Gray number has an odd number of 1s; a 0 is entered if it has an even number of 1s. Thus, the resulting Gray number including the parity bit must have an even number of ones.
3. Place alternating plus and minus signs between the one bits.
4. Sum the series.

Another method is to assign the weight of  $2^{n+1}-1$  to each Gray bit position and then to place alternating plus and minus signs in front of each 1 bit. The sum of the series is the decimal equivalent of the Gray number.

### Gray codes can count

In number sequencing, the straight binary approach suffers from the disadvantage of ambiguity during many transitions.<sup>7</sup> One method of correcting this is to use a Gray-code counter.<sup>8,9</sup>

This can be shown for a 4-bit counter, using J-K flip-flops and NAND gates.

First, a truth table is written showing the sequence to be counted. Next a Karnaugh map is drawn with each Gray state number shown in the square representing the particular combination of variables for that state (see Fig. 6a).

The Karnaugh read-out of the J input to the A flip-flop is shown in Fig. 6b. The numbered squares are the required states; X indicates the optional states.

The input equations can be directly implemented; however, certain savings in hardware can be made by noting the following:

J-A is the EXCLUSIVE OR of B,C, and D; i.e.,  $B \oplus C \oplus D$

K-A is the inverse of J-A; i.e.,  $\overline{B \oplus C \oplus D}$

K-B is A AND the exclusive OR of C and D; i.e.  $A (C \oplus D)$ .

The counter is mechanized, using the simplifications, as shown in 7a. Note that even with these simplifications the counter is quite complex. As the number of bits increases, the ratio of gates per flip-flop also increases. In this type of design the first flip-flop uses more gates than any other. This is in direct contrast to the straight binary counter.

### Simplifications are possible

The Gray-to-decimal conversion (Fig. 5) seems to imply that a Gray counter could be considered similar to a binary counter if a dummy (parity) flip-flop is used prior to the counter proper. This is the trick for simplifying Gray counter design. A new truth table is written using an additional column for parity. Simplifications are made on the Karnaugh map and the input equations written as before.

Figure 7b shows the resulting counter, using J-K flip-flops and NAND gates. The counter consists of flip-flops A, B, C, and D. Flip-flop P (parity) is the dummy. Note that flip-flop D has redundant gating. This is necessary to bring the counter into synchronization if a disallowed state should occur.

The addition of one flip-flop reduces the number of NAND gates in the counter from 21 to 6. The saving is even more pronounced for counters of greater length.

There is one additional feature of the Gray code that should be mentioned. With the exception of the most significant column, each column of the truth table is completely symmetrical. It is therefore possible to convert the basic Gray counter of Fig. 7b into an up/down counter by merely selecting the output of flip-flop P. The circuit for accomplishing this is much simpler than in a straight binary counter.<sup>10</sup>

In the process of converting a Gray number to

#### a) Convert Gray 1011101 to decimal

128	64	32	16	8	4	2	1	
1	0	1	1	1	0	1	1	parity bit

$$1011101 \text{ Gray} = 128 - 32 + 16 - 8 + 2 - 1 = 105$$

This is equivalent to:  $(2^{n+1}-1) - (2^{p+1}-1) + (2^{r+1}-1) - \dots$

or  $2(2^n - 2^p + 2^r - \dots)$  for an even number of terms

or  $2(2^n - 2^p + 2^r - \dots) - 1$  for an odd number of terms

Note that n, p, r... are assigned only to 1 positions

b) or	127	63	31	15	7	3	1
	1	0	1	1	1	0	1

$$1011101 \text{ Gray} = 127 - 31 + 15 - 7 + 1 = 105$$

This is equivalent to:  $\sum_{i=0}^{i=n} 2^i - \sum_{i=0}^{i=p} 2^i + \sum_{i=0}^{i=r} 2^i - \dots$

Where n, p, r... are assigned only to 1 positions and the furthest right bit is  $2^0$

5. Gray-to-decimal conversion is based on powers of two. The parity bit is required to give the Gray number even parity. Alternate methods are given in (a) and (b).

decimal, some bits are added, others subtracted, with 0 bits ignored. This implies that the Gray code is in reality a disguised incomplete trinary code. The code is shown unambiguously in Fig. 8 with a parity bit added.

To decode a Gray number, it is necessary to differentiate between the negative and positive read-out of each 1 bit. A Gray counter with this characteristic is possible, using three states rather than two for each bit. Of course, a minimum of two flip-flops are necessary for three states.

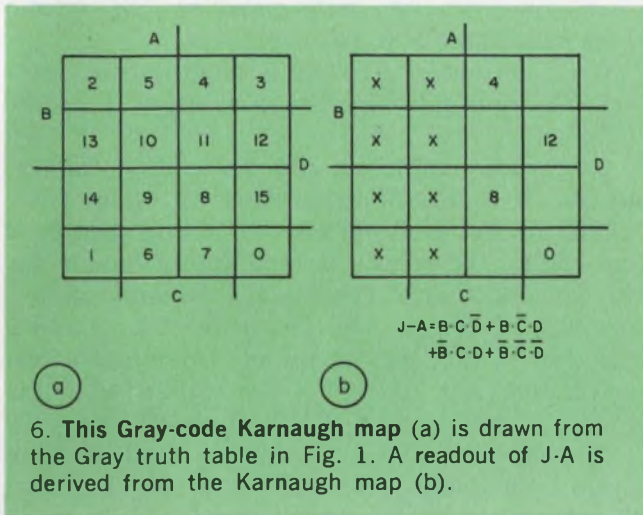
From the table in Fig. 8, it can be seen that the number of 0 entries in each column is the same as the number of combined +1 and -1 entries. Thus, it is obvious that a four state counter with two states decoded as 0 should suffice.

In the actual design, a 2-bit Johnson partition is used. Other partitions are possible but the Johnson appears to be the most efficient. Figure 9 shows the counter with the decoded read-out and truth table.

The counter in Fig. 9 is quite remarkable because it counts in Gray and binary simultaneously. Also, it uses no gates at all. It gives direct parallel conversion between binary and Gray, and it can be used as a Gray to analog converter by applying conventional binary ladder techniques.

The Johnson partition used in this counter is based upon the Johnson or switch-tail counter.





6. This Gray-code Karnaugh map (a) is drawn from the Gray truth table in Fig. 1. A readout of J-A is derived from the Karnaugh map (b).

The Johnson counter is essentially a shift register with the outputs of the last flip-flop inverted and fed back to the first flip-flop. Each pair of flip-flops in Fig. 9 is connected in this fashion.

### Gray code can figure

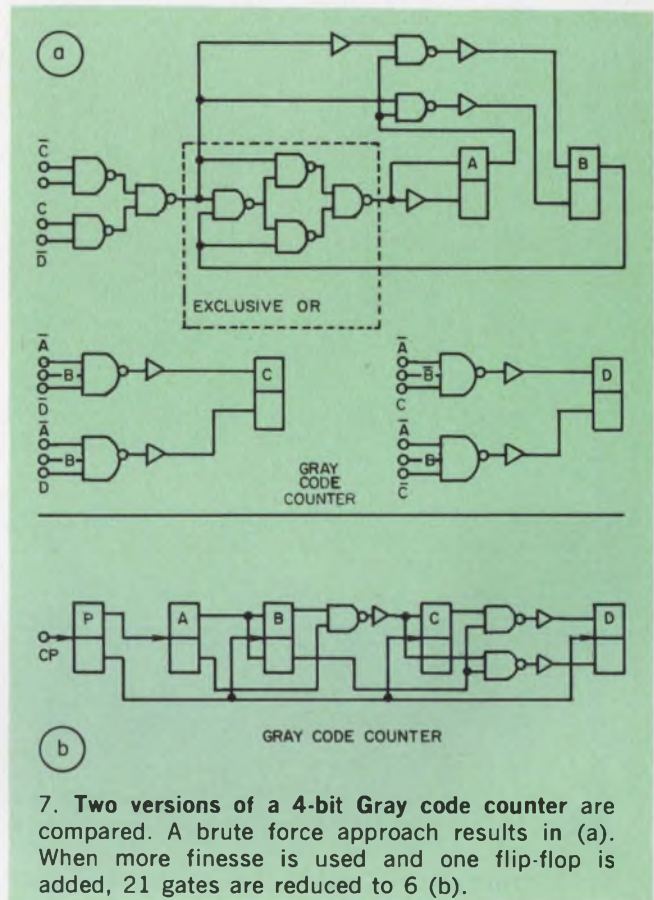
It is a little known fact that arithmetic operations<sup>11</sup> can be performed in Gray code. The amount of hardware necessary to mechanize a Gray arithmetic unit is about three times greater than for binary. There are, however, several advantages in using Gray: It is not necessary to complement the subtrahend in subtracting operations; an automatic parity check is built into the code and can be used as is; and Gray-to-binary conversion is avoided when using encoder inputs.

In decoding a Gray-code number an understood, though not written,  $2^0$  bit is always present, as previously described. This  $2^0$  bit is chosen in order to give even parity to the total Gray number. In Gray arithmetic operations, this "understood" bit is always written and used.

The rules for Gray-code addition are as follows (Fig. 10):

1. Align the two numbers to be added, as in binary.
2. Starting at the right and working left one column at a time, group the 1 bits into pairs. The pairs may be grouped vertically, horizontally, or diagonally. If there is a choice of grouping, vertical takes precedence over diagonal.
3. Write 1, one bit to the left of all vertical and diagonal pairs. These 1s are the equivalent of the carry bits in binary arithmetic.
4. Sum all columns modulo 2 (i.e., for odd number of 1s write 1, for even number of 1s write 0).
5. The modulo 2 sum of these bits will be the desired Gray code sum.

The rules for subtraction are essentially the same as for addition with one exception. Place an imaginary 1 to the left and to the right of the



7. Two versions of a 4-bit Gray code counter are compared. A brute force approach results in (a). When more finesse is used and one flip-flop is added, 21 gates are reduced to 6 (b).

minuend. These 1s will be used for grouping pairs only and will not actually be utilized in the arithmetic (Fig. 10b).

To multiply a Gray number by a power of two ( $2^n$ ), it is only necessary to add  $n$  zeros to the modified Gray number (including the  $2^0$  bit). For example, Gray number 13 is 10111 (including the  $2^0$  bit); to multiply Gray 13 by  $2^3$  merely add three zeros, i.e., 10111000.

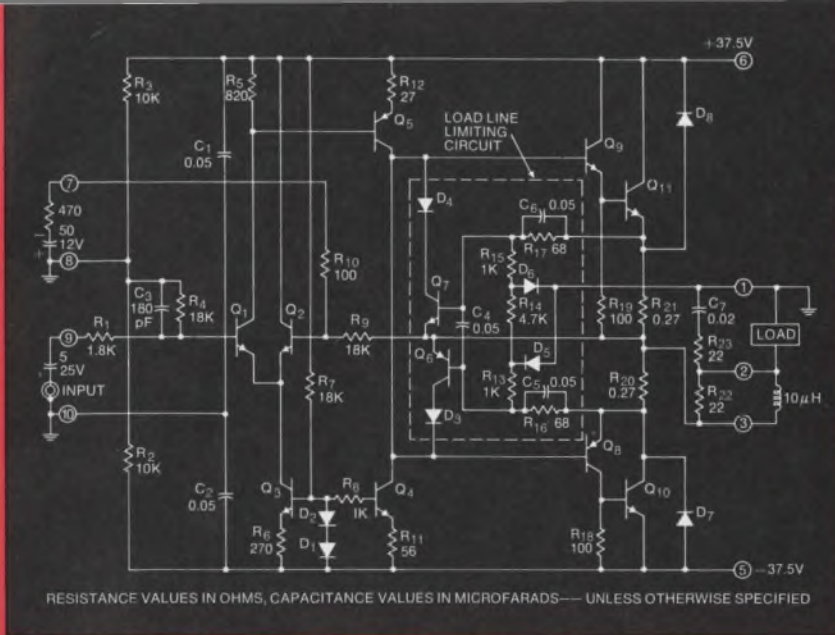
From the above, a procedure for Gray multiplication is possible. The rules are (Fig. 10c)

- (1) Write the multiplicand (A) in modified form and multiply by the most significant 1 of the multiplier (B).

16	8	4	2	1	
D	C	B	A	P	0
0	0	0	0	0	1
0	0	0	1	-1	2
0	0	1	0	-1	3
0	1	-1	0	0	4
0	1	-1	1	-1	5
0	1	0	-1	0	6
0	1	0	0	-1	7
1	-1	0	0	0	8
1	-1	0	1	-1	9
1	-1	1	-1	0	10
1	-1	1	0	-1	11
1	0	-1	0	0	12
1	0	-1	1	-1	13
1	0	0	-1	0	14
1	0	0	0	-1	15

8. Gray code can be considered to be a form of trinary. This truth table illustrates the relationship.





RESISTANCE VALUES IN OHMS, CAPACITANCE VALUES IN MICROFARADS— UNLESS OTHERWISE SPECIFIED

Schematic diagram of unencapsulated TA7625

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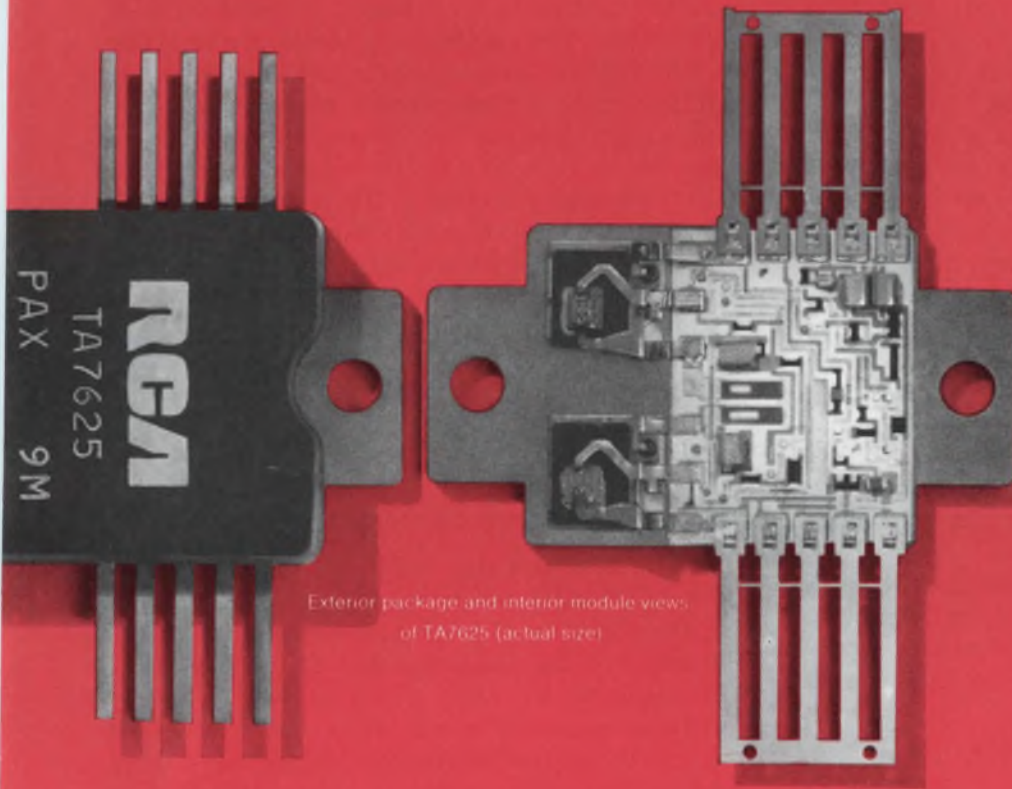
- 7 amperes of peak load current capability
- single or split power supply (30-75 volts)
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For more information on RCA Hybrid Power Circuits, see your local RCA Representative. For technical data, write RCA Electronic Components, Commercial Engineering, Section 1-G2/UC1, Harrison, N. J. 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

INFORMATION RETRIEVAL NUMBER 40



Exterior package and interior module views of TA7625 (actual size)

## For Sales/EE interface: Sell – don't tell.

When designers and salesmen battle each other, they stand to lose not only the war but the customer as well.

The telephone rings in an engineering department and this dialogue follows:

**Salesman:** This is Collins. Why didn't you return my call?

**Engineer:** Sorry, we got busy.

**Salesman:** I'm busy, too, trying to sell your damned product design to a hard-nosed customer!

**Engineer:** Okay, okay! What do you need this time?

**Salesman:** I still need what I asked you for two months ago—that product proposal.

**Engineer:** (Grimaces.) We haven't started on it yet.

**Salesman:** What! My customer is expecting your write-up on the special self-calibration feature—and you haven't even finished the proposal?

**Engineer:** You'll get it as soon as you give us the details on the application you promised us seven weeks ago.

**Salesman:** I got busy, too. Why didn't you remind me?

And so the conversation goes until the salesman or the engineer says something he's sorry for, or hangs up, which leaves the customer hung up as well.

In this particular case, the salesman was at fault. The factory was waiting for the details he promised, and he should have followed up on them. But there's another twist: had he sold the importance of time to his proposal, his support man might have reminded him that he was awaiting details.

Why is there friction between salesmen and engineers? What are the basic antagonisms between them, and what's behind them? Salesmen and factory support men alike complain about being let down, misled, or just plain lied to.

Factory troops claim that the salesmen know nothing about the products they're trying to sell and even less about how they'll be used. They say also that salesmen call in with impossible questions, demand solutions yesterday, and won't take "no" for an answer.

Salesmen, in turn, complain that the factory isn't giving them any support, because they're late on delivery, and they never return a call. Sales types also complain that designers talk like computers instead of people, emphasizing specifications instead of interpreting their meaning to the customer.

Although there's an element of truth in both sides of the story, both protagonists are to blame for the friction between them. On each side, the conflict arises out of a basic misunderstanding that results from a *breakdown in communications*.

For example: Perhaps the salesman hasn't asked the factory the right question. (There's a big difference between "When does that order get out of production?" and "When will it be shipped?" The real question is, "When will my customer have it?") Or the factory hasn't given the salesman useful information. Technical specifications may not communicate much to anyone outside the design team.

### Getting to know your counterpart

One of the keys that will help to open a door to more effective communications is understanding the function of your counterpart. What are the needs of the salesman, and of the engineer? Let's examine the sales function first.

The salesman is much more than an order taker. Not only is he responsible for developing relationships with potential customers so that they will want to own his company's products, but he is also responsible for explaining new products or possible customization that may solve the customer's needs. To do this, he must have a thorough knowledge of the product and how its features relate to the specific application.

To help him carry out this function he needs cooperation—proposals, sales-promotion material and engineering support from the factory. In short, he must be able to do more than recite specifications if he is to gain the confidence of his customers.

If he's done his product homework he won't be guilty of bugging the factory with a lot of ir-

---

**Frank J. Burge**, Marketing Consultant, Ness Consultants Division, Ness Industries, Inc.



commit • examine • summarize • listen

relevant questions. For he must convince the factory that his needs are important. If he treats every problem as a crisis, his inside contact will soon learn to ignore him.

Another function of the salesman is to provide the factory with feedback on product acceptance, changing needs, new product requirements, new markets, and the like. All too often, this function is overlooked, despite the fact that the salesman is in a much better position to supply these inputs than anyone else. He is out in the field, in constant contact with the customer. His observations are vital if the factory is to supply products that coincide with market demand.

The factory engineer, for his part, must be responsive to market needs in terms of product development, and the factory must provide the salesman with adequate product education in terms of customer benefits. The product must be explained to the salesman not in terms of technical specifications, but of what benefits it will bring to the customer's application.

The factory must also provide technical support so that the salesman can respond directly to customer needs. If the salesman has been adequately trained, he will not be asking for proposals that aren't needed.

### Stringing the guidelines

Now that you have a better idea of what your opposite number is responsible for, you should have greater insight into his needs during your next conversation.

Four elementary guidelines in communications will also help to improve understanding. They are: listening; summarization; examination; and commitment.

Since most factory-sales communications come in from the field, we'll take the receiving end, the engineering end, for our analysis. But remember that communication is a two-way street, and the following guidelines apply equally to both parties.

- When the salesman calls make sure you *listen* to him, even though you think he's making an unreasonable request. If you listen carefully enough, you may find his request is not so unreasonable after all, because the idea behind it may be sound. Establish, by example, with each salesman that you are a good listener. He, in turn, will listen more carefully to what you have to say. All too often, we begin to plan our reply even before the other person has finished talking. The only way you'll ever learn what he wants to communicate is with your mouth shut and your mind focused on what he is saying. If the salesman is "windy," let him talk. Later, you can develop a strategy for making him get to the point.

- Then in your own words, *summarize* what

you think you heard. The time to clear up any misunderstanding is while he is still on the phone. If you have misunderstood ask that the data be repeated and listen more attentively. Then, repeat again what you understand has been said. It is the author's belief that at least half of all communications problems between the factory and the field are a direct result of misunderstanding what was communicated.

- Now that you know the problem, *examine* why the customer wants a certain application. During this phase of the communications, you may learn the cause for what seemed like an unreasonable request from the salesman. You may find that what has been requested will not solve the customer's problem. The salesman may have suggested some options that are really not required, or you may find certain important measurements cannot be made unless the product is modified. Since the factory technical troops usually know much more about the product than the salesman, they are in the best position to evaluate and make suggestions on hardware configurations. On the other hand, the salesman is more familiar with his customer's needs. In any case, examine the application carefully.

A word of caution: The salesman may go on the defensive when questioned about the customer's application. If he does, it's because he doesn't know all the answers and feels threatened. Don't pin the poor devil to the wall. Simply explain what data you need and why. He will then realize that you are trying to help him close the sale, and will be more cooperative in finding out what you want to know.

Finally, make certain you both understand what investment the customer is prepared to make. A customer with \$18,000 cannot afford a \$60,000 solution to his problem, even if it is creative.

- Now, make a *commitment* to the salesman—one you can keep. You know how long it will take to get an answer, and how much time is required to write a proposal. Don't be pressured into making unrealistic promises. Normally, the salesman will allow some margin for slippage, but if you always let him down, he'll start demanding immediate answers even when he doesn't need them for a month. He wants to protect his relationship with his customer.

### Sell it—don't tell it!

The important thing to remember is to sell the other person on what you're saying instead of just giving orders. The constant frictions generated by broken promises, delayed reports, and misinformation could, more often than not, be replaced by impressive results of cooperation based on selling instead of telling. ■■

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Actual Size



# TRW®

INFORMATION RETRIEVAL NUMBER 41

## Improved sawtooth generator has grounded reference point

Problems associated with sawtooth generators using operational amplifiers stem from difficulties with resetting. An improved circuit eliminates this problem through the use of a ground-referenced capacitor yet allows high linearity of the classical integrator.

The classical integrator configuration is shown in Fig. 1. The approach has the disadvantage that the discharge switch,  $S_1$ , is difficult to implement since the capacitor is floating between input and output of the amplifier. Switching in this configuration may reduce linearity and make it quite difficult electrically to change the capacitor if a new frequency range should be desired.

These difficulties are avoided by the design in Fig. 2, which has a ground-referenced capacitor and reset switch. This circuit can be reset by standard 5-V IC logic.

If the circuit has been reset with a pulse long enough to completely discharge the capacitor,  $V_c$  will be zero. The reference voltage  $E$  (0 to  $-3$  V) produces an output voltage,  $-R_2/R_3 E$ , which divides across resistors  $R_1$ ,  $R_4$ , and  $R_5$  and causes the capacitor to charge. The charging would be asymptotic except that  $V_c$  adds to the output with a gain of 2 and is fed back by a 0.5 voltage divider with  $R_5$  properly adjusted. This causes the capacitor to charge linearly. In effect, the drop from the capacitor to the output is fixed, and this holds the charging current constant between reset pulses.

$$E_o(s) = \frac{R_2 + R_3}{R_3} V_c(s) - \frac{R_2}{R_3} \frac{E}{s}, \text{ neglecting } R_6$$

$$\text{where } V_c(s) = \frac{R'_4 E_o(s)}{R'_1 R'_4 C s + R'_1 + R'_4}$$

$$R'_1 = R_1 + a R_5, \quad R'_4 = R_4 + (1-a) R_5$$

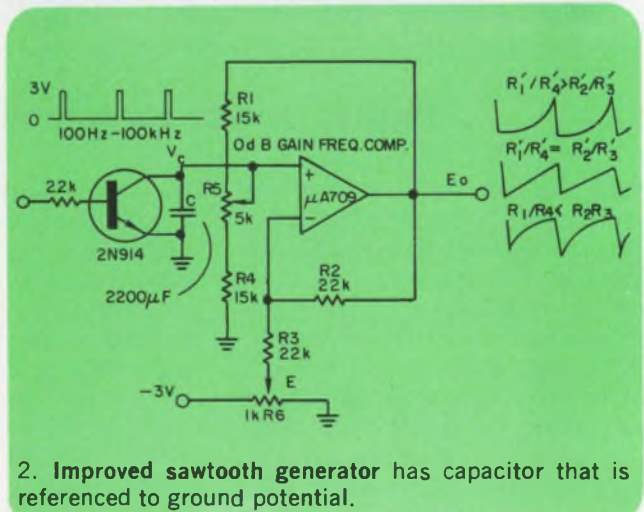
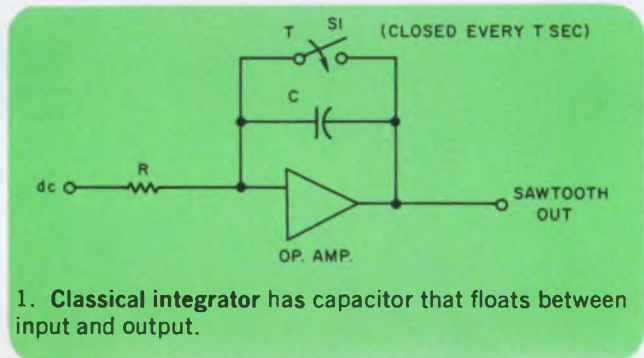
$$\text{Then: } E_o(s) = \frac{-R'_1 R_2 R'_4 E C s - R_2 E R'_1 - R_2 R'_4 E}{s \left( s + \frac{R'_1 R_3 - R_2 R'_4}{R'_1 R_3 R'_4 C} \right) R'_1 R_3 R'_4 C}$$

$$\text{If } R'_1 R_3 - R_2 R'_4 = 0 \text{ or } R'_1/R'_4 = R_2/R_3$$

$$E_o(s) = \frac{-R_2 E}{R_3 s} - \frac{R_2 (R'_1 + R'_4) E}{R'_1 R_3 R'_4 C s^2}$$

$$E_o(t) = \frac{-R_2 E}{R_3} - \frac{R_2 (R'_1 + R'_4) (E) t}{R'_1 R_3 R'_4 C}, \quad 0 < t < T$$

Thus if  $R_5$  is adjusted to give  $R'_1/R'_4 = R_2/R_3$ , a





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		B P	B R	H P	L P									
.001 Hz - 99.9 kHz	3320		X	X		Batt. Op.	2%	24	0.5 mv	80 db	5v/50ma	dc - 1 MHz	24/11 \$ 725	
.001 Hz - 99.9 kHz	3322	X	X	X	X	Batt. Op.	2%	24/48	0.5 mv	80 db	5v/50ma	dc - 1 MHz	34/16 \$1395	
.001 Hz - 99.9 kHz	3340			X	X	Batt. Op.	2%	48	0.5 mv	80 db	5v/50ma	dc - 1 MHz	27/12 \$1075	
.001 Hz - 99.9 kHz	3342	X	X	X	X	Batt. Op.	2%	48/96	0.5 mv	80 db	5v/50ma	dc - 1 MHz	40/18 \$2075	
.01 Hz - 99.9 kHz	3321			X	X	Batt. Op.	2%	24	0.5 mv	80 db	5v/50ma	dc - 1 MHz	24/11 \$ 635	
.01 Hz - 99.9 kHz	3323	X	X	X	X	Batt. Op.	2%	24/48	0.5 mv	80 db	5v/50ma	dc - 1 MHz	34/16 \$1225	
.01 Hz - 99.9 kHz	3341			X	X	Batt. Op.	2%	48	0.5 mv	80 db	5v/50ma	dc - 1 MHz	27/12 \$ 995	
.01 Hz - 99.9 kHz	3343	X	X	X	X	Batt. Op.	2%	48/96	0.5 mv	80 db	5v/50ma	dc - 1 MHz	40/18 \$1825	
.02 Hz - 2 kHz	3308		X				5%	24	0.1 mv	80 db	10v/1ma		35/16 \$ 595	
.02 Hz - 20 kHz	3750	X	X	X	X	Batt. Op.	5%	6, 12, 18, 24	0.2 mv	80 db	10v/2ma	dc - 1 MHz	26/12 \$ 850	
.2 Hz - 20 kHz	3700		X			Batt. Op.	5%	24	0.2 mv	80 db	5v/1ma		19/9 \$ 550	
2 Hz - 200 kHz	3550	X	X	X	X		5%	24	0.2 mv	60 db	5v/10ma	.2 Hz - 3 MHz	15/7 \$ 525	
10 Hz - 1 MHz	3100		X				5%	24	0.1 mv	80 db	3v/10ma		17/8 \$ 590	
10 Hz - 3 MHz	3103		X				5%	24	0.15 mv	80 db	3v/10ma		17/8 \$ 640	
20 Hz - 200 kHz	3500		X				10%	24	0.2 mv	60 db	5v/10ma		14/7 \$ 395	
20 Hz - 2 MHz	3200			X	X		5%	24	0.1 mv	80 db	3v/10ma	dc - 10 MHz	16/8 \$ 450	
20 Hz - 2 MHz	3202	X	X	X	X		5%	24/48	0.1 mv	80 db	3v/10ma	dc - 10 MHz	22/10 \$ 795	

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perfect linear ramp is generated. If  $R'_1/R'_4 < R_2/R_3$  or  $R_1/R_4 > R_2/R_3$  a negative or positive exponential is generated respectively. Adjusting  $R_6$  or  $E$  controls the output amplitude.

If the feedback is greater than 1, the capacitor voltage  $V_c$  adds increasingly to the charging rate, and the output takes off with a positive exponential. When the feedback is less than 1,  $V_c$  adds decreasingly to the charging rate, and the output is a negative exponential.

Changing the polarity of  $E$  changes the polarity of the ramp, but with the circuit shown only a  $-1$ -V peak-to-peak ramp can be generated. The positive ramp amplitude is limited only by the operational amplifier signal swing. If a more negative ramp is desired it is only necessary to keep the transistor base at  $+3$ V in the ON state and negative with respect to the ramp in the OFF state. Note that if the unity feedback condition exists, the amplifier theoretically exhibits an infinite input impedance.

The actual generator output is a dc level summed with the sawtooth. Frequency response of the amplifier limits the high-frequency output to 100 kHz, but a good sawtooth can be taken directly from the capacitor up to several megahertz. A larger capacitor will reduce the low frequency limit, but a longer reset pulse is then required to completely discharge the capacitor. It is suggested that the transistor be connected directly across the capacitor with a single common ground wire to reduce ground transients during the discharge cycle. Although the circuit requires the setting of a potentiometer, the ground-referenced capacitor more than compensates for this disadvantage. All parts used are standard 5% components, and the uA709 was operated with zero dB compensation from  $\pm 15$ -V supplies.

*Robin J. Larson and Gerald A. Dunn, Design Engineers, Department of Defense, Laurel, Md.*  
**VOTE FOR 311**

## Wiring modification improves voltage variable delay circuit

Triggering of an emitter-coupled monostable multivibrator with voltage-variable output pulse duration can be made more reliable by a simple change in the triggering circuit.

In the figure,  $C_1$  and  $R_d$  comprise a differentiating circuit that shapes the triggering pulses. In the absence of triggering pulses  $Q_1$  is OFF and  $Q_2$  is saturated. When a positive pulse of sufficiently large amplitude is applied to the base of  $Q_1$  the circuit goes into a quasi-stable state in which  $Q_1$  is active and  $Q_2$  is OFF. The duration of this quasi-stable state, designated  $T$ , varies linearly with the bias voltage  $V$ . Diode  $D$  prevents the negative pulses from prematurely terminating the output pulses by turning  $Q_1$  OFF.

When  $R_d$  is returned to ground in the conventional manner, the average level of  $V_c$  is zero volts. The peak value of the triggering pulse appearing at the base of  $Q_1$  is:

$$V_{p1} = V + (V_t - V_d - V) [R_b / (R_b + R_t)]$$

where

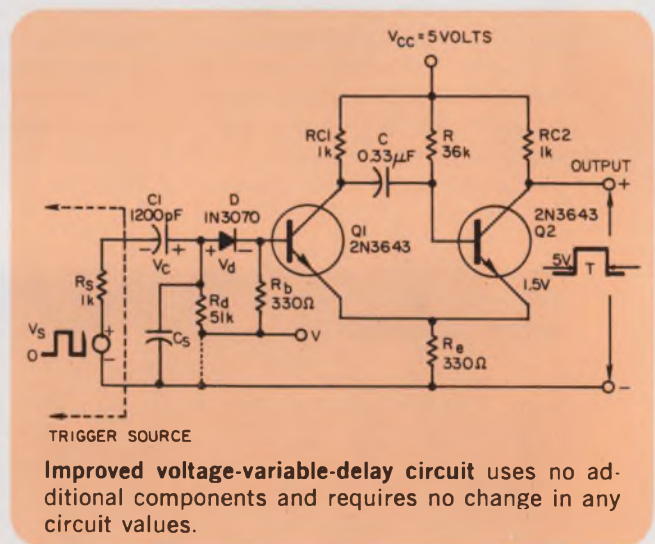
$$V_t = [R_d / (R_d + R_s)] V_s$$

$$R_t = R_s R_d / (R_s + R_d)$$

$V_d$  = forward voltage drop of the diode.

The triggering circuit may be improved by returning  $R_d$  to  $V$  as shown. Now the average level of  $V_c$  is  $V$ . The peak value of the triggering pulse appearing at the base of  $Q_1$  is now:

$$V_{p2} = V + (V_t - V_d) [R_b / (R_b + R_t)]$$



Note that:

$$V_{p2} = V_{p1} + V [R_b / (R_b + R_t)]$$

This assumes that  $C_1$  is sufficiently large so that the attenuating effect of  $C_s$  (stray capacitance) is negligible.

The modified circuit provides a larger triggering pulse at the base of  $Q_1$  with no change in the total number or value of components. This results in more reliable triggering by providing a margin of safety against variations in either the



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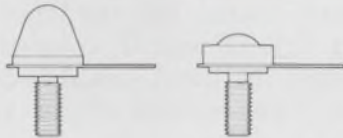
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Design these powerful infrared sources into your next card or tape readers, intrusion alarms, or calibration units. Anything that uses silicon detectors wants our ME 2 and ME 5 GaAs infrared emitters. They give you a 2500-mil<sup>2</sup> emitting area with either lambertian (ME 2) or collimated (ME 5) radiation patterns. Guaranteed minimum output: 10 milliwatts at 1 amp. (Less expensive ME 2A and 5A versions radiate 7.5 mW.)

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Forward voltage: 1.3 V typ ( $I_f = 1.0$  A)

Rise time: 10 nanoseconds

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Bright red solid state lights are here. And affordable!

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750 ft-lamberts @ 20ma; thousands ready to be shipped from your Monsanto distributor at \$1.50 each.

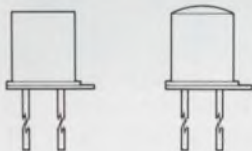
Finally, a price that lets you justify GaAsLITEs for high volume applications. MV 50s can replace miniature and sub-miniature lamps down to the T3/4 size. Their solid-state reliability makes them ideal for indicator lights in computer systems, data processing equipment, communications systems, and as diagnostic lights on pc boards. And just think what you could do with them in large arrays and in optical logic systems. . . .

Size: 0.10" diameter

Output: 750 ft-lamberts (6500 Å) @ 1.6V, 20 ma

Switching time: 1 nanosecond

Price: 1-9, \$2.30; 1,000, \$1.50



### The superfast detector

Our 500-picosecond silicon PIN photodiodes, MD 1 and MD 2, complement our light-emitting diodes.

High speed optical switching has all kinds of sexy uses today: Laser detecting, for instance, and optical encoding. Even simple burglar alarms can use it.

Their half-a-nanosecond response cycle makes them perfect mates for Monsanto GaAsLITEs. And they work with other sources, too. Packaged in standard transistor cans, they're easy to handle and mount. Available with either flat lens or built-in optics.

Rise time: .5 nanoseconds ( $V_R = 20V$ ;  $R_L = 50\Omega$ )

Breakdown voltage: 50V ( $I_R = 10\mu A$ )

Sensitivity: MD 1 1.5 µA/mW/cm<sup>2</sup> (min) (.9 microns,  $V_R = 20$  volts)

MD 2 3.0 µA/mW cm<sup>2</sup> (min) (.9 microns,  $V_R = 20$  volts)

Price: 1-9, \$6.25; 1,000, \$3.40

## Monsanto

All available through Schweber, Semiconductor Specialists, Kierulff or K-tronics. For additional technical information and world-wide distributor list, write Monsanto Electronic Special Products, 10131 Bubb Road, Cupertino, California 95014. (408) 257-2140

voltage of the triggering source or the triggering level of the multivibrator.

The multivibrator shown can be reliably triggered with values of  $V_s$  greater than or equal to 3.9 volts for all values of  $V$  between 1.10 and 1.80 volts. As  $V$  is varied over this range, the

output pulse duration varies from 1.10 to 8.35 ms. The recovery time of the circuit is approximately 1.7 ms.

*A. J. Duelm, Research Engineer, Southwest Research Institute, San Antonio, Tex.*

VOTE FOR 312

## Find the absolute value of bipolar pulses

Many applications require that bipolar pulses be counted, without regard to their polarity. A circuit that modifies such pulses so that their absolute number can be determined is shown in the illustration.

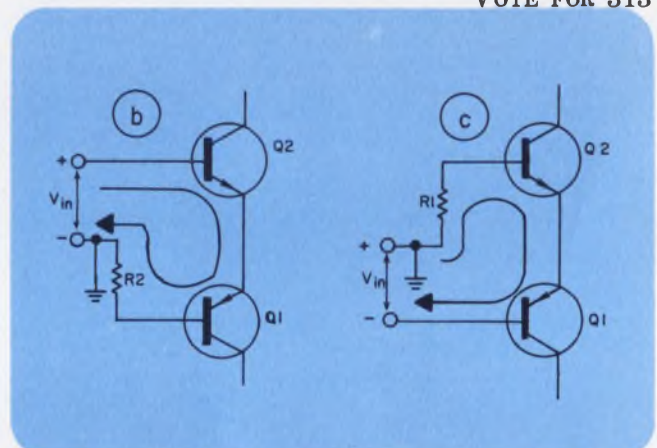
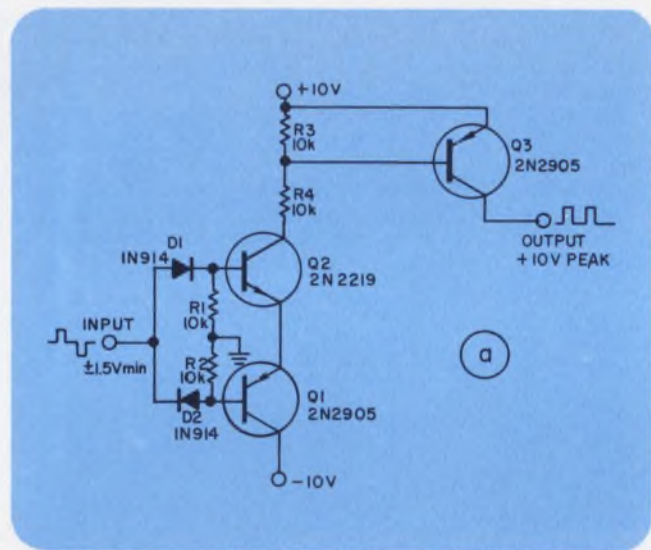
If the input signal is positive,  $D_1$  conducts.  $D_2$  is reverse-biased, and the input current path is

shown in (b).  $Q_1$  and  $Q_2$  also conduct, biasing  $Q_3$ . This makes the output of  $Q_3$  positive.

If the input signal is negative,  $D_2$  conducts,  $D_1$  is reverse biased, and the input current path is that of (c).  $Q_1$  and  $Q_2$  conduct in the same way as when the input signal is positive, again biasing  $Q_3$ . The output of  $Q_3$  is thus again positive.

*R. L. Billon, Tech. Manager, ALP UNION TECHNIQUE, Grenoble, France.*

VOTE FOR 313



**Bipolar signal is converted to its absolute value with only three transistors (a). Current flow through  $Q_1$  and  $Q_2$  is the same for both positive (b) and negative (c) inputs.**

## Use an audible alarm to indicate a blown fuse

Much time is often wasted before a blown fuse is detected and replaced. This is particularly true in prototype debugging, since the engineer may feel that his unproved design, rather than an accidentally blown fuse, is causing the problem. In unattended equipment such as component life-test racks and process-control systems, a positive means of quickly alerting personnel to a blown fuse would be of great value. Fuse holders with neon indicators, though useful, do not adequately

satisfy this need, since their signal may not be observed when it would be of greatest value.

An audible alarm wired across all system fuses, as shown in the figure, will be activated whenever a fuse blows. The alarm can be one of the small panel-mounting piezoelectric units now available through electronic distributors, or an inexpensive doorbell buzzer. Diodes are required for isolation when more than one fuse is being monitored, but they also permit the use of alarms

# ZENERS



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silicon chips in zeners, temperature-compensated zeners, scr's, rectifiers, core drivers, general purpose diodes and tunnel diodes.

that require dc for proper operation.

Fuse holders having built-in neon indicators can be used in this circuit, to show which fuse needs replacement.

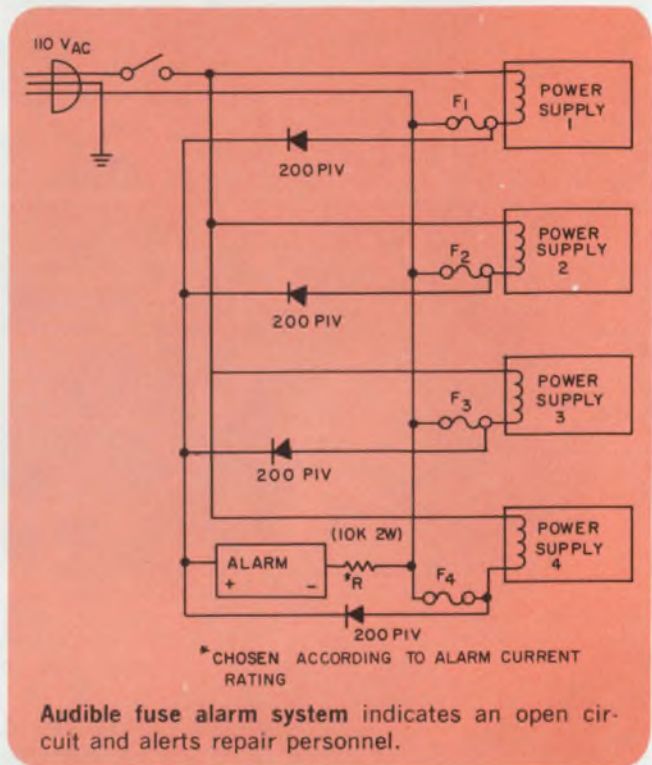
*Thomas E. Skopal, Design Engineer, Acopian Corp., Easton, Pa.*

VOTE FOR 314

# VOTE

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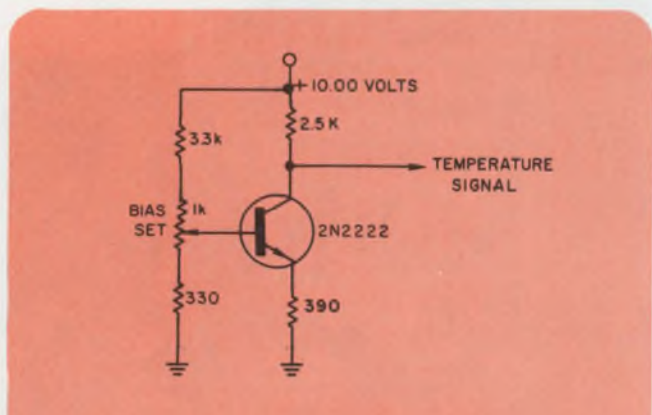
## Linear temperature sensor uses only a single transistor

Variation in the base-emitter voltage of a transistor can be used to sense temperature and, through transistor action, provide a high level output. Linearity is approximately  $\pm 1\%$  over a temperature range of  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ .

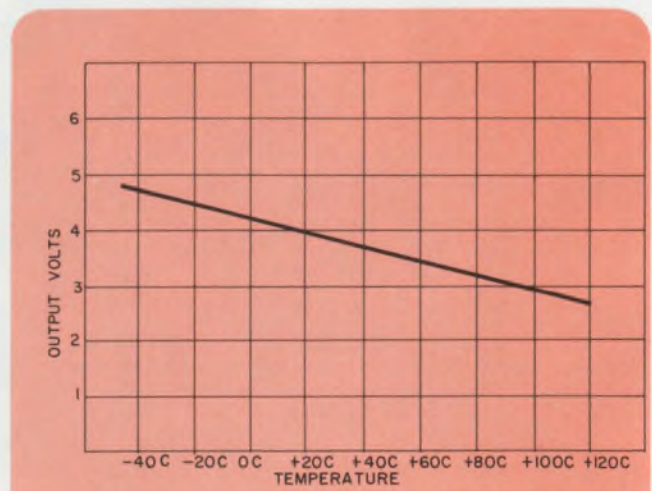
The transistor biased as a dc amplifier is shown in Fig. 1. A high beta silicon transistor (2N2222) is used with a low-resistance base bias

network. The 2N2222 was chosen because it has a low thermal resistance from junction to case. The case is connected to the collector, thus providing fast response to temperature change.

Output scale factor is controlled by the ratio



1. Transistor temperature sensor uses transistor with collector connected to case for fast response.



2. Temperature calibration curve is within  $\pm 1\%$  between  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ .

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There's another benefit unique to these instruments that's not immediately apparent. Converter and counter ranges actually overlap so you derive the final answer by merely adding the converter dial reading and counter reading. There's no need to remember to subtract readings over any part of the frequency range.

Even before the latest improvements, no other counter could match the

usefulness and flexibility of the 5245 Series. We now offer fourteen different plug-ins to help you make all the measurements you need. These include six frequency converters; transfer oscillator to 18 GHz; two time interval units; two prescalers; video amplifier; DVM; and preset unit.

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The price of the new 5254C Heterodyne Converter is \$825. The

5248L counter is \$2900. You won't find a more economical single-package solution to your dc to 3 GHz counter needs. Your local HP field office has all the details. Give them a call. Or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.



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of emitter to collector resistor. Bias point is controlled by the bias-set potentiometer. The output scale factor is very constant from transistor to transistor; however, the bias point varies considerably between transistors. For this reason, the bias-set potentiometer must be adjusted for each unit at a standard temperature.

Fig. 2 shows the calibration curve.

James M. Loe, Engineer Specialist, Philco-Ford Corp., Blue Bell, Pa.

VOTE FOR 315

## Varactor diode is the key to a simple frequency divider

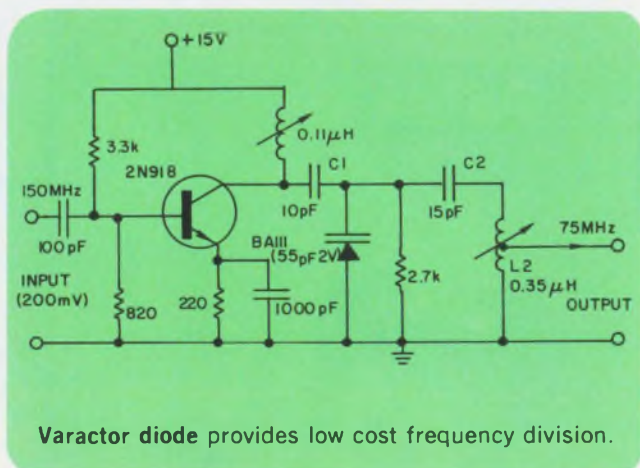
In a parametric amplifier the pump frequency is twice the frequency of the signal to be amplified. Increasing the gain of the amplifier will eventually turn it into an oscillator producing an output signal exactly half the frequency of the pump frequency. This effect can be exploited to create a frequency divider.

As shown in the figure,  $L_1C_1$  resonates at 150 MHz and is coupled to  $L_2C_2$ , which resonates at 75 MHz due to varactor BA111. In this circuit the divider operates over a 4% bandwidth. Using a high Q inductor for  $L_2$  increases the bandwidth. The output level is relatively insensitive to input level changes up to 10 dB.

This circuit costs a tenth the price of an IC designed to operate at these frequencies. This same technique can be extended to higher frequencies.

M. Stevens, D. Steward, Design Engineers, Cossor Electronics Ltd., Harlow, Essex, England.

VOTE FOR 316



Varactor diode provides low cost frequency division.

## Go/no go circuit gives visual indication of RTL logic level

Trouble shooting a board containing many digital ICs is tedious when using a scope and probe. A go/no go visual indication greatly reduces the effort involved.

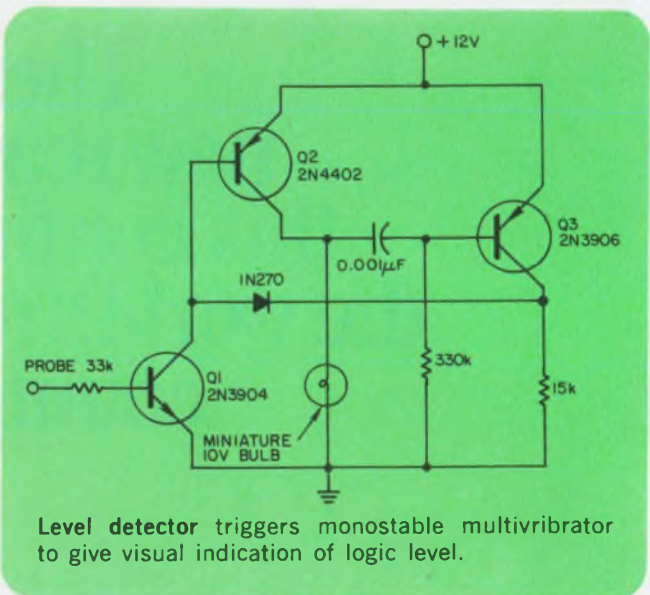
The simple probe shown in the figure lights up when a pulse or dc level above 0.7 V is found, and minimizes eye and head movements. The input impedance is high enough to protect most digital circuits from loading.

Level detector  $Q_1$  has the same threshold (0.7 V) as RTL logic. If this level is exceeded,  $Q_1$  turns on, triggering a 1-ms monostable multivibrator ( $Q_2$  and  $Q_3$ ). This turns on the lamp (L) momentarily. Steady inputs above 0.7 V hold L on.

This circuit is easily packaged in a 3/8-inch-diameter plastic tube with the probe tip epoxied at one end. A light emitting diode (example: HP 5082-4400) coupled with a 470Ω series resistor may be substituted for the lamp if faster response is desired.

J. M. Firth, Design Engineer, National Research Council of Canada, Ottawa, Canada.

VOTE FOR 317



Level detector triggers monostable multivibrator to give visual indication of logic level.

## Make tables with a time-shared computer

Every engineer has his own table requirements, and most engineers have access to time-shared computers, but how many engineers think of using these computers to make tables for their own special needs?

Here are a few examples that illustrate how



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INFORMATION RETRIEVAL NUMBER 46

```

NSE-1      8:14  52 FRI 08/29/69
100 PRINT "          VOLTS IN
110 PRINT" DBRN  600 OHMS  DBM          DBRN  600 OHMS  DBM"
115 PRINT
120:      ###  ##.#####  ###  ###  ##.#####  ###
130 LET D=SQR(6E-10)
140 FOR A=0 TO 45
150 LET C=A-90
160 LET E=C+46
170 LET F=A+46
180 LET B=(EXP((A*LOG(10))/20))*D
190 LET G=(EXP((F*LOG(10))/20))*D
200 PRINT USING 120,A;B;C;F;G;E
210 NEXT A
220 END
    
```

(a)

```

NSE-1      8:08  52 FRI 08/29/69
          VOLTS IN          VOLTS IN
          600 OHMS         600 OHMS
DBRN      DBM          DBRN      DBM
0         -90         46        -44
1         -89         47        -43
2         -88         48        -42
3         -87         49        -41
4         -86         50        -40
5         -85         51        -39
    
```

(b)

1. Routine generates a chart showing the relationship between dB of reference noise (DBRN), voltage across 600 ohms, and dBms. The program is listed in (a). The chart is divided into two parts that are printed out side by side (b). The first column entries go to DBRN=45, and the second to 91. Only the first five entries in each column are shown here.

```

RTRF
100 PRINT "THIS TABLE IS BASED ON PURELY RESISTIVE IMPEDANCES."
110 PRINT
120 PRINT
130 PRINT"          Z(1):Z(2)          RETURN LOSS          REFLECTION LOSS"
140 PRINT
150:      ###.##:1          ###.##DB          ###.##DB
160 FOR L=1.25 TO 5 STEP .25
170 GOSUB 240
180 NEXT L
190 FOR M=6 TO 30
200 LET L=M
210 GOSUB 240
220 NEXT M
230 STOP
240 LET A=L+1
250 LET B=A^2
260 LET C=L-1
270 LET D=4*L
280 LET E=20*((LOG(A/C))/LOG(10))
290 LET F=10*((LOG(B/D))/LOG(10))
300 PRINT USING 150,L;E;F
310 RETURN
320 END
    
```

(a)

```

RTRF      7:59  52 FRI 08/29/69
THIS TABLE IS BASED ON PURELY RESISTIVE IMPEDANCES.
          Z(1):Z(2)          RETURN LOSS          REFLECTION LOSS
1.25:1          19.88DB          .85DB
1.50:1          13.98DB          .18DB
1.75:1          11.29DB          .34DB
2.00:1          9.54DB          .51DB
2.25:1          8.30DB          .70DB
    
```

(b)

2. Return reflection loss (RTRF) is programmed in (a) and tabulated in (b). The table is set up for impedance ratios to 30:1. Only the first five entries are listed. Lines 160 and 190 of the program make the spacing between impedance ratios 0.25 from 1.25 to 5.00 and 1.00 from 5.00 to 30.00.

easy it is to make tables that are useful in telephone transmission. The programs are in BASIC and employ a useful addition to the language—image statements. These are offered in one form or another by most time-sharing services.

The tables are arranged to have a slightly wider than usual left-hand margin so that nothing will be hidden by binding. The equations are available from many sources. Bell System Engineering Practices or ITT's "Reference Data For Radio Engineers" are two examples.

Bill E. Johnson, Design Engineer, Pacific N.W. Bell Telephone Co., Portland, Ore.

VOTE FOR 318

## Two-transistor circuit blocks wrong voltage polarity/level

Many circuits can be destroyed if improper voltage or polarity is applied. A simple yet effective technique, using only two transistors, avoids this possibility.

The circuit shown in the figure prevents circuit burnout caused by the accidental application of incorrect supply voltage or polarity. This is accomplished without shorting the supply as in SCR and zener protectors. Under normal supply voltage, Q<sub>1</sub> is ON and Q<sub>2</sub> is OFF provided that:

$$R_1 \leq \beta_1 [V - (V_D + V_{BE1})] / I_{L(max)}$$

$$I \gg I_{L(max)} / \beta_1 \beta_2$$

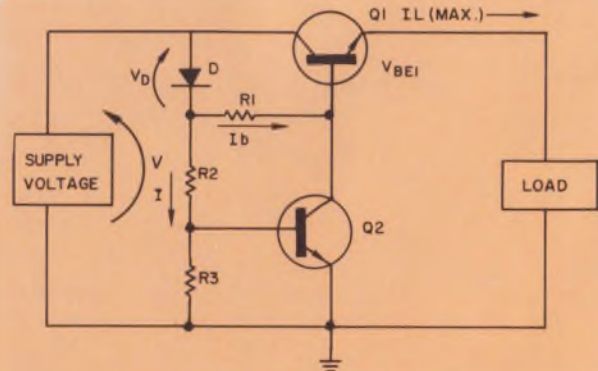
$$R_3 \leq V_{BE2} / I$$

$$R_2 = (V - V_D) / I - R_3$$

In case the supply voltage exceeds V, Q<sub>2</sub> turns ON, diverting the base current I<sub>b</sub> to ground thus turning Q<sub>1</sub> OFF. In the case of wrong polarity, Q<sub>1</sub> never turns on due to the absence of base current I<sub>b</sub> which is blocked by diode D.

Arthur W. Vemis, Development Engineer, Aerospace Research Inc., Brighton, Mass.

VOTE FOR 319



Voltage watchdog prevents wrong level or polarity from being applied to load.



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INFORMATION RETRIEVAL NUMBER 47

# ELECTRONIC DESIGN

## semiannual

### index of articles

The articles in the various sections of this index are grouped under key words that indicate their general topics. Articles are listed more than once if they have to do with more than one general topic.

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- ART Technical Article
- IFD Idea for Design
- PF Product Feature
- SR Special Report

#### Subject Listing

- Avionics
- Circuits & Circuit Theory
- Communications
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- Computers & Data Processing
- Consumer Electronics
- Displays
- General Industry
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- Management
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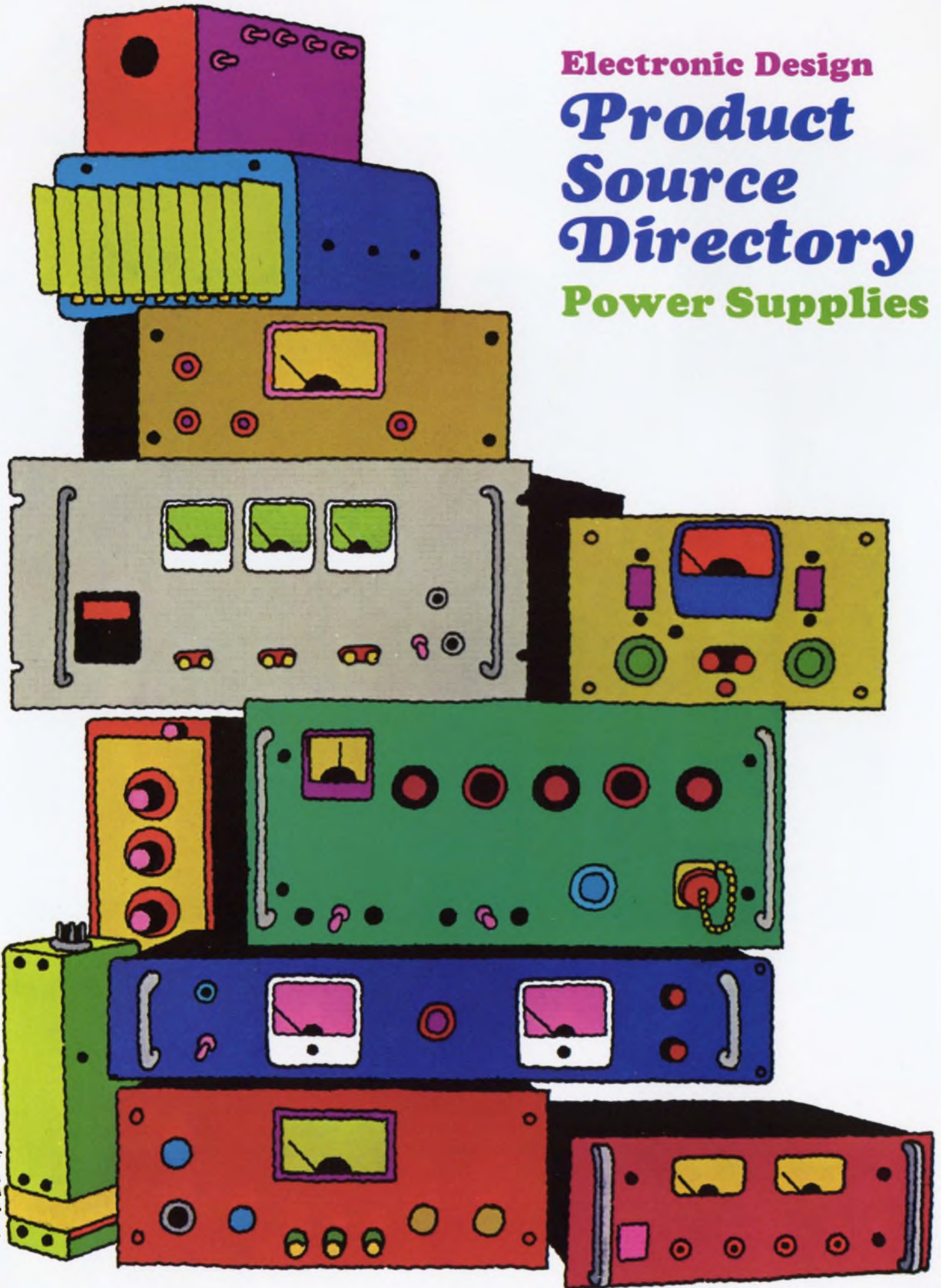
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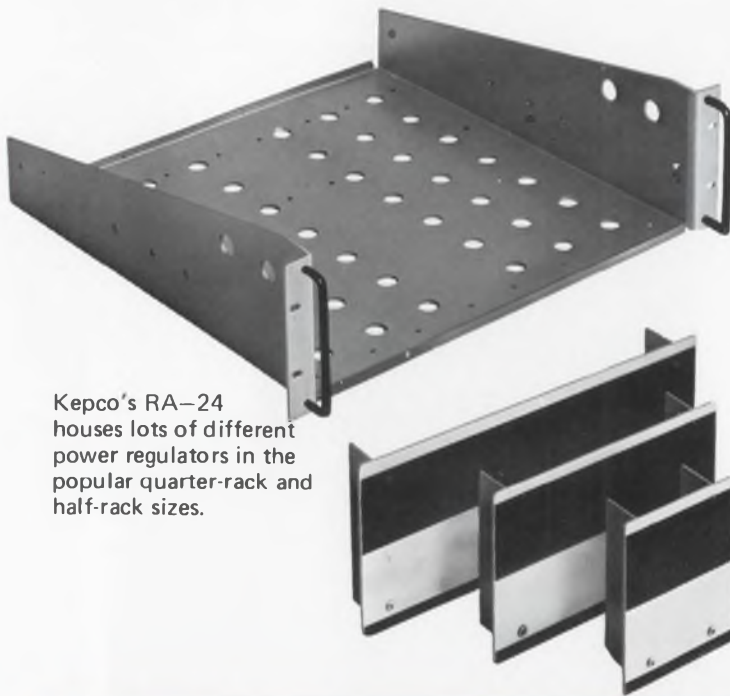


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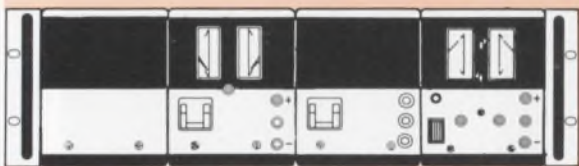


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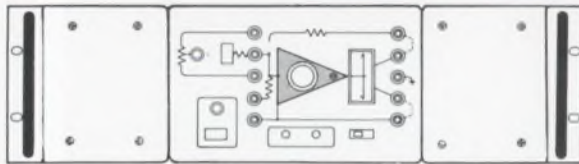
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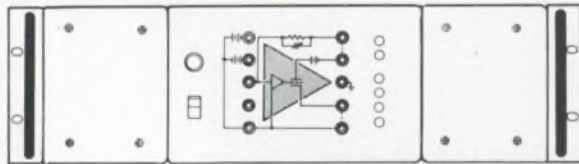
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# Product Source Directory

## DC Power Supplies

Compiled and edited by **Greg Guercio, Directory Manager**

Specifications for approximately 3500 power supplies made by 68 manufacturers are presented in convenient tabular form to assist you with your requirements. In addition, technical articles bring you up to date on power-supply technology and the factors to consider when selecting power supplies.

For convenience power supplies have been divided into five categories.

- High Current
- Constant Current
- High Voltage
- Laboratory type
- Modular type

See the how-to-use section on page D4 for a detailed description of each type. Obtain complete manufacturers' data by using the reader service numbers in the Master Cross Index on page D6.

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# How to use the tables

Each table covers a particular type of power supply and lists pertinent technical specifications. Notes describing additional features for all power supplies are located at the end of each section.

Power supplies have been divided into five basic categories for ease of use. There are two tables on each page.

- **High Current**—Includes those supplies having maximum output currents greater than 3 A and cover output voltages up to 1500 V. These are sorted by maximum voltage in the column color-coded white.

- **Constant Current**—Represents those supplies that are current regulated. They are sorted by maximum current in the column color-coded white.

- **High Voltage**—Includes those supplies having output voltages of 1500 V and up. They are sorted by maximum voltage in the column color-coded white.

- **Laboratory Type**—Power supplies in this category have maximum output currents of less than 3 A and cover output voltages up to 1500 V. They are sorted by maximum voltage in the column color-coded white.

- **Modular Type**—These supplies cover the voltage range from 0 V to 50 V. They all have inputs of 95 to 130 Vac. Modular types are sorted by maximum voltage in the column color-coded white.

The following abbreviations apply to all power-supply listings:

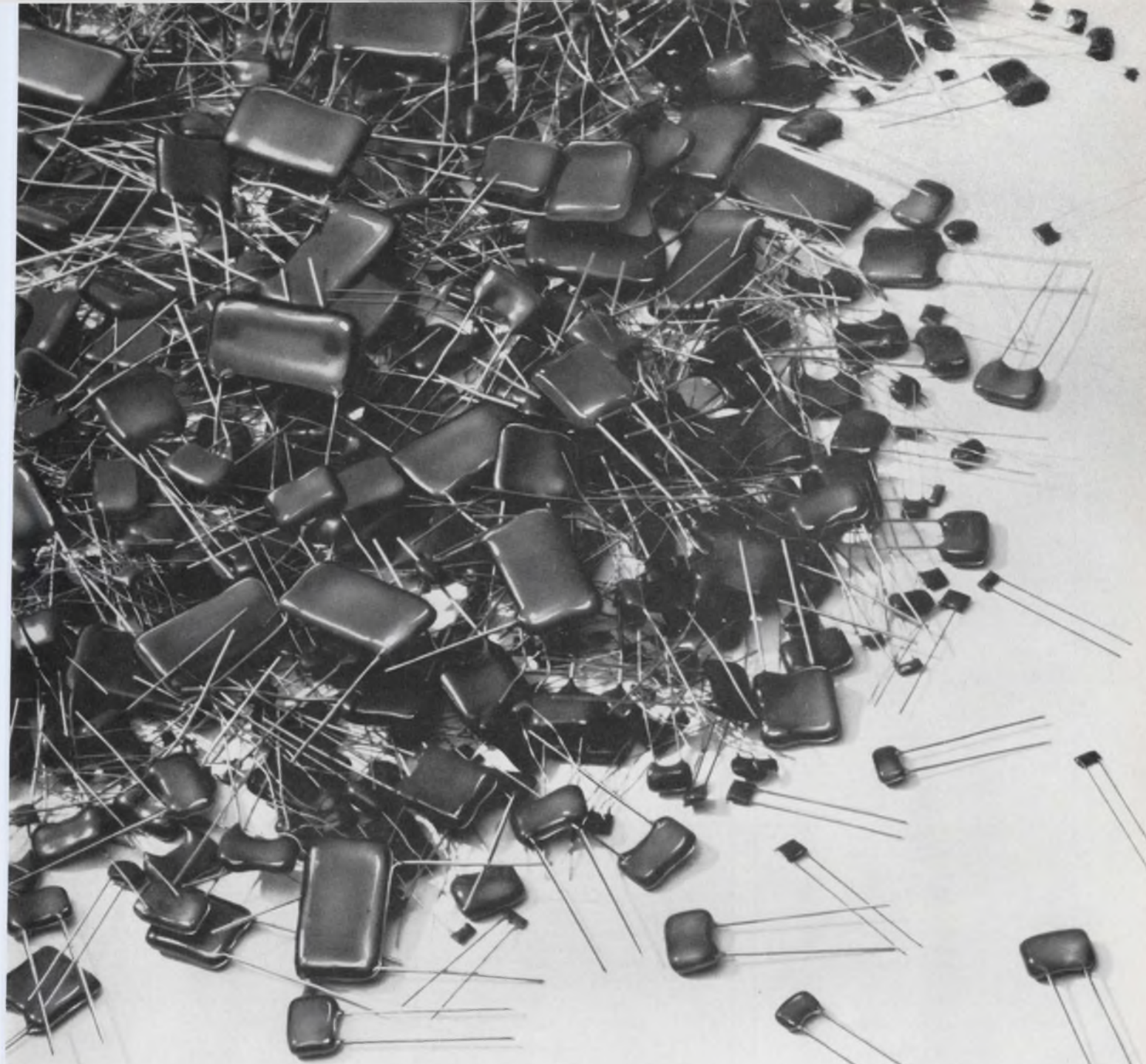
- ina—information not available
- n/a—not applicable
- req.—request

An index of models by manufacturers, with the exception of modular supplies, is included at the end of each table. A location code is included after each model, permitting quick location of specifications for that instrument.

Power-supply specifications are given in separate columns. The complete specifications for any one power supply can be read across the page.

The complete name, address and Reader Service offerings can be found in the Master Cross Index on page D6.

Those companies advertising in the power-supply section are marked with an asterisk.



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# Master Cross Index

Abbrev.	Company	Reader Service No.
Abbott	Abbott Transistor Labs. 5200 W. Jefferson Blvd. Los Angeles, Calif. 90016 (213) WE 6-8185	351
ACDC	ACDC Electronics 2979 N. Ontario St. Burbank, Calif. 91504 (213) 849-2414	352
Acme	Acme Electric Corp. 28 Water St. Cuba, N.Y. (716) 768-2400	353
Acopian	Acopian Corp. P.O. Box 585 Easton, Pa. 18042 (215) 258-5441	354
Arnold	Arnold Magnetics Corp. 11264 Playa Ct. Culver City, Calif. 90230 (213) 870-7014	355
Assoc. Spec.	Associated Specialties Co. 1751 Main Street Orefield, Pa. 18089 (215) 395-9172	356
Atlas	Atlas Controls 10 Cheney St. Dorchester, Mass. 02121 (617) 445-0180	357
AUL	AUL Inc. 139-30 34th Road Flushing, N.Y. 11354 (212) 886-0600	358
Beco	Beco Solid State Electronics P.O. Box 686 Salem, Va. 24153 (703) 774-8625	359
Bertan	Bertan Associates 15 Newton Rd. Plainview, N.Y. 11803 (516) 293-5340	360
Buchler	Buchler Instruments 1327 16th St. Fort Lee, N.J. 07024 (201) 945-1188	361
Burr-Brown	Burr-Brown International Airport Ind. Pk. 6730 S. Tucson Blvd Tucson, Ariz. 85706 (602) 294-1431	362

Abbrev.	Company	Reader Service No.
CEA	CEA Division Berkleionics Inc. 1221 S. Shamrock Monrovia, Calif. 91016 (213) 359-9261	363
Chalco	Chalco Engineering 15126 S. Broadway Gardena, Calif. 90247 (213) FA 1-0121	364
Christie	Christie Electric Corp. 3410 W. 67th St. Los Angeles, Calif. 90043 (213) 750-1151	365
CP	Computer Products 2709 N. Dixie Highway P.O. Box 23849 Ft. Lauderdale, Fla. 33307 (305) 565-9565	366
Del	Del Electronics 250 E. Sanford Blvd. Mt. Vernon, N.Y. (914) 699-2000	367
Deltron	Deltron Inc. Wissahickon Ave. N. Wales, Pa. 19454 (215) 669-9261	368
D-B	Dressen-Barnes 250 N. Vinedo Ave. Pasadena, Calif. 91107 (213) 681-0643	369
Dynage	Dynage Inc. 1331 Blue Hills Ave. Bloomfield, Conn. 06002 (203) 243-0315	370
Elasco	Elasco Inc. 5 Northwood Rd. Bloomfield, Conn. 06002 (203) 242-0708	371
EPL	Electro Products Labs. 6125 W. Howard St. Chicago, Ill. 60648 (312) 647-8744	372
EMC	Electronic Measurement Div. Rowan Controller 2 Crescent Place Oceanport, N.J. 07757 (201) 229-5000	373
ERA	Electronic Research Assoc. 67 Sand Park Road Cedar Grove, N.J. (201) 239-3000	374

Abbrev.	Company	Reader Service No.
Endevco	Endevco 801 S. Arroyo Pkwy. Pasadena, Calif. 91109 (213) 681-2401	375
Fluke	John Fluke Mfg. P.O. Box 7428 Seattle, Wash. 98133 (206) 774-2211	376
GE	General Electric Co. Specialty Transformer Dept. Fort Wayne, Ind. (219) 743-7431	377
Grafix	Grafix, Inc. P.O. Box 3296 Albuquerque, N.M. 87110 (505) 265-6905	378
Hamner	Hamner Division Harshaw Chemical Co. 6801 Cochran Road Salon, Ohio (216) 248-7400	379
Heath	Heath Co. Benton Harbor, Mich. 49022 (616) 983-3961	380
H-P	Hewlett Packard Co. New Jersey Div. 110 Locust Ave. Berkeley Heights, N.J. 07922 (201) 464-1234	381
Hipo	Hipotronics Inc. P.O. Drawer A Route 22 Brewster, N.Y. 10509 (914) 279-8091	382
Holt	Holt Instrument Labs. P.O. Box 230 Oconto, Wis. 54153 (414) 834-2222	383
Hyp	Hyperion Industries 134 Coolidge Ave. Watertown, Mass. 02172 (617) 926-0140	384
ITI	ITI Electronics Inc. 369 Lexington Ave. Clifton, N.J. 07011 (201) 473-0900	385
Int. Cont.	International Contronics Inc. 1038 W. Evelyn Ave. Sunnyvale, Calif. 94086 (408) 736-7620	386

Abbrev.	Company	Reader Service No.
Keithley	Keithley Instruments Inc. 28775 Aurora Rd. Cleveland, Ohio 44139 (216) 248-0400	387
Keppo	Keppo Inc. 131-38 Sanford Ave. Flushing, N.Y. 11352 (212) 461-7000	388
Lambda	Lambda Electronics 515 Broad Hollow Rd. Melville, N.Y. 11746 (516) MY 4-4200	389
Litton	Litton Industries Special Products Data Systems Div. 9001 Fullbright Ave. Chatsworth, Calif. 91311 (213) 781-8211	390
Mid-East	Mid-Eastern Industries 660 Jerusalem Rd. Scotch Plains, N.J. 07076 (201) 233-5900	391
Monroe	Monroe Electronics 5 Vernon St. Middleport, N.Y. 14105 (716) 735-3721	392
NJE	NJE Corp. 20 Boright Ave. Kenilworth, N.J. 07033 (201) 272-6000	393
North Hills	North Hills Electronics Alexander Place Glen Cove, N.Y. 11542 (516) 671-5700	394
Nucor	Nuclear Corp. of America 2 Richwood Place Denville, N.J. 07834 (201) 627-4200	395
P/N	Philbrick/Nexus Research 17 Allied Drive Nedham, Mass. 02026 (617) 329-1600	396
Plastic	Plastic Capacitors 2620 N. Clybourn Ave. Chicago, Ill. 60614 (312) 348-3735	397

Abbrev.	Company	Reader Service No.
Power Des	Power Designs Inc. 1700 Shames Drive Westbury, N.Y. 11590 (516) 333-6200	398
Power/Mate	Power/Mate Corp. 514 S. River St. Hackensack, N.J. 07601 (201) 343-6294	399
Powertec	Powertec Div. of Airtronics Inc. 9168 Desoto Ave. Chatsworth, Calif. 91311 (213) 882-0004	400
Prec Stan	Precision Standards Corp. 1701 Reynolds Santa Ana, Calif. 92705 (714) 546-0431	401
RCA	RCA Electronic Components & Devices Harrison, N.J. 07029 (201) 485-3900	402
Ratelco	Ratelco Inc. 610 Pontius Ave. N. Seattle, Wash. 98109 (206) 624-7770	403
R-S	Rohde & Schwarz 111 Lexington Ave. Passaic, N.J. 07055 (201) 773-8010	404
Rosemont	Rosemont Plug-in Inc. 1416 Lebanon Rd. Nashville, Tenn. 37210 (615) 244-1330	405
Scint	Scintillonics Inc. P.O. Box 701 Ft. Collins, Col. 80521 (303) 482-4752	406
SCI	Semi-conductor Circuits 163 Merrimac St. Woburn, Mass. 01801 (617) 935-5200	407
Sorensen	Sorensen Operation Raytheon Co. Richards Ave. Norwalk, Conn. 06856 (203) 838-6571	408

Abbrev.	Company	Reader Service No.
Spectro	Spectromagnetic Industries 25393 Huntswood Ave. Hayward, Calif. (415) 782-1300	409
Spellman	Spellman High-Voltage 1930 Adee Ave. Bronx, N.Y. 10469 (212) 547-0306	410
Techni	Technipower Inc. Benrus Center Ridgefield, Conn. 06877 (203) 438-0333	411
Topaz	Topaz Inc. 3802 Houston St. San Diego, Calif. 92110 (714) 297-4815	412
TDI	Transistor Devices Horsehill Road Cedar Knolls, N.J. (201) 267-1900	413
Trygon	Trygon Electronics 111 Pleasant Ave. Roosevelt, N.Y. 11575 (516) 378-2800	414
Uni-Volt	Universal Voltronics 27 Radio Circle Drive Mt. Kisco, N.Y. 10549 (914) 241-1300	415
Valor	Valor Instruments Inc. 2430 Amsler Torrance, Calif. 90505 (213) 534-2322	416
Vector	Vector Engrg Inc. 58 Brown Ave. Springfield, N.J. 07081 (201) 379-7800	417
Wanless	Wanless Electric Co. Industrial/Distributor Products Div 2165 S. Grand Ave. Santa Ana, Calif. 92705 (714) 546-8990	418



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If this suggests things we might talk about, write or phone Mr. Richard Vieser, General Manager.

**TUNG-SOL DIVISION**

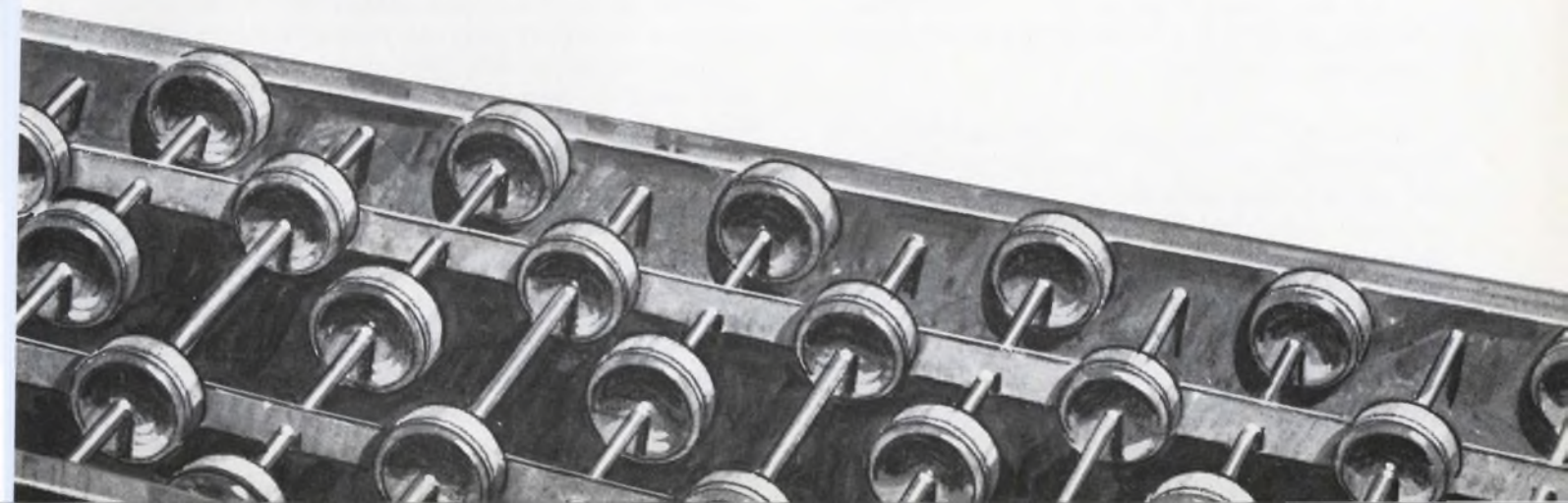
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# Avoid the pitfalls of power-supply connections

Modern power supplies are flexible, high-performance instruments designed to deliver a constant or controlled output with a maximum of reliability and versatility. In many cases, however, the user inadvertently degrades this performance capability by making improper wiring connections to the input, output, or control terminals. In other words, he falls into one of the five pitfalls of connecting power supplies:

- Improper dc distribution.
- Ground loops.
- Improper remote-sensing connections.
- Improper remote-programming connections.
- Improper ac power-input connections.

This article presents rules for avoiding each of the pitfalls.

## Avoid improper dc distribution

The simplest, and most common, example of improper load wiring is illustrated in Fig. 1. Each load sees a power-supply voltage that is dependent upon the current drawn by the other loads and the IZ drops they cause in some portion of the load leads. Since most power-supply loads draw a current that varies with time, a time-varying interaction results among the loads. In some cases this interaction can be ignored, but in most applications the resulting noise, pulse coupling, or tendency toward interload oscillation are undesirable and often unacceptable. Avoidance of this problem leads to the first rule:

*A1. Designate a single pair of terminals as the positive and negative dc distribution terminals (DCDTs).*

These two DCDTs may be the power-supply output terminals, the B+ terminals at the dc load (or the B+ terminals on one of several parallel dc loads connected to the same supply), or a separate pair of terminals established expressly for dc distribution. If remote sensing is *not* used,

locate the DCDTs as close as possible to the power-supply output terminals. Optimum performance results when the supply terminals themselves are used as the DCDTs (Fig. 2).

If remote sensing is used, the DCDTs should be located as close as possible to the load terminals. Sensing leads should then be connected from the supply sensing terminals to the DCDTs (Fig. 3).

From Figs. 2 and 3, then, the next rule is apparent:

*A2. Connect one pair of wires directly from the power-supply output terminals to the DCDTs, and then a separate pair of leads directly from the DCDTs to each load.*

There should be no direct connection from one load to another, except by way of the DCDTs.

Although for clarity the diagrams show the load and sensing leads as straight lines, some immunity against pickup from stray magnetic fields is obtained by twisting each pair of plus and minus load leads, and all sensing leads should be shielded as explained later.

*A3. Be sure that the dc load-wire sizes are adequate.*

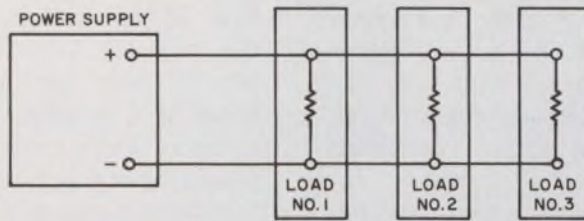
As a bare minimum, each load wire must be of sufficient size to tolerate the power-supply output current that would flow if the associated load terminals were short-circuited. However, impedance and coupling considerations usually dictate the use of larger load-current wires than are required to satisfy current rating requirements.

Power supplies and load wires are normally expressed in terms of their schematic equivalents: the battery symbol and line connections. The simplistic circuit models that these symbols imply are adequate for many purposes, but we must resort to more exact models when evaluating the regulation properties of a power supply connected to its load(s).

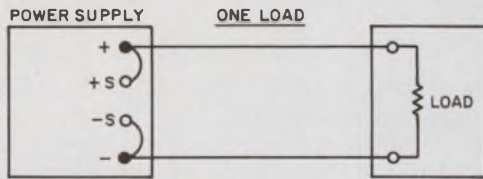
The battery symbol represents an ideal constant voltage source with perfect regulation and zero output impedance at all frequencies. How-

---

Arthur M. Darbie, Hewlett-Packard Co., Berkeley Heights, N.J.

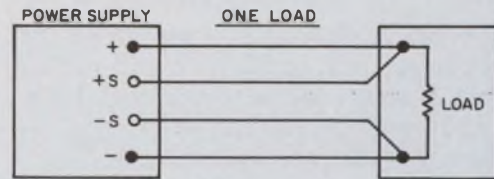


1. A common example of improper load wiring results in time-varying interaction among the loads.



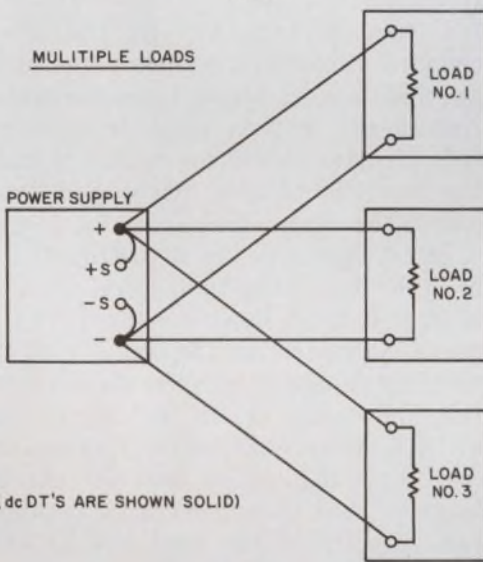
(dc DT'S ARE SHOWN SOLID)

(a)



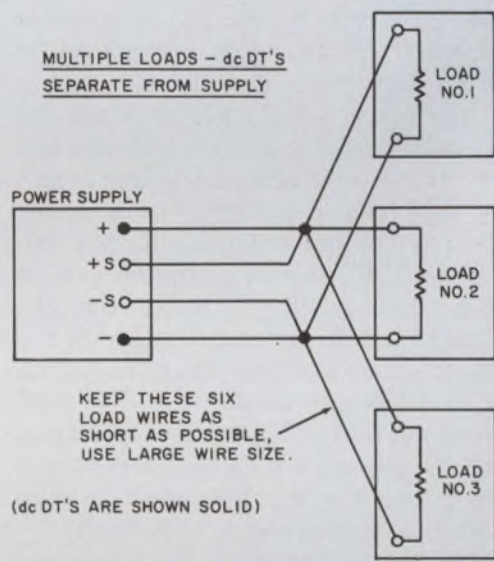
(dcDT'S ARE SHOWN SOLID)

(a)



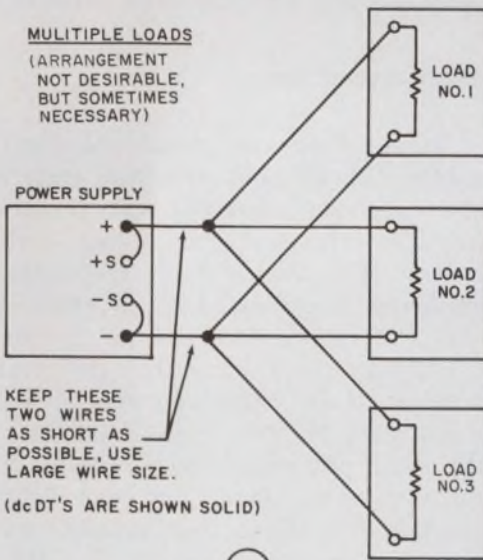
(dc DT'S ARE SHOWN SOLID)

(b)



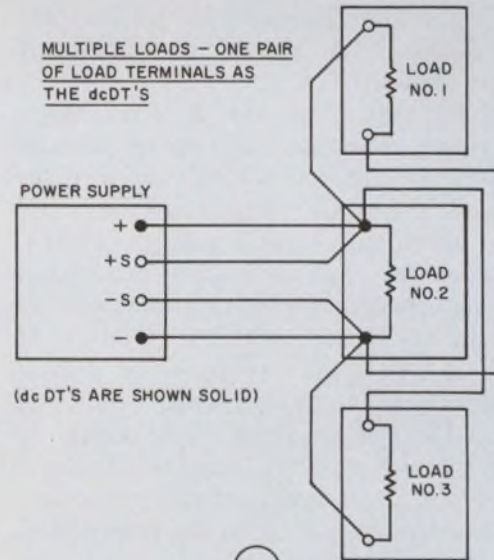
(dc DT'S ARE SHOWN SOLID)

(b)



(dc DT'S ARE SHOWN SOLID)

(c)



(dc DT'S ARE SHOWN SOLID)

(c)

2. When remote sensing is not used the dc distribution terminals should be close to the supply's output terminal.

3. When remote sensing is used the dc distribution terminal should be close to the load terminals.

ever, every regulated power supply has some small output impedance at low frequencies and a much higher output impedance at high frequencies. Thus a more exact circuit model for a power supply includes an equivalent source resistance and inductance (Fig. 4).

$R_s$  is the power-supply output impedance at dc, and it is found by dividing the load regulation by the current rating. For example, a power supply that has a load regulation of 10 mV for a full load change of 10 A has an equivalent  $R_s$  of 1 m $\Omega$ , a typical value. Similarly, a power supply with an output impedance of 0.2 ohm at 100 kHz and 2 ohms at 1 MHz has an equivalent high-frequency output impedance,  $L_s$ , of 0.32  $\mu$ H—a value typical of high performance supplies.

For determining necessary load-wire sizes, it is usually sufficient to consider only the equivalent lumped constant series resistance and inductance ( $L_n$ ,  $L_1$ ,  $L_2$  . . . and  $R_n$ ,  $R_1$ ,  $R_2$  . . .). Given wire size and length, lumped equivalents can be determined from wire tables and charts.

In general, the power-supply performance degradation seen at the load terminals becomes significant whenever the wire size and length result in a load-wire impedance comparable to or greater than the equivalent power-supply output impedance. With one load, this degradation can be evaluated by comparing  $2R_n$  with  $R_s$ , and  $2L_n$  with  $L_s$ . The total impedance seen by the load is  $Z_T = (R_s + 2R_n) + j\omega(L_s + 2L_n)$ , and the variation of the dc load voltage caused by a sinusoidal variation of load current is  $E_{AC} = I_{AC}Z_T$ . If load-current variations are more pulse or step-shaped than sinusoidal, then the resulting load voltage "spike" will have a magnitude  $e_i = L_T di/dt$  where  $L_T = L_s + 2L_n$ , and  $di/dt$  is the maximum rate of change of load current.

If these calculations indicate that the resulting variations in dc voltage provided to the load are greater than desired, then shorter and/or larger load leads are required.

With multiple loads (Fig. 4b) it is necessary to consider separately the common or mutual impedance seen by the loads— $(R_s + 2R_n) + j\omega(L_s + 2L_n)$ —and the added impedance seen by each load individually— $(R_1 + j\omega L_1)$ ,  $2(R_2 + j\omega L_2)$ , etc. Remember that the mutual impedance presents an opportunity for a variation of one load current to cause a dc voltage variation at another load. If the loads are pulse or digital circuits, false triggering may result. Similarly, if one load is the output stage of a high-gain amplifier, and another load contains low-level stages feeding the same signal path, unintentional feedback may occur via this mutual impedance, with resulting amplifier oscillation.

Connecting remote sensing to the load terminals of Fig. 4a or the DCDTs of Fig. 4b has the effect of reducing  $R_n$  by a factor equal to the loop

gain of the power-supply regulator, usually of the order of  $10^3$ ,  $10^4$ , or  $10^5$ . However, remote sensing does not in general alter the effective value of  $L_n$  seen by the load, since  $L_n$  predominates at frequencies above the bandwidth of the power-supply regulator.

Since remote sensing affords little or no reduction in the effective load-wiring impedance at high frequencies, some amount of capacitive load decoupling is sometimes desirable when multiple loads are connected to a power supply.

*A4. Consider adding a local decoupling capacitor across each pair of load and distribution terminals.*

This addition reduces the high-frequency impedance seen by any individual load looking back toward the power supply, and reduces high-frequency mutual coupling effects between loads fed from the same supply. The use of load decoupling capacitors is most often employed with multiple loads drawing pulse currents with short rise times; without local decoupling these current changes can cause spikes that travel down the load distribution wires and falsely trigger one of the other loads (Fig. 5).

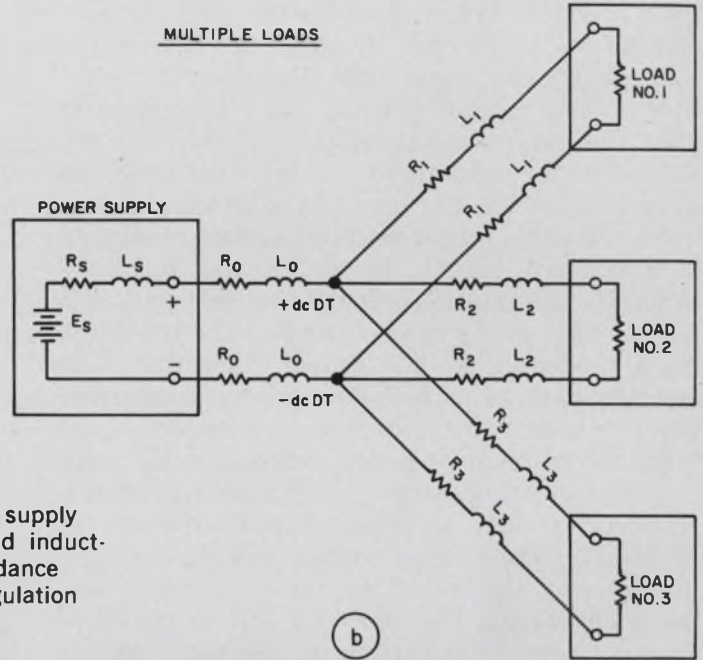
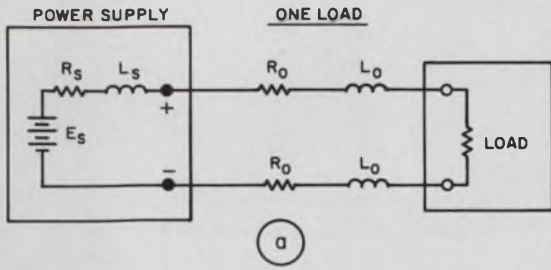
To be effective, the high-frequency impedance of local decoupling capacitors,  $C_n$ ,  $C_1$ ,  $C_2$ , and  $C_3$  of Fig. 5, must be lower than the impedance of wires connected to the same load. Thus a decoupling capacitor must be chosen with care, with full knowledge of its inductance and effective series resistance, as well as its capacitance. Moreover, it is imperative that the shortest possible leads be used to connect local decoupling capacitors directly to the load and DCDT terminals (not to the other points along the dc wiring path) so that the wiring impedance between the capacitor and its connection point is minimized.

**Avoid ground loops**

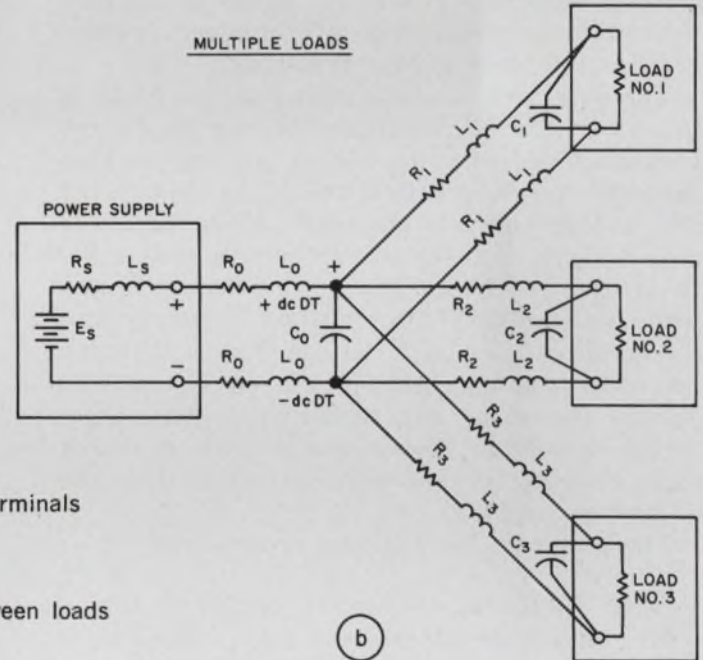
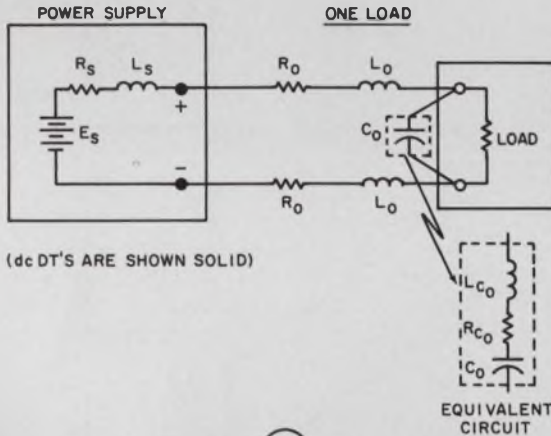
Ground loops represent the most persistent, subtle, difficult-to-analyze and generally troublesome problem connected with power-supply wiring. The origins of ground-loop problems are so diverse that the designer frequently resorts to empirical solutions. A little extra thought and care will reduce or eliminate this problem.

Start by recognizing that the ideal concept of a single "quiet" ground potential is a snare and a delusion. No two ground points have exactly the same potential. The potential differences in many cases are small, but even a difference of a fraction of a volt in two "ground" potentials will cause amperes of current to flow through a complete ground loop.

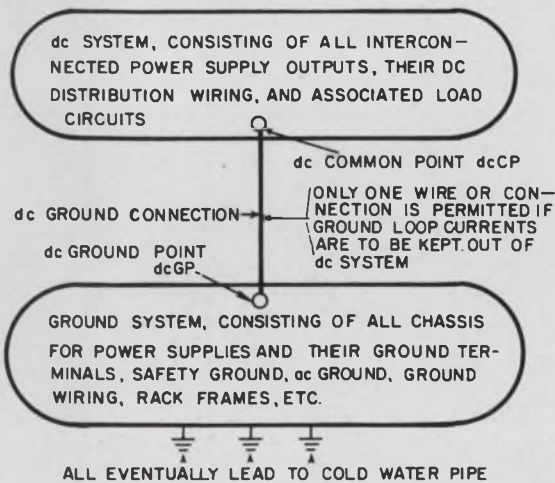
To avoid ground-loop problems, it is necessary to have only one ground return point in a power-



4. A more exact circuit model for a power supply includes an equivalent source resistance and inductance.  $R_s$  is the power-supply output impedance at dc and is found by dividing the load regulation by the current rating.



5. Adding a local decoupling capacitor across each pair of load and distribution terminals reduces the high-frequency impedance seen by any individual load looking back toward the power supply. It also reduces high-frequency mutual coupling effects between loads fed from the same supply.



6. Avoid ground-loop problems by having only one ground return point in a power-supply system.

supply system, which includes the power supply and all its loads and all other power supplies connected to the same loads. However, the selection of the best dc ground point is dependent upon the nature and complexity of the load and the dc wiring, and there are practical problems in large systems that tend to force compromises.

For example, a rack-mounted system consisting of separately mounted power supplies and loads generally has multiple ground connections—each instrument usually has its own chassis tied to the third, “safety ground,” lead of its power cord. and the rack is often connected by a separate wire to safety ground (the cold-water pipe). With the instrument panels screwed to the rack frame, circulating ground currents are inevitable. However, as long as these ground currents are confined to the ground system and do not flow through any portion of the power-supply dc distribution wiring, the effect on system performance is probably negligible. In essence, then, as long as you do not allow the dc distribution circuits to have any conductive paths in common with ground currents, you will in general reduce or eliminate ground-loop problems.

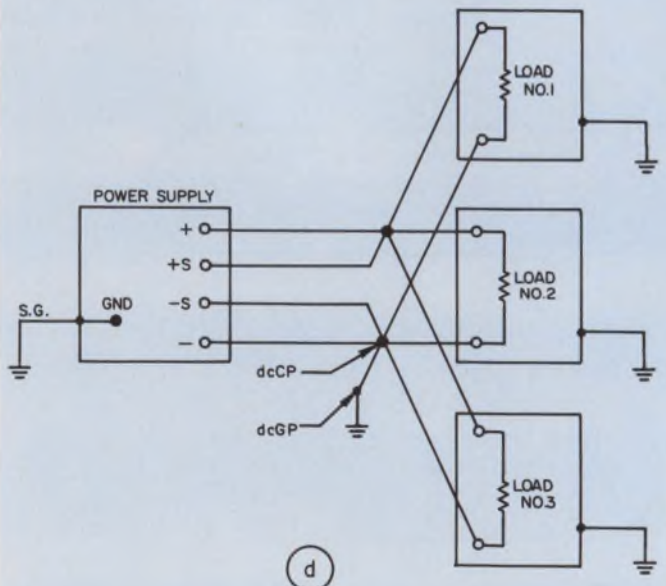
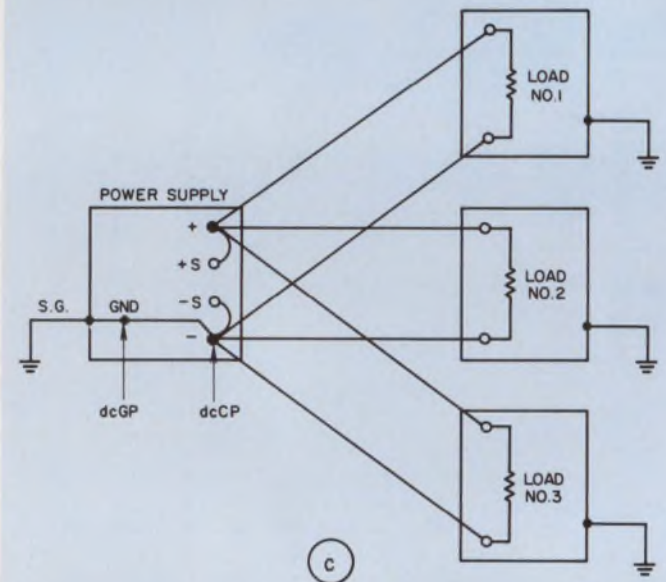
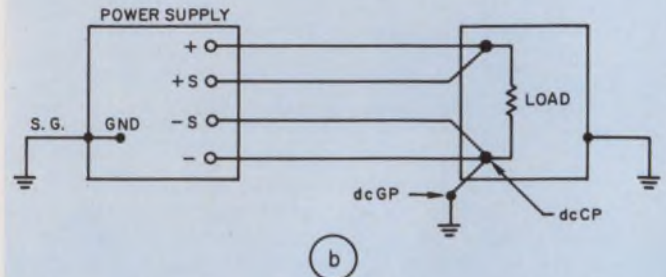
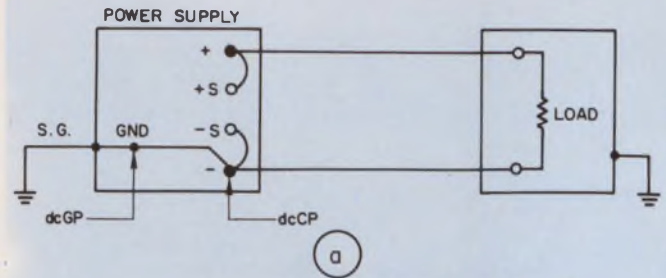
The only way to avoid such common paths is to connect the dc distribution system to ground with only one wire. In Fig. 6, dc (and signal) currents circulate within the upper box, while ground-loop currents circulate within the lower box. So long as there is only one connection between the two boxes, the ground-loop currents, while not eliminated, do not affect the power-supply dc output and load circuits. Notice that any magnetic coupling between the dc system and ground system or any capacitive leakage from the dc system to ground can provide a return path, enabling ground-loop current to link the dc and ground.

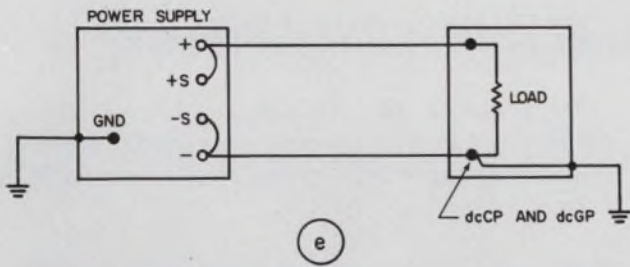
The first rule for avoiding ground-loop is:

*B1. Designate one of the dc distribution terminals as the dc common point (DCCP).*

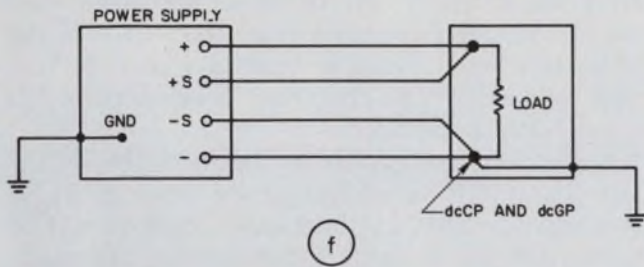
There should be only one dc common point per dc system. If the supply is to be used as a positive source, then the minus DCDT is the dc common point; if it is to be a negative source, then the plus DCDT is the DCCP. Here are some added tips for selecting the best dc common point.

- **Single ungrounded load:** Select either the positive or negative dc distribution terminal as the dc common point. A single isolated load exists when a power supply is feeding only one load, and that load circuit has no internal connections to the chassis or ground. If the power-supply output terminals are to be used as the dc distribution terminals, then the dc common point will be either the positive or negative power-supply output terminal (Fig. 7a). If remote sensing is to be

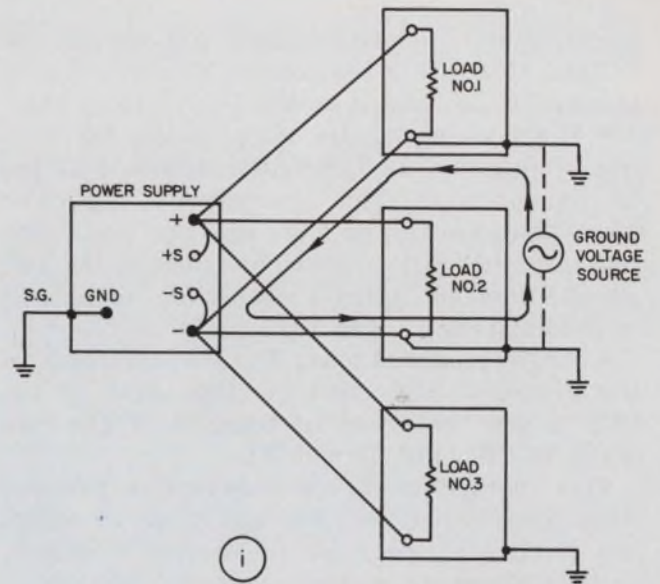




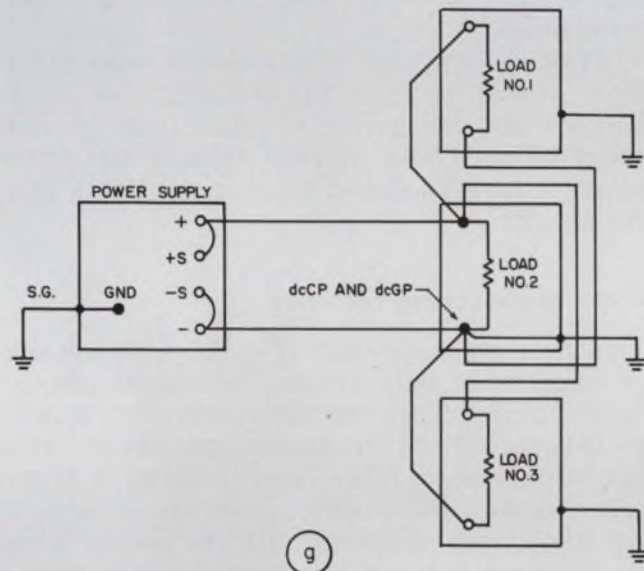
(e)



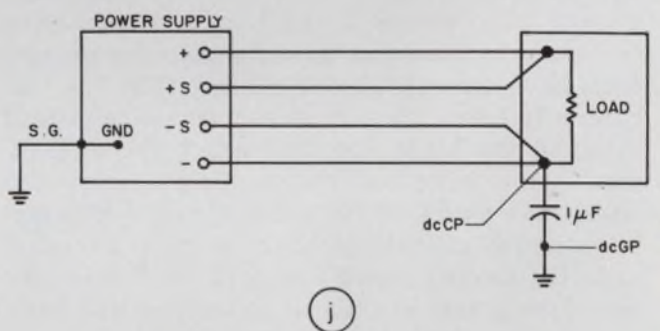
(f)



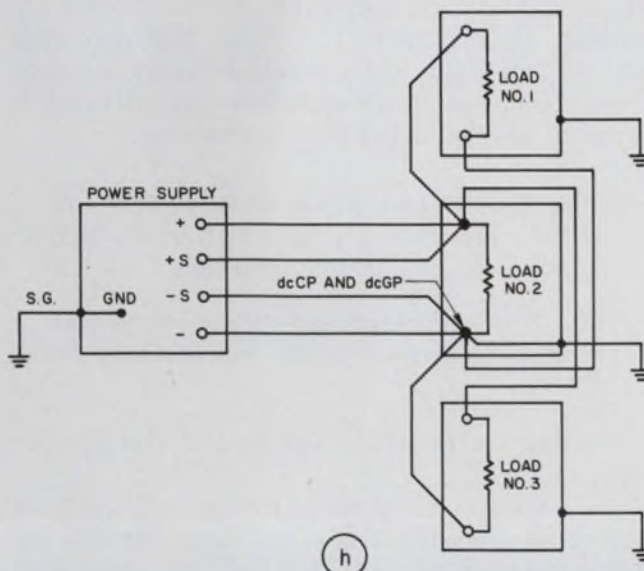
(i)



(g)



(j)



(h)

- 7a. For single ungrounded load, without remote sensing, select either plus or minus dc distribution terminal as the dc common point.
- 7b. For single ungrounded load, with remote sensing, select either plus or minus load terminals as the dc common point.
- 7c, d. This alternative is applicable when there are two or more separate loads with separate pairs of load leads, and none of the load circuits has an internal connection to chassis or ground.
- 7e, f. Single ground load without remote sensing (e) and with sensing (f). The load terminals of the grounded load must be designated as the DCDTs, and the ground terminal of the load is the DCCP.
- 7g, h. This method of DCCP selection is followed when there is only one load and it has an essential internal connection to ground or chassis (g) without sensing or (h) with sensing.
- 7i. Ground current path through dc load wires is inevitable, unless each connection is removed from all but one load.
- 7j. Loads ungrounded from ground: The dc common point should be shorted to the dc ground point through a 1 μF capacitor instead of through a solid-wire connection.

employed and the load terminals will serve as the DCDTs, then either the positive or negative load terminal is designated as the DCCP. (Fig. 7b).

▪ **Multiple ungrounded loads:** Select the positive or negative dc distribution terminal as the dc common point. This alternative is applicable when there are two or more separate loads with separate pairs of load leads, and none of the load circuits has an internal connection to chassis or ground (Fig. 7c and 7d).

▪ **Single grounded load:** The load terminals of the grounded load must be designated as the DCDTs and the grounded terminal of the load is the DCCP. (Fig. 7e and 7f).

This method of DCCP selection is followed when there is only one load and it has an essential (internal) connection to ground or chassis, or when there are multiple loads and only one of them has an internal connection to ground or chassis (Fig. 7g and 7h).

▪ **Multiple loads, with two or more individually grounded:** This situation must be avoided or eliminated, if possible. There can be no avoidance of ground-loop currents circulating through dc and load wiring as long as separate loads connected to the same power supply (or dc system) have separate ground returns (Fig. 7i). One cure is to break the circuit connection to ground in all of the loads and then select the dc common point following the multiple ungrounded alternative above, or break the circuit connection to ground in all but one of the loads and treat it as in the single grounded case. In other cases the only satisfactory solution is to increase the number of power supplies.

▪ **Load system floated at a dc potential above ground:** In some applications it is necessary to operate the power-supply output at a fixed voltage above or below ground potential. In these cases it is usually advantageous to designate a dc common point, using whichever of the four above alternatives is appropriate, just as though conductive grounding would be employed. Then this dc common point should be shorted to the dc ground point through a 1  $\mu$ F capacitor, instead of through a solid-wire connection (Fig. 7j).

*B2. Designate a particular terminal, which is connected to ground as the dc ground point (DCGP)*

The dc ground point may be any single terminal, existing or added, which is part of the ground system of Fig. 6, and which is conductively connected to "safety ground" of the building wiring system and eventually to the cold-water pipe and earth. It may be the separate *ground terminal* located on one of the power supplies or loads in a system, or it may be a special *system ground* terminal, buss or plane established ex-

pressly for ground-connection purposes.

*B3. Connect the DCCP to the DCGP (unless one load is already grounded), making certain there is only one conductive path between these two points.*

This connection should be short, and the wire size used should be such that the total impedance from the DCCP to the DCGP is not large compared with the impedance from the DCGP to the ultimate ground. Braided leads are used to further reduce the high-frequency component of the ground lead impedance.

Sometimes the impedance between the DCCP and the DCGP is minimized by using a single terminal for both. In these cases, care should be taken that all dc system connections are made at one end of the terminal, or bar, and any ground-system connections at the other, so that the dc and ground-system currents are not intertwined.

When checking for unintentional paths from dc to ground, be sure that any straps or wires between the power-supply output and ground terminals have been removed (unless this is the single desired connection between the DCCP and the DCGP).

#### Avoid remote-sensing problems

In using remote sensing (Fig. 8), some amount of compromise with respect to normal power-supply performance characteristics can be expected, particularly transient performance and output impedance. When remote sensing is properly employed, these compromises are of secondary importance compared with the performance improvement at the remote terminals. The necessary precautions for insuring proper remote-sensing performance are in part interrelated with the precautions already given for establishing a proper dc distribution system and avoiding ground loops. The rules detailed earlier must be understood and followed before any attempt is made to use the added rules given here.

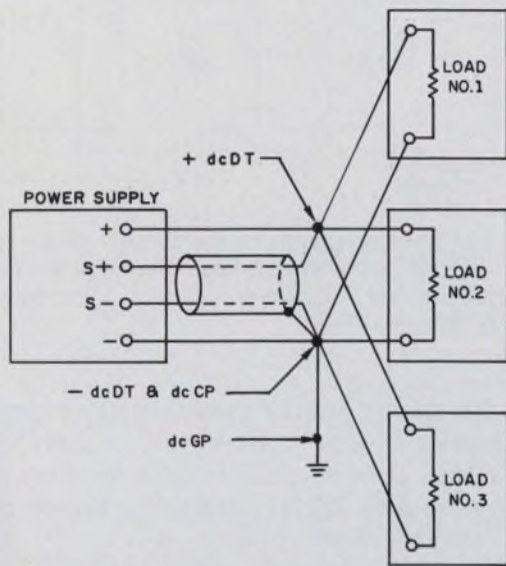
*C1. Remove any straps or wires that connect the power-supply sensing terminals to the power-supply output terminals.*

*C2. Using shielded two-wire cable, connect the power-supply sensing terminals to the DCDTs.*

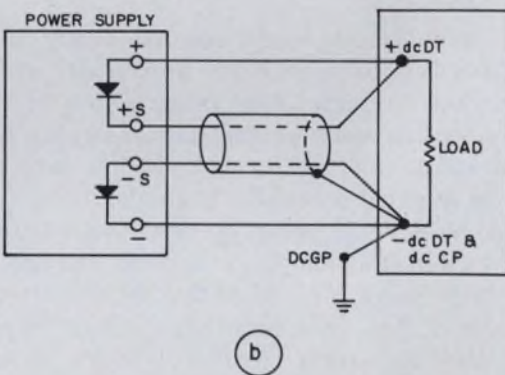
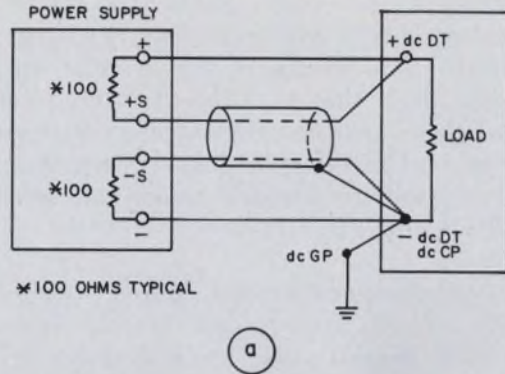
Do not use the shield as one of the sensing conductors.

To ensure that the temperature coefficient of the copper sensing leads will not significantly affect the power-supply temperature coefficient

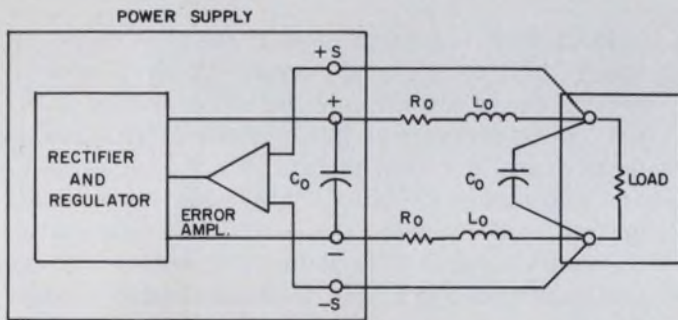




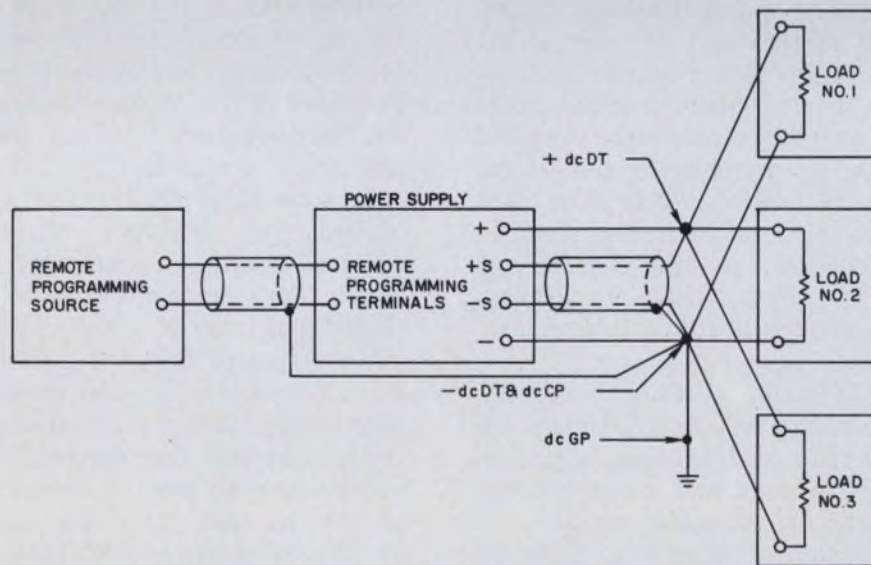
8. Remote sensing leads and shields are shown properly connected.



9. Sensing protection using resistor configuration is shown in (a) using diode configuration in (b).



10. In remote sensing, impedance of the load leads is included inside the power-supply feedback loop. Oscillation will occur due to phase shift and added time delay.



11. Proper connection of remote programming leads and shields is shown.

and stability specifications, it is necessary to keep the IR drop in the sensing conductors less than 20 times the power-supply temperature coefficient (stated in mV/°C.)

*C3. Connect the end of the shield to the DCCP. Leave the other end unconnected.*

In nearly all cases this method of connecting the sensing shield will minimize ripple at the load distribution terminals. Experiment may in rare cases show that a different ground return point for this shield is preferable. In such cases, it is important to verify by experiment that this relative advantage applies under all possible combinations of load and line.

*C4. Eliminate or protect against any possibility of an open-circuit remote-sensing path that might occur on a long-term or transient basis.*

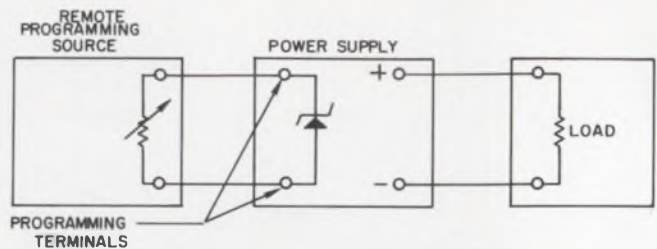
Such open-circuit conditions are likely if the remote-sensing path includes any relay, switch, or connector contacts. Any interruption of hard wire connection between the power-supply sensing terminals and the dc distribution terminals should be avoided wherever possible.

When a sensing open occurs, the regulator circuit within the supply reacts as though the load voltage were zero. Usually, the output voltage corrects this deficiency by climbing rapidly toward the maximum rectifier voltage, a value that is significantly larger than the power supply's maximum rated output voltage.

To reduce the degree of output overshoot that can result from opened remote-sensing connections, many regulated power supplies include internally wired resistors or small silicon diodes, as shown in Fig. 9. If they are not part of the power supply, and if the power-supply application involves long sensing leads, sensing paths that include relay, switch, or connector contacts, or any other cause of open circuits in the remote sensing paths, then the user should in most cases add either resistors or silicon diodes. Connect them directly between corresponding sensing and output terminals, and check their effectiveness by opening the sensing path and noting the resulting output voltage rise.

If the diode configuration of Fig. 9b is used, operation will be satisfactory up to about a 0.5 volt drop in either load lead between a power-supply output terminal and the corresponding DCDT; greater drops use diodes in series.

If the resistor configuration of Fig. 9a is included by the manufacturer or added by the user, it may be necessary to check that the power rating of this resistor is adequate, particularly for sizable sensing drops. Remember that the actual



12. When programming the output using a remote source the use of a zener across the programming terminals will prevent the supply's output from exceeding a predetermined limit.

dissipation in the remote-sensing protection resistors is  $E_D^2/R$ , where  $E_D$  is the IR drop from either power-supply output terminal to the corresponding DCDT, and  $R$  is the ohmic value of the protective resistor.

*C5. Determine the minimum wire size for the load current leads from the power-supply output terminals to the DCDTs.*

Most well regulated power supplies have an upper limit to the load-current IR drop around which remote sensing may be accomplished without losing proper regulation control. This maximum drop limitation is typically 0.5, 1, or 2 V, and may apply to the positive, negative, or both output leads. Consult the instruction manual or the manufacturer if in doubt concerning the exact limitation applicable to a particular supply.

*C6. Check for possibility of power-supply oscillation when connected in the system for remote sensing.*

Impedance of the load leads is included inside the power-supply feedback loop (Fig. 10). In remote-sensing applications involving small or long load wires, there is a tendency for power-supply oscillation to occur due to phase shift and added time delay.

In some cases readjusting a "transient recovery" or "loop stability" control inside the supply will be adequate; in more severe cases the power-supply loop equalization may have to be redesigned and tailored for the application.

As suggested previously in rule A4, capacitor  $C_0$  is commonly included to suppress load transients and reduce the power-supply impedance at the load at high frequencies. The capacitor must be chosen with care if power-supply oscillation is to be avoided, since any capacitor resonances or other tendency toward high impedance within or near the bandpass of the power-supply regulator will reduce loop stability. It is therefore common in extreme remote-sensing applications to remove  $C_0$  from the supply and use it as  $C_0'$ .

*C7. Check for proper current limiting operation while the power supply is connected in the system for remote sensing.*

With some power-supply designs, the resistance of one of the current-carrying leads adds to the resistance used for current limit monitoring, thereby reducing the threshold value at which current limiting begins. Watch whether the current limit value changes significantly while shorting out +S to +OUT and -S to -OUT at the power supply. If it does, look in the instruction manual for corrective adjustments.

#### **Avoid improper remote-programming connections**

*D1. Carefully note and follow the power-supply manufacturer's instructions for strapping patterns and correct connection terminals for remote programming.*

Different terminals, and many different connection patterns are possible. The proper ones depend upon the power-supply design, whether the programming input will be resistance, voltage, or current, and whether remote control will be exercised over the power-supply voltage loop or its current loop, or both (Fig. 11).

*D2. Using shielded two-wire cable, connect the power-supply programming terminals to the remote-programming source.*

Do not use the shield as one of the programming conductors. With most supplies, the programming current (10 mA or less) associated with resistance programming the voltage loop can be found by taking the reciprocal of the specified programming coefficient (e.g., 1000 ohms/volt = 1 mA programming current).

*D3. Connect one end of the shield to the DCCP. Leave the other end unconnected.*

*D4. Check that programming leads and source will not contribute to output drift, noise, etc.*

The wire size of the programming leads must be adequate to withstand any programming surges. Consider the effects of any large capacitive storage that has to be charged or discharged through the programming leads. The temperature coefficient of very long programming leads may degrade power-supply temperature coefficient and stability specifications. This is particularly true if the power supply is well regulated, or the programming leads are subjected to considerable ambient temperature changes, or when programming is done with low resistance values.

Programming resistors should be wire-wound for low noise and surge immunity, have a temperature coefficient (TC) of 20 ppm/°C or less, depending on the power supply's inherent TC, and be operated at less than one-tenth their power rating to insure that self-heating does not substantially influence TC and noise performance.

Voltage or current sources used to program power supplies must be free of drift, ripple, noise, etc., to the same degree as desired in the power-supply output. Remember that a percentage change in the output of a remote voltage or current programming source causes the same percentage change in the power-supply output.

*D5. Eliminate any possibility of an open-circuit remote-programming path that might occur on either a long-term or transient basis.*

Such open-circuit conditions are likely if the remote-programming path includes any switch, relay, or connector contacts. When resistance is being programmed, any interruption of the programming path, however momentary, is interpreted by the power supply the same as an intentionally programmed high-resistance value. The power-supply output responds by rising rapidly toward the maximum rectifier voltage. By using make-before-break switches and series programming resistor strings, instead of selecting one of several parallel programming resistors, programming overshoots and undershoots can be avoided. With remote voltage or current inputs, an open-circuit programming path usually results in the power-supply output falling to zero or near zero.

*D6. To provide added protection against excessive output due to programming inputs, add protective zener diodes directly across the power-supply programming terminals.*

When resistance programming the output voltage with a remote resistance input, nearly all power-supply designs are such that a zener diode connected across the programming terminals will prevent the power-supply output voltage from exceeding the zener-diode breakdown voltage, regardless of program resistance value. This method also limits the output voltage to the zener value in the event the programming path becomes open-circuited. The zener diode should have a current rating equal to or greater than the power-supply programming current, which is usually the inverse of the programming coefficient.

When the output is programmed using a remote voltage or current source, the use of a zener diode across the programming terminals will prevent the power-supply output from exceeding a

predetermined limit, even though the programming source may provide an excessively high input command (Fig. 12). The relationship between the zener diode and the input limit value depends on the power-supply design and the programming connection. In any case it can be determined by considering the power supply as equivalent to an operation amplifier. The zener diode must have a current rating equal to or greater than the largest current that the remote-programming source can provide. In some cases the power rating of the zener diode can be reduced by a fixed resistance in series with the programming path.

### Avoid improper ac power input connections

The last pitfall to optimum power-supply performance involves the ac power connections.

*E1. Retain ac (hot), acc (cold) and third-wire safety ground continuity without accidental interchange from ac power outlet to the power-supply input terminals.*

Accidental interchanging of ac and safety ground leads may result in the power-supply chassis being elevated to an ac potential equal to the line input voltage. This is a potentially lethal shock hazard if the chassis is not grounded or, if the chassis is grounded, blown fuses or circuit breakers may result.

If ac and acc are accidentally interchanged, the power-supply switches and fuses are thereby placed in series with the cold side of the power line instead of the hot side. If the power-supply fuse later opens as the result of performing its normal protective function, the hot side of the power line will then be connected to exposed components within the power supply.

Accidental interchanging of acc and ground leads places the chassis at the acc potential, giving rise to circulating ground currents flowing through the power-supply chassis and other associated ground return paths. The result is excessive power-supply output ripple and malfunction of associated instruments.

*E2. If an autotransformer (or isolation transformer) is connected between the ac power source and the power-supply input terminals, be sure it is rated for at least 50% of the maximum rms current required by the power supply, and has its common terminal connected to the acc (not ac) terminals of both the power supply and the input power line.*

Because a power-supply input circuit does not draw current continuously, the input current

wave is not sinusoidal, and the peak-to-rms ratio is generally greater than  $\sqrt{2}$ , and can be as high as two or more at full output. To avoid autotransformer saturation, with consequent limiting of peak input current, the autotransformer must have a rating higher than is suggested by the power supply's rms input current. Failure to follow this precaution may result in the power supply not meeting its specifications at full output voltage and current, combined with low input-line-voltage.

If acc is not connected to the common terminal of the autotransformer, the input acc terminal of the power supply will have a higher than normal ac voltage connected to it, contributing to a shock hazard and, in some cases, greater output ripple.

*E3. Do not use an ac input-line regulator to feed a well-regulated power supply without first checking with the power-supply manufacturer.*

Such regulators tend to increase the impedance of the ac line in a resonant fashion, and can cause malfunctioning of the power supplies if they employ SCR or switching-type regulators or preregulators. Since the control action of the most common line-voltage-regulators is accompanied by a change in the ac output waveshape, their advantage in providing a constant rms input to a power supply is practically nil.

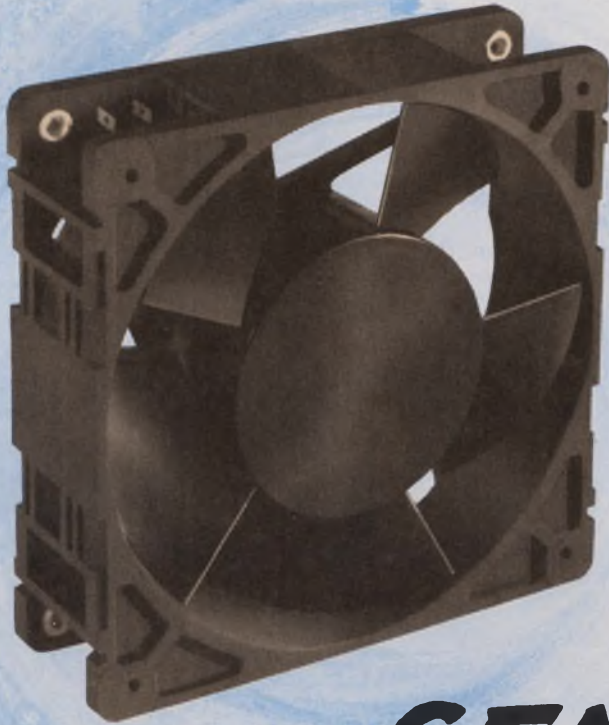
*E4. Be sure that the ac line wire is of adequate size.*

This check is generally not necessary if the power supply comes furnished with its own power cord. However, many larger power supplies require the connection of ac power in accordance with local electrical codes. Manufacturers sometimes prefer not to supply an ac connecting cable with the unit rather than risk providing something that might violate such local codes.

When connecting ac to a power supply for which the manufacturer has not provided an ac cable it is necessary to use a wire size that is at least rated to carry the maximum power-supply input current. A check should be made to determine whether a still larger wire size will be required to retain a sufficiently low impedance from the ac service outlet to the power-supply input terminals, particularly if a long ac cable is involved.

As a rough guideline, it is suggested that any user-provided ac input cable should employ wire size sufficient to insure that its IZ drop at maximum rated power supply input current will be equal to or less than 1% of the nominal line voltage. ■■

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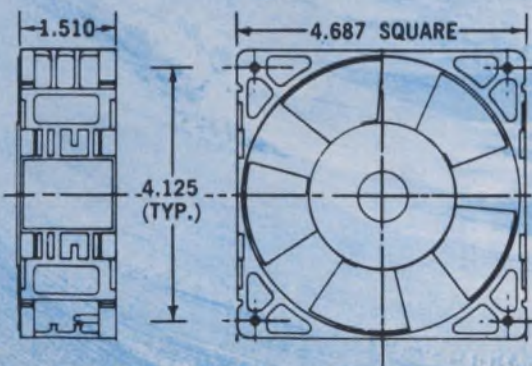
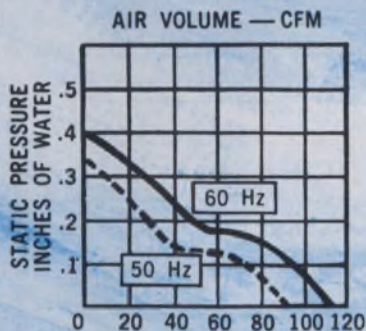
New aerodynamic principles by Rotron permit the Centaur fan to achieve greater aerodynamic efficiencies than ever before from axial flow fans — and with low acoustical disturbance and compact size.

The Centaur with its computer designed five-bladed impeller molded of high impact polycarbonate is precisely matched to a powerful shaded pole motor — available with either oil-impregnated sleeve bearings or precision ball bearings lubricated for life. The recommended operating ambient temperature is  $-40^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$  with sleeve bearings, and  $-40^{\circ}\text{C}$  to  $+72^{\circ}\text{C}$  with ball bearings. The motor is mounted to a spider of die cast aluminum which is in turn assembled to a venturi of high temperature resistant black phenolic.

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# Make sure you pick the right power supply

In selecting a power supply, designers must choose from a wide variety of types. Basically all supplies can be classified into two major subdivisions, linear and nonlinear.

The linear power supply is the most popular because of its ability to have simultaneously high-speed transient response, very good voltage and current regulation and very low output ripple. Although generally quite reliable, it has the disadvantage of dissipating as much heat into its own enclosure and the surrounding environment as the load wattage it supplies.

There are three types of nonlinear power-supply systems in use today: ferroresonant, switching-transistor-regulated and SCR-regulated. These types all contain a nonlinear element that is turned on and off, thus achieving high efficiency in the semiconductors used.

The ferroresonant type has higher losses than the equivalent standard transformer, since during part of each cycle a portion of the core is saturated. This increases the hysteresis losses in the iron. In terms of reliability, the ferroresonant type is the most reliable because it has fewer components.

The typical ferroresonant power supply consists of saturating transformers, an oil-filled ac capacitor, a pair of rectifiers and an electrolytic capacitor or pi filter. Although the paper-wound capacitors do not have a wearout mode as the

electrolytics do, they carry large ac currents. This heats up depending on their dielectric losses and cannot be used in high ambient temperatures.

Although the switching-transistor types run cooler, due to their high efficiency, the switches have a failure mechanism not covered by MIL HBK 217. The high-voltage switching transistor supply depends on its control circuit. If the driver section should fail, leaving one transistor to carry the load, the high-frequency transformer can become dc unbalanced and tend to saturate. This increases the current switching transistor by several times and heats up the junction. Even slightly unbalanced inputs in the square or quasi-square wave increase the exciting magnetizing current, and the transformer must be gapped to prevent saturation.

If one transistor is left on and the other off, and if a dc path is available, transistor failure is immediate. Many of the newer types of circuits use a half bridge that has no normal dc path, and this has the disadvantage of destroying both transistors if one fails since they are across the dc voltage.

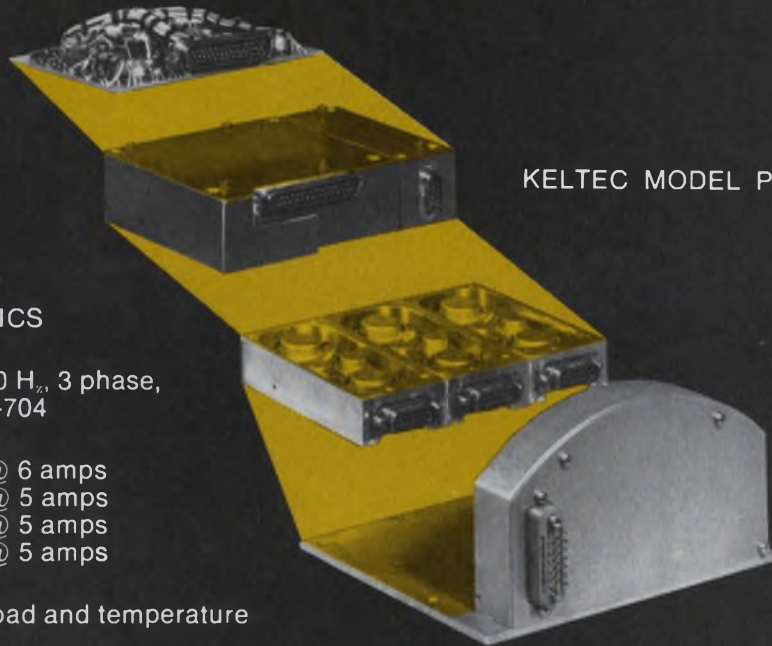
A type that has not been fully exploited in computer applications is the SCR-regulated. These power supplies have more parts than the ferroresonant types, but they have the advantage of better line and load regulation, output voltage and current limiting adjustment. The power supply is very efficient and does not contribute to computer cooling problems. Today's state of the art for various types of regulated dc power supplies is shown in the table. ■■

Robert Hyde, Chief Engineer, Power/Mate Corp., Hackensack, N.J.

Table. Major computer power-supply specifications

Type	Input	Rectifier	Filter	Output adjust %	Line reg %	Load reg %	Current reg %	Cost \$/output	Regulation means	Efficiency avg. %	Features available			
											Over voltage	Over current	Cooling	
Line regulated	ferroresonant													
Narrow range (slot)	xformer	SI	C, LC	none	1	3-10	25	1/W	same as input	75	ext	int	conv	
Wide range	xformer	SI	C	± 5-20	0.03	0.03	25	1/W	transistor (silicon)	40	ext	int	conv	
High wattage:														
> 500 W	xformer	SI	C, LC	100	0.1	0.1	1	0.50/W	transistor (silicon)	30	ext	int	conv	
Low ripple	xformer	SI	C, LC	limited	0.1	0.1	1	0.60/W	SCR & transistor filter	75	ext	int	blower	
Good regulation	xformer	SI	C	100	0.01	0.01	0.1	0.70/W	SCR, transistor switch & pass	70	ext	int	blower	
High efficiency:														
Small size	rectifier	SI	C	100	0.05	0.05	0.1	1/W	switching transistor (Hv)	80	ext	int	conv	
Nominal size	xformer	SI	C	50	0.05	0.05	0.1	1/W	switching transistor (Lv)	75	ext	int	conv	
High wattage	rectifier	SI	C	50	0.05	0.05	0.1	0.50/W	switching SCR (Hv)	75	ext	int	conv	
High voltage:														
Narrow range (100-300 V)	xformer	SI	C	30	0.03	0.03	0.1	1/W	transistor (Hv)	40	ext	int	conv	
Wide range	xformer	SI	C	100	0.01	0.01	0.1	1.50/W	transistor 2 stage (Hv)	30	ext	int	conv	
300-3000 V	xformer	SI	C	100	0.01	0.01	0.1	2/W	vac. tube & S.C. control	25	ext	int	conv	
High current	xformer	SI	C	100	0.1	0.1	0.1	1.50/W	SCR (usually primary)	60	ext	int	option	
5-50 kV	xformer	SI	C mult.	50	0.05	0.05	option	1/W	tube	30	ext	int	option	

# AIRBORNE POWER SUPPLIES WITH MODULAR MAGIC



KELTEC MODEL PS-6945

## CHARACTERISTICS

### INPUT:

115 VAC, 400 Hz, 3 phase,  
per MIL-Std-704

### OUTPUTS:

+28 Volts @ 6 amps  
+15 Volts @ 5 amps  
-15 Volts @ 5 amps  
- 5 Volts @ 5 amps

### REGULATION:

±1% line, load and temperature

### RIPPLE:

25 mv Peak to Peak

### PROTECTIVE CIRCUITRY:

1. Output protection from short circuits for indefinite period without damage.
2. Over voltage — in the event of regulation failure, supplies are terminated in less than 20 microseconds.
3. Overload — supply is protected to prevent damage resulting from overloading in any one of the outputs.

### ENVIRONMENT:

1. Temperature —55°C to +71°C
2. Altitude 50,000 feet
3. Shock, Vibration, Humidity and Explosion per MIL-Std-810
4. Electromagnetic Interference per MIL-I-6181

## OTHER POWER SUPPLY CAPABILITIES

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Low Noise TWT  
Display tube/CRT  
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	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
HC 1	Int Cont	CP5500-1	2	25	0.05	0.05	5	t	995	*Sorensen	Q586-4	5-9	4.4	±0.015	±0.015	0.25	abcdeij	115
	*Trygon	LH54-14	2.5	14	0.01	0.01	1		229	*Sorensen	Q586-8	5-9	8.8	±0.015	±0.015	0.25	abcdeij	170
	*ERA	SR0218	1-3	15	±0.01	0.05	0.8	abd	430	*Sorensen	Q586-15	5-9	16.5	±0.015	±0.015	0.25	abcdeij	300
	*ERA	SR0225	1-3	25	±0.01	0.05	0.8	abd	515	*Sorensen	Q586-30	5-9	33	±0.015	±0.015	0.25	abcdeij	400
	Chalco	T0458F5	2-3.5	58	0.005	0.005	0.01%	abdij	510	*NJE	PVC-10-4	0-10	4	0.01	0.01	0.25	abcde	195
	Chalco	T0497F7	2-3.5	97	0.005	0.005	0.01%	abdij	655	*NJE	LVCII-10-4	0-10	4	0.01	0.01	0.25	abcde	171
	Beco	301	0-4	7.2	0.01	0.1	0.2	dep	reg	*Hyp	HY-V5-10	0-10	4	0.01	0.01	0.5	abcdeij	199
	*H-P	6463A	0-4	2000	50mV	50mV	280	abcdey	3500	*NJE	PVC-10-8	0-10	8	0.01	0.01	0.25	abcde	295
	*Trygon	L3R-4-40	2.5-4.5	40	±0.005	0.005	0.5		470	*H-P	6282A	0-10	10	0.01	0.01	0.5	abcde	350
	*Trygon	L5R4-70	2.5-4.5	70	±0.005	0.005	0.5		575									
HC 2	*ERA	SR054	0-5	4	±0.01	0.05	0.8	abd	325	Halt	275	0-10	10	0.1	0.05	0.02	cd	2060
	*ERA	CP55	5	6.5	0.05	0.03	1	abd	145	Prec Stan	104	0-10	10	0.005	0.01	0.1	abcdef	269
	Wanless	P551-5	5	7.5	±0.005	±0.01	0.75	w	275	*Techi	LA10-12M	0-10	12	±0.1	±0.15	0.2%	abcde	370
	*ERA	SR058	0-5	8	±0.01	0.05	0.8	abd	390	Hyp	HY-S1-10-	0-10	12.5	0.01	0.01	0.5	abcdeij	299
	*ERA	CP510	5	13	0.05	0.03	1	abd	185		12.5							
	Wanless	P552-5	5	15	±0.005	±0.01	0.75	w	325	Prec Stan	109	0-10	15	0.005	0.01	0.1	abcdef	370
	*ERA	CP517	5	22	0.05	0.03	1	abd	230	*Mid-East	HW20-15	0-10	15	0.01	0.01	1	abcde	310
	*ERA	CP525	5	32	0.05	0.03	1	abd	310	*H-P	6256B	0-10	20	0.01	0.01	0.2	abcde	450
	Hyp	HY-S1-5-	0-5	50	0.01	0.01	2	abcdeij	499	Hyp	HY-S1-	0-10	25	0.01	0.01	0.5	abcdeij	499
	*ERA	CP550	5	65	0.05	0.03	1	abd	495		10-25							
									*Techni	LA10-25M	0-10	25	±0.01	±0.15	0.2%	abcde	410	
HC 3	Plastic	LV5-250	4.9-5.1	2.5	0.05	0.05	3	abdfghj	122	*H-P	6259B	0-10	50	0.01	0.01	0.5	abcde	650
	Plastic	LV5-750	4.9-5.1	7.5	0.05	0.05	3	abdfghj	161	*H-P	6260B	0-10	100	0.01	0.01	0.5	abcde	825
	*Trygon	LQS4-3.8	2.5-5.5	3.8	0.01	0.01	0.5		135	Hyp	HY-S1-	0-10	100	0.01	0.01	0.5	abcdeij	1240
	*H-P	6384A	4-5.5	8	1mV	1mV	1	cde	220		10-100							
	*Trygon	LQS4-8.4	2.5-5.5	8.4	0.01	0.01	0.5		174	EMC	SCR10-250	0-10	250	0.1	0.1	5	abcde	1300
	*Kepco	CP56-10M	0-6	10	0.0005	0.005	0.2	abcde	366	EMC	SCR10-500	0-10	500	0.1	0.1	5	abcde	1700
	*Kepco	JQE6-10M	0-6	10	0.0005	0.005	0.2	abcde	289	*Trygon	LQS8-3.1	6.5-10.5	3.1	0.01	0.01	0.5		139
	*Kepco	JQE6-22M	0-6	22	0.0005	0.005	0.2	abcde	520	*Trygon	LQS8-6.5	6.5-10.5	6.5	0.01	0.01	0.5		189
	*Kepco	CP56-22M	0-6	22	0.0005	0.005	0.2	abcde	585	*Trygon	LH58-11.5	6.5-10.5	11.5	0.01	0.01	1		239
	*Kepco	JQE6-45M	0-6	45	0.0005	0.005	0.2	abcde	625	*Trygon	LH58-21	6.5-10.5	21	±0.005	0.005	1		320
HC 4	*Kepco	CP56-45M	0-6	45	0.0005	0.005	0.2	abcde	660	*Trygon	L3R8-25	6.5-10.5	25	±0.005	0.005	0.5		470
	*Kepco	JQE6-90M	0-6	90	0.0005	0.005	0.2	abcde	977	*Trygon	L5R8-50	6.5-10.5	50	±0.005	0.005	0.5		595
	*Kepco	CP56-90M	0-6	90	0.0005	0.005	0.2	abcde	995	Dynage	KHC10/10	9-11	4	±0.05	±0.05	2	abdfg	325
	Wanless	SS51-1	3-6.5	15	±0.03	±0.03	0.5	bv	250	*Trygon	LQ510-	8.5-11.5	6.5	0.1	0.01	0.5		189
	Wanless	SS52-1	3-6.5	25	±0.03	±0.03	0.5	bv	315		6.5							
	*Trygon	HH7-40V	0-7	4	0.01	0.01	0.5		189	*Trygon	LH510-	8.5-11.5	11.5	0.01	0.01	1		239
	*ERA	MS074	0-7	4	0.01	0.05	0.8	abdk	455		11.5							
	Wanless	LAB1	0-7	5	±0.05	±0.05	0.75	de	125	*Trygon	LH510-21	8.5-11.5	21	±0.005	0.005	1		320
	Power Des	6050	0-7	5	0.01	0.01	1	abcd	195	*Trygon	L3R10-25	8.5-11.5	25	±0.005	0.005	0.5		505
	*ERA	MS078	0-7	8	±0.01	0.05	0.8	abdk	595	*Trygon	L5R10-50	8.5-11.5	50	±0.005	0.005	0.5		620
HC 5	Chalco	H0739F5	2-7	38.5	0.005	0.005	0.01%	abdij	510	*ERA	MS124	11-12	4	0.01	0.05	0.8	abdk	455
	Chalco	H0744F5	3.5-7	44	0.005	0.005	0.01	abdij	510	Wanless	P551-12	12	5	±0.005	±0.01	0.75	w	275
	Chalco	T0749F5	4.5-7	49.2	0.005	0.005	0.01%	abdij	510	*ERA	MS128	11-12	8	0.01	0.01	0.05	abdk	595
	Chalco	H0764F7	2-7	64	0.005	0.005	0.01%	abdij	665	Wanless	P552-12	12	10	±0.005	±0.01	0.75	w	325
	Chalco	H0774F7	3.5-7	73.5	0.005	0.005	0.01%	abdij	665	Power	1210S	0-12	10	0.01	0.01	1.5	abcd	329
	Chalco	T0782F7	4.5-7	82	0.005	0.005	0.01%	abdij	655	Des								
	*H-P	6281A	0-7.5	5	0.01	5mV	0.2	abcde	210	Atlas	P3070	12	30	0.5	1	5	dj	880
	*Sorensen	QRE7.5-10	0-7.5	10	±0.01	±0.01	0.3	abcdeij	345	*Kepco	K012-100M	0-12	100	1	1	30	abcde	1095
	*Sorensen	QRE7.5-20	0-7.5	20	±0.01	±0.01	0.3	abcdeij	495	Plastic	LV12-400	11.75-	4	0.05	0.05	3	abdfghj	139
	*Sorensen	QRE7.5-50	0-7.5	50	±0.01	±0.01	0.3	abcdeij	645		12.25							
HC 6	*Trygon	LQS6-3.3	4.5-7.8	3.3	0.01	0.01	0.5		135	Plastic	LV12-600	11.75-	6	0.05	0.05	3	abdfghj	161
	*Trygon	LQS6-7.7	4.5-7.8	7.7	0.01	0.01	0.5		179	Plastic	LV12-800	11.75-	8	0.05	0.05	3	abdfghj	178
	*Trygon	LH56-13.5	4.5-7.8	13	0.01	0.01	1		229		12.25							
	*Trygon	LH56-24	4.5-7.8	24	0.01	0.01	1		320	Dynage	KHC12/12	11-13	3.6	±0.05	±0.05	2	abdfg	325
	*Trygon	L3R6-40	4.5-7.8	40	±0.005	0.005	0.5		470	*Kepco	SM14-7AM	0-14	7	0.01	0.05	1	bcde	427
	*Trygon	L5R6-70	4.5-7.8	70	±0.005	0.005	0.5		595	*Kepco	SM14-	0-14	15	0.01	0.05	1	bcde	552
	Beco	302	0-8	3.6	0.01	0.1	0.2	dep	reg		15AM							
	*Power/	BP-8D	0-8	4	0.01	0.01	0.25	abcdeij	129	*NJE	TC-14-	5-14	15	0.5	0.5	1000	abcd	365
	*Power/	BP-8E	0-8	6.5	0.01	0.01	0.25	abcdeij	210		15M							
	*Power/	BP-8F	0-8	9	0.01	0.01	0.25	abcdeij	235	*NJE	TC-14-	5-14	30	0.5	0.5	1000	abcd	500
									*Kepco	SM14-30AM	0-14	30	0.01	0.05	1	bcde	762	
HC 7	*Power/	BP-8G	0-8	12	0.01	0.01	0.25	abcdeij	290	*NJE	TC-14-	5-14	200	0.5	0.5	1000	abcd	1550
	*Kepco	K58-15M	0-8	15	0.005	0.01	1	abcde	657	*Trygon	LQS12-5.7	11-15	5.7	0.01	0.01	0.5		174
	*Power/	BP-8H	0-8	15	0.01	0.01	0.25	abcdeij	345	*Kepco	CP515-6M	0-15	6	0.0005	0.005	0.2	abcde	366
	*Kepco	K58-25M	0-8	25	0.005	0.01	1	abcde	798	*Kepco	JQE15-6M	0-15	6	0.0005	0.005	0.2	abcde	289
	*Trygon	M3PB-250V	0-8	25	±0.005	0.005	1		575	Hyp	HY-S1-	0-15	10	0.01	0.01	0.5	abcdeij	299
	*Kepco	K58-50M	0-8	50	0.005	0.01	1	abcde	1103		15-10							
	*Trygon	M5PB-500V	0-8	50	±0.005	0.005	1		750	*Kepco	PR15-10M	0-7.5-15	10	±1	2	2%	cde	378
	*Trygon	M7CB-100-	0-8	100	±0.005	0.005	1		995	*Trygon	LH512-10	11-15	10	0.01	0.01	0.5		229
										*Kepco	CP515-12M	0-15	12	0.0005	0.005	0.2	abcde	585
	*Kepco	K58-100M	0-8	100	0.005													



# POWER : DIGITAL SUPPLY with READOUT



## Power Supply Specs:

**Voltage Regulation** ..... (Load) 0.01% + 1 mv  
 (Line) 0.005%

**Current Regulation** ..... (Load) 1.0% + 10 ma  
 (Line) 1.0% + 10 ma

**Ripple (RMS)** ..... 250 microvolts

**Meters** ..... Voltmeter — 3 ranges  
 Ammeter — 3 ranges

## Plug in I.C. Regulator Cards

**Voltage Resolution (3 mv-15 mv)**

## Digital Readout Specs:

### Power Supply Output Readout

Voltage — (19.99V-199.9V) Two Ranges  
 Current\* (.5-1.0-2.0-4.0A) Single Range

### External Voltage Readout

Voltage — (19.99V-199.9V) Two Ranges  
 To be applied into DVM on front panel terminals.

### Three Digit Display with "1" overrange

### Readout Accuracy 0.1%

\*current readout will depend on  
 max. rating of mated power supply.

## FEATURES

- Dial your Output Voltage or Current and Readout on Display.
- Improved Resolution and Voltage/Current Accuracy.
- BCD Signal available for Digital Printout.
- Useable as DVM to read external voltage.

Model No.	Ratings		Price(1)	Model No.	Ratings		Price(1)
	Voltage	Current			Voltage	Current	
LVC II/DVM 10-2	0-10V	0-2A	\$399	LVC II/DVM 10-4	0-10V	0-4A	\$446
LVC II/DVM 20-1	0-20V	0-1A	\$399	LVC II/DVM 20-2	0-20V	0-2A	\$446
LVC II/DVM 50-.5	0-50V	0-.5A	\$399	LVC II/DVM 50-1	0-50V	0-1A	\$446

(1) Price includes Digital Readout as described above.

**ALSO AVAILABLE WITH 0.01% CURRENT REGULATION (PVC POWER SUPPLY)**

# NJE CORPORATION

*Electronic Development and Manufacture*

a subsidiary of  Corporation

**Kenilworth, New Jersey 07033 / (201) 272-6000 / TELEFAX: FFP • TWX: (710) 996-5967**

INFORMATION RETRIEVAL NUMBER 605

	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
HC 8	*Kepco	CPS15-25M	0-15	25	0.0005	0.005	0.2	abcde	660	*H-P	6261B	0-20	50	0.01	0.01	0.5	abcde	775
	*Kepco	JQE15-25M	0-15	25	0.0005	0.005	0.2	abcde	625	Hyp	HY-S1-20-50	0-20	50	0.01	0.01	0.5	abcdej	1240
	*Trygon	L3R12-25	11-15	25	±0.005	0.005	0.5		470									
	*Trygon	M5P15-30	0-15	30	±0.005	0.005	1		660	EMC	SCR20-125	0-20	125	0.01	0.1	5	abcde	1150
	*Kepco	PR15-30M	0-15	30	±1	2	2%	cde	552	*Sorensen	DCR20-125	0-20	144	±0.075	±0.075	0.4%	abcdej	1150
	*Kepco	CPS15-50M	0-15	50	0.0005	0.005	0.2	abcde	995	*Trygon	CR20-150	20	150	0.2	0.2	150		1450
	*Trygon	M5C15-50	0-15	50	±0.005	0.005	1		845	EMC	SCR20-250	0-20	250	0.1	0.1	5	abcde	1500
	*Kepco	JQE15-50M	0-15	50	0.0005	0.005	0.2	abcde	977	*Sorensen	DCR20-250A	0-20	275	±0.1	±0.1	160	abcdej	1500
	*Trygon	L5R12-50	11-15	50	±0.005	0.005	0.5		565									
*Trygon	M7C15-80	0-15	80	±0.005	0.005	1		1250	EMC	SCR20-500	0-20	500	0.1	0.1	5	abcde	2900	
HC 9	Christie	SC015-100-125	2-15	100	0.2	0.2	0.2	abcde	1025	*Trygon	LQS18-4.3	13.5-20.5	4.3	0.01	0.01	0.5		174
	*H-P	6453A	0-15	200	0.2%	0.2%	150	abcdey	1375	*Trygon	LHS18-7.5	13.5-20.5	7.5	0.01	0.01	0.5		229
	Dynace	KHC15/15	14-16	3.2	20.05	20.05	2	abdfg	325	*Trygon	LHS18-13	13.5-20.5	13	0.01	0.01	0.5		320
	Wanless	MP-16	0-16	4	±0.01	±0.01	0.25	dev	225	*Trygon	L3R18-20	13.5-20.5	20	±0.005	±0.005	0.5		505
	Wanless	PCD-16	0-16	4	±0.005	±0.005	0.5		375	*Trygon	L5R18-40	13.5-20.5	40	±0.005	0.005	0.5		620
	Chalco	H1636F5	8-16	25.5	0.005	0.005	0.01%	abdj	510	*ERA	MS244	23-24	4	0.01	0.05	0.8	abdk	455
	Chalco	T1631F5	11-16	30.6	0.005	0.005	0.01%	abdj	510	Wanless	PSS2-24	24	5	±0.005	±0.01	0.75	w	325
	Chalco	H1643F7	8-16	42.8	0.005	0.005	0.01	abdj	665	MS248	23-24	8	0.01	0.05	0.8	abdk	595	
	Chalco	T1651F7	11-16	51	0.005	0.005	0.01%	abdj	655	Plastic	LV24-400	23.5-24.5	4	0.05	0.05	3	abdfghj	150
	*Power/Mate	BP-18E	0-18	3.5	0.01	0.01	0.25	abcdej	210	*Kepco	JQE25-4M	0-25	4	0.0005	0.005	0.2	abcde	289
										*Kepco	JQE25-9M	0-25	9	0.0005	0.005	0.2	abcde	520
									*Kepco	JQE25-18M	0-25	18	0.0005	0.005	0.2	abcde	625	
HC 10	*ERA	MS184	17-18	4	0.01	0.05	0.8	abdk	455	*Trygon	LH54-25	25	25	0.01	0.01	1		320
	*Sorensen	QSB12-4	9-18	4.4	±0.005	±0.005	0.25	abcdej	170	*Kepco	JQE25-36M	0-25	36	0.0005	0.005	0.2	abcde	977
	*Power/Mate	BP-18F	0-18	5	0.01	0.01	0.25	abcdej	235	*Kepco	K025-50M	0-25	50	1	1	40	abcde	995
	*Power/Mate	BP-18G	0-18	6.5	0.01	0.01	0.25	abcdej	290	*Sorensen	QSB18-3	13-26	3.3	±0.005	±0.005	0.25	abcdej	170
	*ERA	MS188	17-18	8	0.01	0.05	0.8	abdk	595	*Sorensen	QSB18-6	13-26	6.6	±0.005	±0.005	0.25	abcdej	255
	*Sorensen	QSB12-8	9-18	8.8	±0.005	±0.005	0.25	abcdej	225	*Sorensen	QSB18-12	13-26	13.2	±0.005	±0.005	0.25	abcdej	325
	*Power/Mate	BP-18H	0-18	9	0.01	0.01	0.25	abcdej	345	*Trygon	LQS24-3.3	18.5-27.5	3.3	0.01	0.01	0.5		174
	*Kepco	KS18-10M	0-18	10	0.005	0.01	1	abcde	604	*Trygon	LH524-5.7	18.5-27.5	5.7	0.01	0.01	0.5		219
	*Kepco	KS18-15M	0-18	15	0.005	0.01	1	abcde	762	*Trygon	LH524-10	18.5-27.5	10	0.01	0.01	0.5		279
	*Sorensen	QSB12-15	9-18	16.5	±0.005	±0.005	0.25	abcdej	325	*Trygon	L3R24-15	18.5-27.5	15	±0.005	0.005	0.5		470
										*Trygon	L5R24-30	18.5-27.5	30	±0.005	0.005	0.5		565
									*ERA	MS284	27-28	4	0.01	0.05	0.8	abdk	455	
HC 11	*Ratelco	PS-9	1-18	20	1	1	10		450	Wanless	MOS Series	5-28	2.1-5	±0.05	±0.05	0.75	du	125-325
	*Kepco	KS18-25M	0-18	25	0.005	0.01	1	abcde	1018	*ERA	MS288	27-28	8	0.01	0.05	0.8	abdk	595
	*Sorensen	QSB12-30	9-18	33	±0.005	±0.005	0.5	abcdej	550	Deltron	LA	3-28	39	0.005	0.005	1	abdgj	109-299
	*Kepco	KS18-50M	0-18	50	0.005	0.01	1	abcde	1428	Plastic	LV28-400	27.4-28.6	4	0.05	0.05	3	abdfghj	150
	*H-P	6466A	0-16-18	500, 600	0.2	0.2	180	abcdey	2600	Plastic	LV28-500	27.4-28.6	5.0	0.05	0.05	3	abdfghj	197
	*NJJE	PVC-20-4	0-20	4	0.01	0.01	0.25	abcde	295	*Power/Mate	BP-30F	0-30	3.5	0.01	0.01	0.25	abcdej	235
	*Mid-East	HW20-4	0-20	4	0.01	0.01	1		225	*Power/Mate	BP-30G	0-30	5	0.01	0.01	0.25	abcdej	290
	*Sorensen	QRS20-4	0-20	4.4	±0.01	±0.01	0.4	abcdej	255									
	Prec Stan	105	0-20	5	0.005	0.01	0.15	abcdef	269									
	*H-P	6285A	0-20	5	0.01	0.01	0.5	abcde	350									
	HC 12	Hyp	HY-S1-20-6	0-20	6	0.01	0.01	0.5	abcdej	249	Prec Stan	111	0-30	5	0.005	0.01	0.18	abcdej
*Techni		LA20-6M	0-20	6	±0.01	±0.15	0.2%	abcde	345	*Power/Mate	BP-30H	0-30	6.5	0.01	0.01	0.25	abcdej	345
*Trygon		RS20-7.5A	20	7.5	0.01	0.01	0.5		430	R-S	NGRS30/10	0-30	10	±10	0.001	0.3	cd	470
Prec Stan		110	0-20	7.5	0.005	0.01	0.15	abcdef	370	R-S	NGGS30/10	0-30	10	±10	0.05	0.5	cd	470
*NJJE		SVC-20-7.5M	0-20	7.5	0.01	0.01	1	abcde	375	EMC	SCR30-100	0-30	100	0.1	0.1	5	abcde	1250
*Sorensen		QRC20-8A	0-20	8	±0.005	±0.005	1	abcdej	425	EMC	SCR30-200	0-30	200	0.1	0.1	5	abcde	1600
*H-P		6286A	0-20	10	0.01	0.01	0.5	abcde	395	*ERA	MS324	31-32	4	0.01	0.05	0.8	abdk	455
*H-P		6263B	0-20	10	0.01	0.01	2	abcde	435	*ERA	LC325	4-32	6.5	±0.01	0.5	0.8	abd	189
*Mid-East		HW20-10	0-20	10	0.01	0.01	1		310	*ERA	TR Series	5-32	to 8	0.05	0.05	2	abdg	275-330
Hyp		HY-S1-20-10	0-20	10	0.01	0.01	0.5	abcdej	349									
HC 13		*Techni	LA20-12M	0-20	12	±0.01	±0.15	0.2%	abcde	375	*NJJE	TC-32-10M	10-32	10	0.5	0.5	1000	abcd
	*H-P	6427B	0-20	15	10mV	20mV	40	abcde	380	*ERA	LC3210	4-32	12.5	±0.01	0.05	0.8	abd	225
	*Trygon	RS20-15A	20	15	0.01	0.01	0.5		465	EPL	PSR-500-32	2-32	15	0.1	1.0	0.5%	c	395
	*Sorensen	QRC20-15A	0-20	15	±0.005	±0.005	1	abcdej	525	*NJJE	SP32-20	10-32	20	50mV	100mV	50	bcd	525
	*NJJE	SVC-20-15M	0-20	15	0.01	0.01	1	abcde	490	*NJJE	TC-32-20M	10-32	20	0.5	0.5	1000	abcd	445
	*Mid-East	PR20-15	0-20	15	0.01	0.01	1	abde	495	*NJJE	SP32-30	10-32	30	50mV	100mV	50	bcd	562
	*Mid-East	RA20-15	0-20	15	0.01	0.01	1	abd	415	*NJJE	TC-32-30M	10-32	30	0.5	0.5	1000	abcd	585
	*H-P	6264B	0-20	20	0.01	0.01	0.2	abcde	525	*NJJE	SP32-50	10-32	50	50mV	100mV	50	bcd	735
	Hyp	HY-S1-20-20	0-20	20	0.01	0.01	0.5	abcdej	449	*NJJE	TC-32-50M	10-32	50	0.5	0.5	1000	abcd	865
	*Techni	LA20-25M	0-20	25	±0.01	±0.15	0.2%	abcde	440									
	HC 14	*Mid-East	RA20-25	0-20	25	0.01	0.01	1		465	*NJJE	SP32-100	10-32	100	50mV	100mV	50	bcd
*Sorensen		QRC20-30A	0-20	30	±0.005	±0.005	1	abcdej	695	*NJJE	TC-32-120M	10-32	120	0.5	0.5	1000	abcd	1570
*NJJE		SVC-20-30M	0-20	30	0.01	0.01	1	abcde	690	*ERA	WR334	1-33	4.8	±0.01	0.05	0.8	abd	255
*Mid-East		PR20-30	0-20	30	0.01	0.01	1		670	*Trygon	LHS28-5.5	22-33	5.5	0.01	0.01	0.5		219
*H-P		6428B	0-20	45	20mV	40mV	40	abcde	550	*Trygon	LHS28-9	22-33	9	0.01	0.01	0.5		279

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We met their battery needs. What can we do for you?

When the Bogen Division of Lear Siegler Inc. designed its solid state Pagemaster—an ingenious pocket-sized device that enables a doctor on a call or a roving employee to be contacted wherever he may be—they needed a special kind of battery to power it. A battery tiny in size yet packed with energy. One that would far outlast ordinary batteries.

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Among our 1000-plus existing battery types—one of which is our high-rate (HRA-2401) Alkaline battery series recently developed for high-drain, low temperature applications—there may be one ready to meet your specifications. If not, we'll design one that will.

As we did for Bogen.

For more information about Mallory battery systems, write: Technical Sales Department, Mallory Battery Company, a division of P. R. Mallory & Co. Inc., South Broadway, Tarrytown, New York 10591. Telephone: 914-591-7000.

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INFORMATION RETRIEVAL NUMBER 606

# High Current Power Supplies

HC	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
HC 15	* ERA	WR338	1-33	9.6	±0.01	0.05	0.8	abd	305	* Techni	LA40-25M	0-40	25	±0.01	±0.15	0.2%	abcde	530
	Chalco	H3315F5	16-33	14.5	0.005	0.005	0.01%	abdj	510	* H-P	6434B	0-40	25	18mV	40mV	40	abcde	550
	* Trygon	L3R28-15	24-33	15	±0.005	0.005	0.5		470	* Trygon	M5C36-30	0-40	30	±0.005	0.005	1	abcde	690
	Chalco	T3318F5	22-33	17.8	0.005	0.005	0.01%	abdj	510	* Sorensen	QRC40-30A	0-40	30	±0.005	±0.005	1	abcdej	775
	Chalco	H3324F7	16-33	24	0.005	0.005	0.01	abdj	665	* Mid-East	RA40-30	0-40	30	0.01	0.01	1		665
	Chalco	T3330F7	22-33	30	0.005	0.005	0.01%	abdj	655	* H-P	6268B	0-40	30	0.01	0.01	1	abcde	695
	* Trygon	L5R28-30	24-33	30	±0.005	0.005	0.5		565	* Sorensen	DCR40-35A	0-40	40	±0.075	±0.075	0.4%	abcdej	750
	* ERA	SL36-4M	0-36	4	±0.01	0.05	1	abcde	290	* Trygon	M7C40-50	0-40	50	±0.005	0.005	1		975
* Sorensen	Q5B28-4	18-36	4.4	±0.005	±0.005	0.25	abcdej	255	* H-P	6269B	0-40	50	0.01	0.01	1	abcde	875	
HC 16	* NJE	RVC36-5M	0-36	5	0.01	0.01	1	abcde	375	EMC	SCR40-60A	0-40	60	0.1	0.1	5	abcde	1010
	Power Des	3650S	0-36	5	0.01	0.01	1.5	abcd	299	* Sorensen	DCR40-60A	0-40	69	±0.075	±0.075	0.4%	abcdej	925
	Power Des	3650R	0-36	5	0.01	0.01	0.5	abcde	350	EMC	SCR40-125	0-40	125	0.1	0.1	5	abcde	1375
	* Kepco	K536-5M	0-36	5	0.005	0.01	1	abcde	552	* Sorensen	DCR40-125A	0-40	138	±0.1	±0.1	160	abcdej	1375
	* Kepco	SM36-5AM	0-36	5	0.01	0.05	1	bcde	415	EMC	SCR40-250	0-40	250	0.1	0.1	5	abcde	2500
	* Kepco	JQE36-6M	0-36	6	0.0005	0.005	0.2	abcde	520	* Sorensen	DCR40-250A	0-40	275	±0.1	±0.1	160	abcdej	2340
	* ERA	SL36-8M	0-36	8	±0.01	0.05	1	abcde	355	* Sorensen	DCR40-500A	0-40	550	±0.1	±0.1	0.4%	abcdej	3850
	* Sorensen	Q5B28-8	18-36	8.8	±0.005	±0.005	0.25	abcdej	325									
* H-P	6433B	0-36	10	18mV		36mV	36	abcde	370									
HC 17	Power Des	36100R	0-36	10	0.01	0.01	0.5	abcde	463	* NJE	SP41-20	10-41	20	50mV	100mV	50	bcd	800
	* Kepco	K536-10M	0-36	10	0.005	0.01	1	abcde	657	* NJE	SP41-30	10-41	30	50mV	100mV	50	bcd	940
	* Kepco	SM36-10AM	0-36	10	0.01	0.05	1	bcde	552	Chalco	H4511F5	22-45	11	0.005	0.005	0.01%	abdj	510
	* NJE	SY36-10M	10-36	10	0.01	0.01	1	abcd	390	Chalco	T4514F5	29-45	13.8	0.005	0.005	0.01%	abdj	510
	* ERA	SL-36-12M	0-36	12	±0.01	0.05	1	abcde	455	Chalco	H4518F7	22-45	18.4	0.005	0.005	0.01%	abdj	665
	* Kepco	JQE36-13M	0-36	13	0.0005	0.005	0.2	abcde	625	Chalco	T4523F7	29-45	23	0.005	0.005	0.01%	abdj	655
	* NJE	RVC-36-15M	0-36	15	0.01	0.01	1	abcde	545	* Kepco	K045-30M	0-45	30	1	1	20	abcde	895
	* Kepco	K536-15M	0-36	15	0.005	0.01	1	abcde	767	Deltron	OEM	3-48	9	0.05	0.05	1	abdgi	75-85
* Kepco	SM36-15AM	0-36	15	0.01	0.05	1	bcde	657	Deltron	N	3-48	36	0.005	0.005	0.5	abdgi	79-299	
HC 18	* Trygon	M5P36-15	0-36	15	±0.005	0.005	1		615	* Christie	SC048-40-125	2-48	40	0.25	0.25	20	abcde	940
	* NJE	SY-36-20M	10-36	20	0.01	0.01	1	abcd	485	R-S	NGR550/5	0-50	5	±10	0.001	0.2	cd	670
	* ERA	SL36-25M	0-36	25	±0.01	0.05	1	abcde	650	EMC	SCR50-200	0-50	200	0.1	0.1	10	abcde	2500
	* NJE	RVC-36-25M	0-36	25	0.01	0.01	1	abcde	690	* NJE	TC-52-6M	20-52	6	0.5	0.5	1000	abcd	420
	Power Des	36250A	0-36	25	0.01	0.01	0.5	abcde	875	* NJE	TC-52-12M	20-52	12	0.5	0.5	1000	abcd	850
	* Kepco	JQE36-25M	0-36	25	0.0005	0.005	0.2	abcde	977	* Trygon	LH548-3.3	32-53	3.3	0.01	0.01	0.5		229
	* Kepco	K536-30M	0-36	30	0.005	0.01	1	abcde	1208	* Trygon	LH548-5.8	32-53	5.8	0.01	0.01	0.5		295
	* NJE	SY-36-30M	10-36	30	0.01	0.01	1	abcd	645	* Trygon	L3R48-8.5	32-53	8.5	±0.005	0.005	0.5		520
* H-P	6456B	0-36	100	0.2%	0.2%	160	abcdey	1275	* Trygon	L5R48-17	32-53	17	±0.005	0.005	0.5		640	
HC 19	* Trygon	CR36-100	36	100	0.2	0.2	150		1350	* Kepco	JQE55-9M	0-55	9	0.0005	0.005	0.2	abcde	625
	Hyp	HY-CR3-28-100	18-36	100	0.2	0.2	180	abcdej	1150	EPL	PSR-500-55	2-55	10	0.1	1.0	0.5%	c	395
	* H-P	6469A	0-36	300	0.2	0.2	180	abcde	2300	* Kepco	JQE55-18M	0-55	18	0.0005	0.005	0.2	abcde	977
	Plastic	LV36-400	35.3-36.7	4	0.05	0.05	3	abdfghj	215	Atlas	P3130	45-55	25	±2%	±2%	1%	d	835
	Christie	SC036-50-125	2-37	50	0.25	0.25	200	abcde	839	* Power/Mate	BP-60H	0-60	3.25	0.01	0.01	0.25	abcdej	360
	* Kepco	PR38-5M	0-19-38	5	±1	2	1%	cde	357	* NJE	SVC-60-3.5M	0-60	3.5	0.01	0.01	1	abcde	365
	* Kepco	PR38-15M	0-38	15	±1	2	1%	cde	520	Hyp	HY-S1-60-5	0-60	5	0.01	0.01	0.5	abcdej	349
	* Sorensen	QRC40-4A	0-40	4	±0.005	±0.005	1	abcdej	350	* H-P	6438B	0-60	5	30mV	60mV	120	abcde	360
* NJE	SVC-40-5M	0-40	5	0.01	0.01	1	abcde	345										
* Mid-East	HW40-5	0-40	5	0.01	0.01	1		295										
HC 20	Hyp	HY-S1-40-5	0-40	5	0.01	0.01	0.5	abcdej	299	* Kepco	KS60-5M	0-60	5	0.005	0.01	1	abcde	678
	* H-P	6266B	0-40	5	0.01	0.01	0.2	abcde	435	* NJE	SY-60-6M	10-60	6	0.01	0.01	1	abcd	420
	* H-P	6291A	0-40	5	0.01	0.01	0.5	abcde	395	* Mid-East	RA60-7	0-60	7	0.01	0.01	1		425
	* Trygon	RS40-5A	40	5	0.01	0.01	0.5		445	* Mid-East	PR60-7	0-60	7	0.01	0.01	1		500
	* Techni	LA40-6M	0-40	6	±0.01	±0.15	0.2%	abcde	360	* NJE	SVC-60-7M	0-60	7	0.01	0.01	1	abcde	595
	* Sorensen	QRC40-8A	0-40	8	±0.005	±0.005	1	abcdej	470	* Trygon	RS60-7.5A	60	7.5	0.01	0.01	0.5		625
	* NJE	SVC-40-10M	0-40	10	0.01	0.01	1	abcde	475	Hyp	HY-S1-60-7.5	0-60	7.5	0.01	0.01	1	abcdej	499
	* Mid-East	PR-40-10	0-40	10	0.01	0.01	1		485	* Kepco	KS60-10M	0-60	10	0.005	0.01	1	abcde	940
* Mid-East	RA40-10	0-40	10	0.01	0.01	1		415	* Trygon	M5P60-10	60	10	±0.005	0.005	1		660	
* Hyp	HY-S1-40-10	0-40	10	0.01	0.01	0.5	abcdej	399										
HC 21	* H-P	6267B	0-40	10	0.01	0.01	0.2	abcde	525	* NJE	SY-60-12M	10-60	12	0.01	0.01	1	abcd	515
	* Trygon	RS40-10A	40	10	0.01	0.01	0.5		475	Lambda	LK-340A	0-60	13.5	0.015	0.015	0.5	abcdeg	330
	* Sorensen	DCR40-10A	0-40	11.5	±0.075	±0.075	0.4%	abcdej	360	* NJE	SVC-60-14M	0-60	14	0.01	0.01	1	abcde	690
	* Techni	LA40-12M	0-40	12	±0.01	±0.15	0.2%	abcde	420	* Mid-East	PR60-14	0-60	14	0.01	0.01	1		670
	* Sorensen	QRC40-15A	0-40	15	±0.005	±0.005	1	abcdej	650	* Mid-East	RA60-14	0-60	14	0.01	0.01	1		510
	* NJE	SVC-40-20M	0-40	20	0.01	0.01	1	abcde	670	* Trygon	M5C60-15	60	15	±0.005	0.005	1		725
	* Mid-East	PR40-20	0-40	20	0.01	0.01	1		675	* Sorensen	DCR60-13A	0-60	15	±0.075	±0.075	0.4%	abcdej	500
	* Mid-East	RA40-20	0-40	20	0.01	0.01	1		440	* H-P	6439B	0-60	15	60mV	120mV	60	abcde	550
* Raelco	PS-8	1-40	20	1	1	10		500	* H-P	6274A	0-60	15	0.01	0.01	0.5	abcde	695	
* Sorensen	DCR40-20A	0-40	23	±0.075	±0.075	0.4%	abcdej	500										

	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV			
HC 22	*NJE	SY-60-18M	10-60	18	0.01	0.01	1	abcd	665	EPL	PSR-500-125	2-125	5	0.1	1.0	0.5%	425		
	*Kepco	KS60-20M	0-60	20	0.005	0.01	1	abcde	1418	*Mid-East	RA125-6.5	0-125	6.5	0.01	0.01	1	560		
	*Mid-East	RA60-20	0-60	20	0.01	0.01	1		675	*NJE	SVC-125-6.5M	0-125	6.5	0.01	0.01	1	abcde	1110	
	*Sorensen	DCR60-25A	0-60	28.8	±0.075	±0.075	0.4%	abcdej	875	*Mid-East	PR125-6.5	0-125	6.5	0.01	0.01	1	875		
	*Trygon	M7C60-30	60	30	±0.005	0.005	1		1070	*Trygon	L3R100-4	80-126	4	±0.005	0.005	0.5	530		
	Lambda	LK-350	0-60	35	0.015	0.015	0.5	abcdeg	640	*Trygon	L5R100-8	80-126	8	±0.005	0.005	0.5	680		
	*Sorensen	DCR60-40A	0-60	45	±0.075	±0.075	0.4%	abcdej	1090	*Sorensen	DCR150-5A	0-150	5.75	±0.075	±0.075	0.4%	abcdej	600	
	Lambda	LK-360-FM	0-60	66	0.015	0.015	0.5	abcdej	950	*Sorensen	DCR150-10A	0-150	11.5	±0.075	±0.075	0.4%	abcdej	850	
	*H-P	6459A	0-64	50	0.2	0.2	160	abcdey	1275	*Sorensen	DCR150-15A	0-150	17.3	±0.075	±0.075	0.4%	abcdej	900	
*H-P	6472A	0-64	150	0.02	0.02	160	abcdey	2600	*Sorensen	DCR150-35A	0-150	38.5	±0.1	±0.1	500	abcdej	1500		
HC 23	*Trygon	CR65-55	0-65	55	0.2	0.2	150		1350	*Sorensen	DCR150-70A	0-150	77	±0.1	±0.1	500	abcdej	2495	
	*Kepco	K070-20M	0-70	20	1	1	30	abcde	995	*Kepco	PR1556-4M	0-155	4	±1	2	0.6%	cde	473	
	*Kepco	SM75-5AM	0-75	5	0.01	0.05	1	bcde	552	*Kepco	SM160-4AM	0-160	4	0.01	0.05	1	bcde	657	
	*Kepco	JQE75-6.5M	0-75	6.5	0.0005	0.005	0.2	abcde	625	*Trygon	M5C160-5	160	5	±0.005	0.005	1		995	
	*Kepco	SM75-8AM	0-75	8	0.01	0.05	1	bcde	657	*Trygon	M7C160-15	160	5	±0.005	0.005	1		1550	
	*Kepco	JQE75-13M	0-75	13	0.0005	0.005	0.2	abcde	977	*Techni	LA160-6M	0-160	6	±0.01	±0.15	0.2%	abcde	565	
	*NJE	TC-80-4M	25-80	4	0.5	0.5	1000	abcd	850	*Trygon	M7C160-8	160	8	±0.005	0.005	1		1250	
	*Sorensen	DCR80-5A	0-80	5.75	±0.075	±0.075	0.4%	abcdej	380	*Techni	LA160-12M	0-160	12	±0.01	±0.15	0.2%	abcde	680	
	*Techni	LA80-6M	0-80	6	±0.01	±0.15	0.2%	abcde	430	*Trygon	SCR160-30	0-160	30	0.1	0.1	10	abcde	1500	
*NJE	TC-80-8	25-80	8	0.5	0.5	1000	abcd	545	*Trygon	L5R150-6	115-161	6	±0.005	0.005	0.5		690		
HC 24	*Sorensen	DCR80-10A	0-80	11.5	±0.075	±0.075	0.4%	abcdej	600	*Trygon	Deltron	L	0.5-200	72	0.005	0.005	0.5	abdgi	190-924
	*Kepco	PR80-8M	0-80	8	±1	2	0.7%	cde	499	*H-P	6477A	0-220	50	0.2	0.2	330	abcdey	2600	
	*Techni	LA80-12M	0-80	12	±0.01	±0.15	0.2%	abcde	535	Deltron	C	3-250	36	0.003	0.003	0.5	abdgi	75-470	
	*NJE	TC-80-20	25-80	20	0.5	0.5	1000	abcd	850	*Sorensen	DCR300-5A	0-300	5.75	±0.075	±0.075	0.4%	abcdej	850	
	*Sorensen	DCR80-18A	0-80	20.7	±0.075	±0.075	0.4%	abcdej	850	*Sorensen	DCR300-8A	0-300	9.2	±0.075	±0.075	0.4%	abcdej	925	
	*Techni	LA80-25M	0-80	25	±0.01	±0.15	0.2%	abcde	660	*Sorensen	DCR300-18A	0-300	19.8	±0.1	±0.1	0.4%	abcdej	1500	
	*Sorensen	DCR80-30A	0-80	34.5	±0.075	±0.075	0.4%	abcdej	900	*Sorensen	DCR300-35A	0-300	38.5	±0.1	±0.1	0.4%	abcdej	2495	
	*Trygon	L3R65-6	50-83	6	±0.005	0.005	0.5		530	*H-P	6479A	0-300	35	0.2	0.2	300	abcdey	2600	
	*Trygon	L5R65-12	50-83	12	±0.005	0.005	0.5		650	Lambda	LB-700	0-300	300	0.05	0.1	10	abcdeg	1100	
*Kepco	JQE100-5M	0-100	5	0.0005	0.005	0.2	abcde	625	EMC	SCR500-5	0-500	5	0.1	0.1	10	abcde	1300		
HC 25	*NJE	TC-100-6	40-100	6	0.5	0.5	1000	abcd	625	EMC	SCR500-10	0-500	10	0.1	0.1	10	abcde	1700	
	R-S	NGR100/10	0-100	10	±10	0.001	0.5	cd	750	*H-P	6483B	0-440	25,	0.5	0.5	600	abcdey	2600	
	*Kepco	JQE100-10M	0-100	10	0.0005	0.005	0.2	abcde	977			0-500,	20,						
	Deltron	SP	0-100	50	0.005	0.005	0.5	abcdej	220-920			0-600	15						
	EMC	SCR100-100	6-100	100	0.1	0.1	10	abcde	2500										
	*Trygon	CR10-30	110	30	0.2	0.2	550		1450										
	*H-P	6475A	0-110	100	0.2	0.2	220	abcdey	2600										
	*Kepco	KS120-5M	0-120	5	0.005	0.01	1	abcde	1019										
	*Kepco	KS120-10M	0-120	10	0.005	0.01	1	abcde	1523										
*Mid-East	RA125-3.2	0-125	3.2	0.01	0.01	1		425											
HC 26	*Mid-East	PR125-3.2	0-125	3.2	0.01	0.01	1		575										
	*NJE	SVC-125-3.2M	0-125	3.2	0.01	0.01	1	abcde	765										

- a. Remote programming
- b. Remote sensing
- c. Price includes meters
- d. Solid state
- e. Automatic crossover from constant current to constant voltage.
- f. Dual output
- g. This model designation covers a series of modular supplies. These supplies are listed in the tables according to their output voltage.
- h. Control section and high voltage tank enclosed in one unit.
- i. Reversible polarity.
- k. Specify BC series for 0.5% line & load regulation at reduced cost.
- p. 310 series for remote programming and sensing.
- t. Multi output type
- u. Select any voltage by selecting the desired voltage and current after letter series. Constant current models available.
- v. IC Power Supply
- w. Slot type
- y. Line & load regulation combined

## Index by Model Number

Name	Model	Code	Name	Model	Code	Name	Model	Code
Atlas	P3070	HC5	H4518F7	HC17		T0782F7	HC5	
Atlas Controls	P3130	HC19	H0739F5	HC5		SCO15-100-12S	HC9	
			H0744F5	HC5		SCO36-50-12S	HC19	
Beco	301	HC1	H0764F7	HC5		Electric Corp.	SCO48-40-12S	HC18
Beco Solid State Systems	302	HC6	H0774F7	HC5				
			T1631F5	HC9		Deltron	C	HC25
			T1651F7	HC9		Deltron, Inc.	L	HC24
			T3330F7	HC15			LA	HC11
Chalco	H1636F5	HC9	T4514F5	HC17			N	HC17
Chalco Engineering	H1643F7	HC9	T4523F7	HC17			OEM	HC17
	H3315F5	HC15	T0458F5	HC1			SP	HC25
	H3324F7	HC15	T0497F7	HC1				
	H4511F5	HC17	T0749F5	HC5		Dynage	KHC10/10	HC4



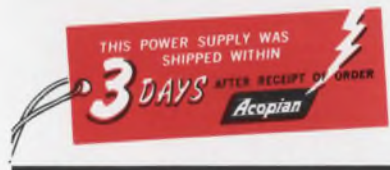
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# POWER SUPPLIES

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## Index by Model Number (continued)

Name	Model	Code	Name	Model	Code
Dynage, Inc.	KHC12/12	HC6		6463A	HC1
	KHC15/15	HC9		6464A	HC7
EMC Electronic Measurement Div.	SCR10-250	HC3		6466A	HC11
	SCR10-500	HC3		6469A	HC19
	SCR20-125	HC8		6472A	HC22
	SCR20-250	HC8		6475A	HC25
	SCR20-500	HC8		6477A	HC24
	SCR30-100	HC12		6479A	HC25
	SCR30-200	HC12		6483B	HC26
	SCR40-60	HC16		275	HC1
	SCR40-125	HC16		<b>Holt</b>	
	SCR40-250	HC16		Holt	
	SCR50-200	HC18		Instrument	
	SCR100-100	HC25		<b>Hyp</b>	
	SCR160-30	HC24		Hyperion	HY-CR3-28-100
SCR500-5	HC25		Industries	HY-S1-5-50	HC2
SCR500-10	HC25			HY-S1-10-12.5	HC2
				HY-S1-10-25	HC2
				HY-S1-10-100	HC3
				HY-S1-15-10	HC7
				HY-S1-20-6	HC12
				HY-S1-20-10	HC12
				HY-S1-20-20	HC13
				HY-S1-20-50	HC8
				HY-S1-40-5	HC20
				HY-S1-40-10	HC20
				HY-S1-60-5	HC19
				HY-S1-60-7.5	HC20
				CPS500-1	HC1
<b>EPL</b>	PSR-500032	HC13	<b>Int Cont</b>		
Electro- Products Labs	PSR-500-55	HC19	International		
	PSR-500-125	HC21	Contronics		
<b>ERA</b>	CP55	HC2	<b>Kepeco</b>	SPS6-10M	HC3
Electronic Research Associates	CP510	HC2	Kepeco Inc.	SPS6-22M	HC3
	CP517	HC2		CPS6-45M	HC4
	CP525	HC2		CPS6-90M	HC4
	CP550	HC2		CPS15-6M	HC7
	LC325	HC12		CPS15-12M	HC7
	LC3210	HC13		CPS15-25M	HC8
	MS074	HC4		CPS15-50M	HC8
	MS078	HC4		JQE6-10M	HC3
	MS124	HC5		JQE6-22M	HC3
	MS128	HC5		JQE6-45M	HC3
	MS184	HC10		JQE6-90M	HC4
	MS188	HC10		JQE15-6M	HC7
	MS244	HC9		JQE15-12M	HC7
	MS248	HC9		JQE15-25M	HC8
	MS284	HC10		JQE15-50M	HC8
	MS288	HC11		JQE25-4M	HC9
	MS324	HC12		JQE25-9M	HC9
	SL36-4M	HC15		JQE25-18M	HC9
	SL36-8M	HC16		JQE25-36M	HC10
	SL36-12M	HC17		JQE36-6M	HC16
	SL36-25M	HC18		JQE36-15M	HC17
	SR054	HC2		JQE36-25M	HC18
	SR058	HC2		JQE55-4.5M	HC18
	SR0218	HC1		JQE55-9M	HC19
	SR0225	HC1		JQE55-18M	HC19
	TR Series	HC12		JQE75-6.5M	HC23
	WR334	HC14		JQE75-13M	HC23
WR338	HC15		JQE100-5M	HC24	
			JQE100-10M	HC25	
			KO12-100M	HC5	
			KO25-50M	HC10	
			KO45-30M	HC17	
			KO70-20M	HC23	
			KS8-15M	HC7	
			KS8-25M	HC7	
			KS8-50M	HC7	
			KS8-100M	HC7	
			KS18-10M	HC10	
			KS18-15M	HC10	
			KS18-25M	HC11	
			KS18-50M	HC11	
			KS36-5M	HC16	
			KS36-10M	HC17	
			KS36-15M	HC17	
			KS36-30M	HC18	
<b>H-P</b>	6256B	HC2			
Hewlett- Packard Co.	6259B	HC3			
	6260B	HC3			
	6261B	HC8			
	6263B	HC12			
	6264B	HC13			
	6266B	HC20			
	6267B	HC21			
	6268B	HC15			
	6269B	HC15			
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	6281A	HC5			
	6282A	HC1			
	6285A	HC11			
	6286A	HC12			
	6291A	HC20			
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# Index by Model Number (continued)

Name	Model	Code	Name	Model	Code	Name	Model	Code
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	DCR300-5A	HC25		LA10-12M	HC2		L3R65-6	HC24
	DCR300-8A	HC25	<b>Techni</b>	LA10-25M	HC2		L3R100-4	HC22
	DCR300-18A	HC25	Technipower,	LA20-6M	HC12		L5R-4-70	HC1
	DCR300-35A	HC25	Inc.	LA20-12M	HC13		L5R6-70	HC6
	QRC20-8A	HC12		LA20-25M	HC13		L5R8-25	HC4
	QRC20-15A	HC13		LA40-6M	HC20		L5R10-50	HC4
	QRC20-30A	HC14		LA40-12M	HC21		L5R12-50	HC8
	QRC40-4A	HC19		LA40-25 M	HC15		L5R18-40	HC9
	QRC40-8A	HC20		LA80-6M	HC23		L5R24-30	HC10
	QRC40-30A	HC15		LA80-12M	HC24		L5R28-30	HC15
	QRE7.5-10	HC5		LA80-25M	HC24		L5R48-17	HC18
	QRE7.5-20	HC5		LA160-6M	HC24		L5R65-12	HC24
	QRE7.5-50	HC5		LA160-12M	HC24		L5R100-8	HC22
	QRS20-4	HC11	<b>Trygon</b>	CR10-30	HC25		L5R150-6	HC24
	QSB6-4	HC1	Trygon	CR20-150	HC8		LH54-14	HC1
	QSB6-8	HC1	Electronics	CR36-100	HC19		LH54-25	HC10
	QSB6-15	HC1		CR65-55	HC23		LH56-13.5	HC6
	QSB6-30	HC1		HH7-40V	HC4		LH56-24	HC6
	QSB12-4	HC10		L3R-4-40	HC1		LH58-11.5	HC3
	QSB12-8	HC10		L3R6-40	HC6		LH58-21	HC3
	QSB12-15	HC10		L3R8-25	HC4		LHS10-11.5	HC4
	QSB12-30	HC11		L3R10-25	HC4		LHS10-21	HC4
	QSB18-3	HC10		L3R12-25	HC8		LHS12-10	HC7
	QSB18-6	HC10		L3R18-20	HC9		LHS12-18	HC7
	QSB18-12	HC10		L3R24-15	HC10		LHS18-7.5	HC9
	QSB28-4	HC15		L3R28-15	HC15		LHS18-13	HC9
							LHS24-5.7	HC10
							LHS24-10	HC10
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							LHS28-9	HC14
							LHS48-3.3	HC18
							LHS48-5.8	HC18
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							LQS4-8.4	HC3
							LQS6-7.7	HC6
							LQS8-3.1	HC3
							LQS8-6.5	HC3
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							M3P8-250V	HC7
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							M5C36-30	HC15
							M5C60-15	HC21
							M5C160-5	HC24
							M5P8-500V	HC7
							M5P15-30	HC8
							M5P36-15	HC18
							M5P60-10	HC20
							M7C8-100-0V	HC7
							M7C15-80	HC8
							M7C40-50	HC15
							M7C60-30	HC22
							M7C160-8	HC24
							M7C160-15	HC24
							RS20-7.5A	HC12
							RS20-15A	HC13
							RS40-5A	HC20
							RS40-10A	HC21
							RS60-7.5A	HC20
						<b>Wanless</b>	LABI	HC4
						Wanless	MOS series	HC11
						Electric Co.	MP-16	HC9
							PCD16	HC9
							PSS1-5	HC2
							PSS1-12	HC5
							PSS2-5	HC2
							PSS2-12	HC5
							PSS2-24	HC9
							SSS1-1	HC4
							SSS2-1	HC4

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INFORMATION RETRIEVAL NUMBER 610

# Constant Current Power Supplies

	Mfr	Model	OUTPUT			REGULATION			Notes	Price \$	Mfr	Model	OUTPUT			REGULATION			Notes	Price \$	
			Min mA	Max Amps	Max Volts	Line %	Load %	Ripple mV					Min mA	Max Amps	Max Volts	Line %	Load %	Ripple mV			
CC 1	North Hills	CS-120	0.0001	0.001	2000	0.07	0.07	0.15%		995	* Trygon	HR40-750	0	0.75	40	0.01	0.05	0.15	abcde	169	
	* Kepco	ABC2500M	0	0.002	2500	0.1	0.1	0.1	abcde	383	* Kepco	CK40-0.8M	1	0.8	40	0.01	0.01	0.05%	abcde	281	
	North Hills	CS-151	0.1	0.01	±10	0.0005	0.0005	0.0002%	bdj	2995	* Kepco	H88AM	0	0.8	325	0.01	0.01	0.01%	abcde	435	
	* Kepco	ABC1500M	0	0.01	1500	0.1	0.1	0.1	abcde	309	* Kepco	ABC2-1M	0	1	2	0.1	0.5	0.1%	abcde	131	
	* Kepco	ABC1000M	0	0.02	1000	0.1	0.1	0.1	abcde	309	* Kepco	ABC15-1M	0	1	15	0.1	0.5	0.1%	abcde	175	
	* Kepco	ABC425M	0	0.05	425	0.1	0.1	0.1	abcde	220	* Trygon	SHR20-3A	0	1	20	0.01	0.01	0.5	abcde	239	
	* Kepco	ABC200M	0	0.1	200	0.1	0.1	0.1	abcde	220	* Trygon	DL40-1	0	1	20	0.01	0.01	0.25	abcdef	249	
	* H-P	61868	0	0.1	300	25ppm	25ppm	0.005	abcde	475	* Kepco	CC21-1M	0	1	21	0.0005	0.005	0.02%	abcde	195	
												* Trygon	DL40-1	0	1	40	0.01	0.01	0.25	abcdef	249
	CC 2	* Kepco	BHK2000-0.1M	0	0.1	2000	100µA	100µA	0.1	abcde	825	* Trygon	SHR60-1A	0	1	60	0.01	0.01	0.05	abcdef	239
Keithley		225	1x10 <sup>-7</sup>	0.1	±100	±0.005	±0.005	0.01%	dej	550	* Kepco	JQE100-1M	0	1	100	0.005	0.01	0.02%	abcde	300	
North Hills		CS-11	0.001	0.1	100	0.001	0.001	0.02%	d	1295	* Kepco	KS120-1M	0	1	120	0.01	0.01	0.1%	abcde	578	
EMC		C612AM	0.001	0.1	260	0.15	0.10	0.0005	abc	320	* Kepco	H8250M	0	1	250	0.01	0.01	0.01%	abcde	595	
* Kepco		PAX100-0.1HS	1	0.1	100	0.1	0.1	1		104	North Hills	CS-12	0.001	1	12.5	0.001	0.001	0.02%	d	1495	
Int. Cont.		CC200	30	0.1	100	0.05	0.05	1		190	EMC	C630CM	0.01	1	280	0.15	0.10	0.004	abc	962	
North Hills		CS-152	0.1	0.15	±25	0.0005	0.0005	0.0002%	bdj	3495	* Kepco	PAX7-1HS	1	1	7	0.1	0.1	1		104	
											* Sorensen	DCR300-1.25A	0	1.44	300	±0.075	±0.075	0.4%	abcdej	400	
											* Kepco	CC15-1.5M	0	1.5	15	0.0005	0.005	0.02%		195	
CC 3		North Hills	CS-153	0.1	0.15	±100	0.0005	0.0005	0.0002%	bdj	4500	* Trygon	HH32-1.5	0	1.5	32	0.01	0.01	0.5	abcde	165
	* Kepco	PAX72-1.5HS	1	0.15	72	0.1	0.1	1		104	* Trygon	HR20-1.5	0	1.5	20	0.01	0.05	0.15	abcde	169	
	* Kepco	CC100-0.2M	0	0.2	100	0.0005	0.0005	0.02%		195	* Kepco	CK36-1.5M	1	1.5	36	0.01	0.01	0.05%	abcde	321	
	* Kepco	ABC100-0.2M	0	0.2	100	0.1	0.5	0.1%	abcde	197	* Trygon	SHR40-1.5A	0	1.5	40	0.01	0.01	0.5	abcde	239	
	* Kepco	H82AM	0	0.2	325	0.01	0.01	0.01%	abcde	325	* Kepco	JQE75-1.5M	0	1.5	75	0.005	0.01	0.02%	abcde	300	
	* Kepco	BHK1000-0.2M	0	0.2	1000	100µA	100µA	0.1	abcde	825	* Kepco	CC7-2M	0	2	7	0.0005	0.005	0.02%	abcde	195	
											* Kepco	ABC7.5-2M	0	2	7.5	0.1	0.5	0.1%	abcde	175	
											* Trygon	DL40-1	0	2	20	0.01	0.01	0.25	abcdef	249	
											* Trygon	T50-2	0	2	50	0.05	0.05	0.5	bcde	249	
	CC 4	Buchler	3-1014A	4	0.2	1000	±1	±1	1	edj	595	* Kepco	JQE55-2M	0	2	55	0.005	0.01	0.02%	abcde	300
EMC		C633CM	0.0022	0.22	730	0.15	0.10	0.001	abc	700	* Kepco	KS60-2M	0	2	60	0.01	0.01	0.1%	abcde	552	
* H-P		6181B	0	0.25	100	25ppm	0.02		abcde	425	Deltron	CA/CD	0	2	100	0.05	0.05	0.25	abde	99-	
* Kepco		ABC30-0.3M	0	0.3	30	0.1	0.5	0.1%	abcde	131									119		
* Kepco		CC72-0.3M	0	0.3	72	0.0005	0.005	0.02%		195	* Trygon	HR160-2B	0	2	160	0.01	0.01	0.5	abcde	510	
EMC		C633CM	0.0022	0.3	420	0.15	0.10	0.0005	abc	500	* Trygon	HR60-2.5B	0	2.5	60	0.01	0.01	0.5	abcde	355	
* Kepco		PAX36-0.3HS	1	0.3	36	0.1	0.1	1		104	* Kepco	JQE-100-2.5M	0	2.5	100	0.005	0.01	0.02%	abcde	520	
* Kepco		BHK500-0.419	0	0.4	500	100µA	100µA	0.1	abcde	825	* Kepco	KS120-2.5M	0	2.5	120	0.01	0.01	0.1	abcde	730	
											Plastic	LVC5-250	500	2.5	4.9-5.1	0.05	0.05	3	abdfghj	132	
CC 5		* Kepco	H8 4AM	0	0.4	325	0.01	0.01	0.01%	abcde	365	* Sorensen	DCR150-2.5A	0	2.88	150	±0.075	±0.075	0.4%	abcdej	360
	* Kepco	CC40-0.5M	0	0.5	40	0.0005	0.005	0.02%		195	* Sorensen	DCR300-2.5	0	2.88	300	±0.075	±0.075	0.4%	abcdej	600	
	* Kepco	ABC40-0.5M	0	0.5	40	0.1	0.5	0.1%	abcde	175	* Trygon	HH15-3	0	3	15	0.01	0.01	0.5	abcde	169	
	* H-P	6177B	0	0.5	50	25ppm	25ppm	0.04	abcde	425	* Kepco	JQE36-3M	0	3	36	0.005	0.01	0.02%	abcde	289	
	* Trygon	SHR160-500B	0	0.5	160	0.01	0.01	0.5	abcde	329	* Trygon	HR40-3B	0	3	40	0.01	0.01	0.5	abcde	325	
	* Trygon	DL40-1	0	0.5	40	0.01	0.01	0.25	abcdef	249	* Kepco	JQE75-3M	0	3	75	0.005	0.01	0.02%	abcde	520	
	* Kepco	ABC18-0.5M	0	0.5	18	0.1	0.5	0.1%	abcde	131	Deltron	RP	0	3	100	.005	.005	0.25	abcdej	159-205	
	CC 6	* Kepco	H8525M	0	0.5	525	0.01	0.01	0.01%	abcde	550	* Kepco	CK18-3M	1	3	18	0.01	0.01	0.05%	abcde	321
North Hills		CS-111	0.001	0.5	250	0.0025	0.0025	0.03%	d	1795	Plastic	LVC48-300	500	3	47-49	0.05	0.05	3	abdfghj	225	
* Kepco		PAX21-0.5HS	1	0.5	21	0.1	0.1	1		104	Plastic	LVC36-300	500	3	35.3-36.7	0.05	0.05	3	abdfghj	160	
* Kepco		CK60-0.5M	1	0.5	60	0.01	0.01	0.05%	abcde	321	* Trygon	HH7-40V	0	4	7	0.01	0.01	0.5	abcde	189	
* Kepco		H86AM	0	0.6	325	0.01	0.01	0.01%	abcde	395	* Kepco	JQE25-4M	0	4	25	0.005	0.01	0.02%	abcde	289	
* Kepco		ABC10-.75M	0	0.75	10	0.1	0.5	0.1%	abcde	131	* Sorensen	QRC40-4A	0	4	40	±0.005	±0.005	0.2	abcde	350	
* Kepco		PAX15-.75HS	1	0.75	15	0.1	0.1	1		104	Plastic	LVC12-400	500	4	12.25	0.05	0.05	3	abdfghj	149	
											Plastic	LVC24-400	500	4	24.5	0.05	0.05	3	abdfghj	160	
											Plastic	LVC28-400	500	4	28.6	0.05	0.05	3	abdfghj	160	
											Plastic	LVC36-400	500	4	36.7	0.05	0.05	3	abdfghj	225	

Reader service numbers for literature and application notes, see page D6.

Companies advertising in the power supply section are marked by an asterisk.

Additional features explained on p. D36.

Manufacturers and model numbers, see p. D37.

# Weston does its own thing: an AC/DC, Volts/Amps/Ohms, bench/panel/portable DMM...

Nobody does it like Weston, because nobody else has as much metering and digital experience.

That's why our new Model 1240 multi-meter is not just an assemblage of stock components fitted to a package, but a custom-designed instrument embodying the very latest in technology by the leader in precision measurement.

From its rugged, glass-filled thermo-plastic case down to its feather-touch pushbuttons, this is proprietary engineering at its finest.

Versatility? The Weston 1240 goes anywhere. It will fit your attache case, weighs only four pounds when carried by its self-contained handle (which doubles as a tilt stand for bench use), and comes completely equipped for

mounting in a standard 3½" panel. No extras to buy.

An external switch provides for 115V or 230V operation, and if you're in the boondocks you can plug in an optional battery pack.

Other user exclusives . . . complete circuit overload protection, fuses replaceable from outside the case, recessed controls, in-house designed positive-detent range switch, pluggable Nixie\* tubes, automatic polarity and outrange indication.

Performance-wise, the Model 1240 is a 3½-digit, high-impedance unit with ten DC, ten AC and six Ohms ranges, plus full voltage and current measuring capability. Accuracy is 0.1% of reading  $\pm .05\%$  F.S. on DC volts.

Weston engineered features include patented dual slope\*\* integration and shunt circuitry, ultra-reliable gold-on-gold switch contacts, and non-blinking display with automatic decimal positioning.

Also available at less cost is our Model 1241 DC volt/ohm meter. Both models are in stock now for immediate delivery. See them at your Weston Distributor, or ask us about the "going thing" in measurement . . . the Model 1240 DMM by Weston.

WESTON INSTRUMENTS DIVISION,  
Weston Instruments, Inc., Newark, N.J.  
07114, a Schlumberger company

**WESTON®**

\*Registered trademark, Burroughs Corp.  
\*\*U.S. Pat. #3,051,939 and patents pending.

for  
**\$379.<sup>50</sup>**  
complete.



	Mfr	Model	OUTPUT			REGULATION			Notes	Price \$	Mfr	Model	OUTPUT			REGULATION			Notes	Price \$
			Min mA	Max Amps	Max Volts	Line %	Load %	Ripple mV					Min mA	Max Amps	Max Volts	Line %	Load %	Ripple mV		
CC 7	* Kepco	JQE55-4.5M	0	4.5	55	0.005	0.01	0.02%	abcde	520	* Kepco	KS36-15M	0	15	36	0.01	0.01	0.1%	abcde	767
	* Trygon	HR20-5B	0	5	20	0.01	0.01	0.5	abcde	329	* Trygon	M5P36-15	0	15	36	±0.005	0.005	1	abcde	615
	* Trygon	HR40-5B	0	5	30	0.01	0.01	0.5	abcde	325	* Sorensen	QRC40-15A	0	15	40	±0.005	±0.005	0.2	abcde	650
	* Kepco	KS36-5M	0	5	36	0.01	0.01	0.1%	abcde	552	* Trygon	M5C60-15	0	15	60	±0.005	0.005	1	abcde	725
	Power Des	3650R	0	5	36	0.01	0.01	0.5	abcde	350	* Sorensen	DCR60-13A	0	15	60	±0.075	±0.075	0.4%	abcde	500
	* Trygon	RS40-5A	0	5	40	0.01	0.01	0.5	abcde	445	* Trygon	M7C160-15	0	15	160	±0.005	0.005	1	abcde	1550
	* Trygon	HR60-5B	0	5	60	0.01	0.01	0.5	abcde	375	* Sorensen	DCR150-15A	0	17.3	150	±0.075	±0.075	0.4%	abcde	900
	* Kepco	KS60-5M	0	5	60	0.01	0.01	0.1%	abcde	678	* Kepco	JQE25-18M	0	18	25	0.005	0.01	0.02%	abcde	625
	* Trygon	DL40-1	0	5	80	0.01	0.01	0.25	abcdef	249	* Kepco	JQE55-18M	0	18	55	0.005	0.01	0.02%	abcde	977
										Chalco	V0019F5	0	19	100	0.005	0.005	0.01%	abcde	1000	
CC 8	* Kepco	JQE100-5M	0	5	100	0.005	0.01	0.02	abcde	625	* Sorensen	DCR300-18A	0	19.8	300	±0.1	±0.1	0.4%	abcde	1500
	* Kepco	KS120-5M	0	5	120	0.01	0.01	0.1%	abcde	1019	* Kepco	KS60-20M	0	20	60	0.01	0.01	0.1%	abcde	1418
	* Trygon	M5C160-5	0	5	160	±0.005	0.005	1	abcde	995	* Sorensen	DCR80-18A	0	20.7	80	±0.075	±0.075	0.4%	abcde	850
	* Kepco	CK8-5M	1	5	8	0.01	0.01	0.05%	abcde	363	* Kepco	JQE6-22M	0	22	6	0.005	0.01	0.02	abcde	520
	Plastic	LVC28-500	500	5	28.6	0.05	0.05	3	abdfghj	207	Chalco	V5022F7	0	22	150	0.005	0.005	0.01%	abcde	1200
	* Sorensen	DCR80-5A	0	5.75	80	±0.075	±0.075	0.4%	abcde	380	* Sorensen	DCR40-20A	0	23	40	±0.075	±0.075	0.4%	abcde	500
	* Sorensen	DCR150-5A	0	5.75	150	±0.075	±0.075	0.4%	abcde	600	* Kepco	KS8-25M	0	25	8	0.01	0.01	0.1%	abcde	798
	* Sorensen	DCR300-5A	0	5.75	300	±0.075	±0.075	0.4%	abcde	850	* Trygon	M3P8-250V	0	25	8	±0.005	0.005	1	abcde	575
	* Kepco	JQE15-6M	0	6	15	0.005	0.01	0.02%	abcde	289	* Kepco	JQE15-25M	0	25	12	0.005	0.01	0.02%	abcde	625
CC 9	* Kepco	JQE36-6M	0	6	36	0.005	0.01	0.02%	abcde	520	* Kepco	KS18-25M	0	25	18	0.01	0.01	0.1%	abcde	1428
	Plastic	LVC12-600	500	6	12.25	0.05	0.05	3	abdfghj	171	Power Des	36250A	0	25	36	0.01	0.01	0.5	abcde	875
	* Kepco	JQE75-6.5M	0	6.5	75	0.005	0.01	0.02%	abcde	625	* Kepco	JQE36-25M	0	25	36	0.005	0.01	0.02%	abcde	977
	* Trygon	RS20-7.5A	0	7.5	20	0.01	0.01	0.5	abcde	430	* Spectra	6030	200	28	75	0.005	0.005	2	acd	2290
	* Trygon	HR40-7.5B	0	7.5	40	0.01	0.01	0.5	abcde	395	* Sorensen	DCR60-25A	0	28.8	60	±0.075	±0.075	0.4%	abcde	875
	* Trygon	RS60-7.5A	0	7.5	60	0.01	0.01	0.5	abcde	625	* Trygon	M5P15-30	0	30	15	±0.005	0.005	1	abcde	660
	Plastic	LVC5-750	500	7.5	5.1	0.05	0.05	3	abdfghj	171	* Sorensen	QRC20-30A	0	30	20	±0.005	±0.005	0.2	abcde	695
	* Sorensen	QRC20-8A	0	8	20	±0.005	±0.005	0.2	abcde	425	* Trygon	M5C36-30	0	30	36	±0.005	0.005	1	abcde	690
	* Sorensen	QRC40-8A	0	8	40	±0.005	±0.005	0.2	abcde	470	* Kepco	KS36-30M	0	30	36	0.01	0.01	0.1%	abcde	1208
										* Sorensen	QRC40-30A	0	30	40	±0.005	±0.005	0.2	abcde	775	
CC 10	* Trygon	M7C160-8	0	8	160	±0.005	0.005	1	abcde	1250	Chalco	F6030F5	0	30	60	0.005	0.005	0.01%	abcde	950
	* Kepco	CK2-8M	1	8	2	0.01	0.01	0.05%	abcde	363	* Trygon	M7C60-30	0	30	60	±0.005	0.005	1	abcde	1070
	Plastic	LVC12-800	500	8	12.25	0.05	0.05	3	abdfghj	189	* Trygon	CR110-30	0	30	110	0.2	0.2	550	cey	1450
	* Kepco	JQE25-9M	0	9	25	0.005	0.01	0.02%	abcde	520	Spectra	6021	100	30	30	0.005	0.005	5	acd	1180
	* Kepco	JQE55-9M	0	9	55	0.005	0.01	0.02%	abcde	625	Spectra	6121	-300	+30	30	0.005	0.005	5	acd	1240
	* Sorensen	DCR300-8A	0	9.2	300	±0.075	±0.075	0.4%	abcde	925	Chalco	V0032F7	0	32	100	0.005	0.005	0.01%	abcde	1200
	* Kepco	JQE6-10M	0	10	6	0.005	0.01	0.02%	abcde	289	Spectra	6010	1000	33	300	0.005	0.005	10	cdf	12,850
	* Kepco	KS18-10M	0	10	18	0.01	0.01	0.1%	abcde	762	Spectra	6009	1000	33	300	0.005	0.005	10	cd	7780
	* Trygon	HR20-10B	0	10	20	0.01	0.01	0.5	abcde	369	* Sorensen	DCR80-30A	0	34.5	80	±0.075	±0.075	0.4%	abcde	900
	* Kepco	KS36-10M	0	10	36	0.01	0.01	0.1%	abcde	657	* Kepco	JQE25-36M	0	36	25	0.005	0.01	0.02%	abcde	977
	Power Des	36100R	0	10	36	0.01	0.01	0.5	abcde	463	Chalco	F4538F5	0	38	45	0.005	0.005	0.01%	abcde	900
	* Trygon	RS40-10A	0	10	40	0.01	0.01	0.5	abcde	475	* Sorensen	DCR150-35A	0	38.5	150	±0.1	±0.1	500	abcde	1500
* Trygon	M5P60-10	0	10	60	±0.005	0.005	1	abcde	660	* Sorensen	DCR300-35A	0	38.5	300	±0.1	±0.1	0.4%	abcde	2495	
* Kepco	KS60-10M	0	10	60	0.01	0.01	0.1%	abcde	940	* Sorensen	DCR40-35A	0	40	40	±0.075	±0.075	0.4%	abcde	750	
* Kepco	JQE100-10M	0	10	100	0.005	0.01	0.02%	abcde	977	Christie	SC048-40-125	2000	42	48	0.25	0.25	200	abcde	940	
* Kepco	KS120-10M	0	10	120	0.01	0.01	0.1%	abcde	1523	* Kepco	JQE6-45M	0	45	6	0.005	0.01	0.02%	abcde	625	
Halt	275	10	10	10	0.1	0.05	0.15, 0.02%	cd	2060	* Sorensen	DCR60-40A	0	45	60	±0.075	±0.075	0.4%	abcde	1090	
CC 12	* Sorensen	DCR80-10A	0	11.5	80	±0.075	±0.075	0.4%	abcde	600	Chalco	F3348F5	0	48	33	0.005	0.005	0.01%	abcde	900
	* Sorensen	DCR150-10A	0	11.5	150	±0.075	±0.075	0.4%	abcde	850	* Kepco	KS8-50M	0	50	8	0.01	0.01	0.1%	abcde	1103
	* Kepco	JQE15-12M	0	12	15	0.005	0.01	0.02%	abcde	520	* Trygon	M5P8-500V	0	50	8	±0.005	0.005	1	abcde	750
	* Kepco	JQE36-13M	0	13	36	0.005	0.01	0.02%	abcde	625	* Kepco	JQE15-50M	0	50	15	0.005	0.01	0.02%	abcde	977
	* Kepco	JQE75-13M	0	13	75	0.005	0.01	0.02%	abcde	977	* Trygon	M5C15-50	0	50	15	±0.005	0.005	1	abcde	845
	Chalco	V5013F5	0	13	150	0.005	0.005	0.01%	abcde	1000	* Kepco	KS18-50M	0	50	18	0.01	0.01	0.1%	abcde	1428
	* Kepco	KS8-15M	0	15	8	0.01	0.01	0.1%	abcde	657	* Trygon	M7C40-50	0	50	40	±0.005	0.005	1	abcde	975
	* Kepco	KS18-15M	0	15	18	0.01	0.01	0.1%	abcde	1018	Chalco	F6050F7	0	50	60	0.005	0.005	0.01%	abcde	1100
	* Sorensen	QRC20-15A	0	15	20	±0.005	±0.005	0.2	abcde	525	Deltron	SP	0	50	100	0.005	0.005	0.5	abcde	195-
	* Trygon	RS20-15A	0	15	20	0.01	0.01	0.5	abcde	465									925	

- a. Remote programming
- b. Remote sensing
- c. Price includes meters
- d. Solid state
- e. Automatic crossover from constant current to constant voltage.
- f. Dual output
- g. This model designation covers a series of modular supplies. These supplies are listed in the tables according to their output voltage.
- h. Control section and high voltage tank enclosed in one unit.
- i. Reversible polarity.
- y. Line & load regulation combined

Reader service numbers for literature and application notes, see page D6.

Companies advertising in the power supply section are marked by an asterisk.

Manufacturers and model numbers, see p. D37.

	Mfr	Model	OUTPUT			REGULATION			Notes	Price \$	Mfr	Model	OUTPUT			REGULATION			Notes	Price \$	
			Min mA	Max Amps	Max Volts	Line %	Load %	Ripple mV					Min mA	Max Amps	Max Volts	Line %	Load %	Ripple mV			
CC 13	*Trygon	CR65-55	0	55	65	0.2	0.2	0.15	cey	1350	*Sorensen	DCR40-125A	0	138	40	±0.1	±0.1	160	abcdej	1375	
	Christie	SC015-50-125	2500	55	37	0.25	0.25	200	abcde	839	*Sorensen	DCR20-125A	0	144	20	0.075	0.075	0.4%	abcdej	1150	
	Chalco	F4563F7	0	63	45	0.005	0.005	0.01%	abcdej	1000	*Trygon	CR20-150	0	150	20	0.2	0.2	0.15	cey	1450	
	*Sorensen	DCR40-60A	0	69	40	±0.075	±0.075	0.4%	abcdej	925	Spectra	6004	-1000	+155	56	0.0005	0.0005	3	acdj	5990	
	Chalco	F1675F5	0	75	16	0.005	0.005	0.01%	abcdej	900	Spectra	6020	-1.5A	262	94	0.0005	0.0005	6	acdj	9600	
	*Sorensen	DCR150-70A	0	77	150	±0.1	±0.1	500	abcdej	2495	Sorensen	DCR20-250A	0	275	20	±0.1	±0.1	160	abcdej	1500	
*Trygon	M7C15-80	0	80	15	±0.005	0.005	1	abcde	1250												
CC 14	Chalco	F3380F7	0	80	33	0.005	0.005	0.01%	abcdej	1000	*Sorensen	DCR40-250A	0	275	40	±0.1	±0.1	15	abcdej	2340	
	*Kepco	JQE6-90M	0	90	6	0.005	0.01	0.02%	abcde	977	*Sorensen	DCR40-500A	0	500	550	±0.1	±0.1	0.4%	abcdej	3850	
	*Kepco	KS8-100M	0	100	8	0.01	0.01	0.1%	abcde	1523	*Sorensen	DCR20-1000	0	1100	20	±0.1	±0.1	160	abcdej	4200	
	*Trygon	M7C8-1000V	0	100	8	±0.005	0.005	1	abcde	995											
	*Trygon	CR36-100	0	100	36	0.2	0.2	0.15	cey	1350											
	Spectra	6003	-1000	+110	39.6	0.0005	0.0005	2	acdj	4940											
	Christie	SC015-100-125	5000	110	15	0.2	0.2	50	abcde	1025											
Chalco	A1625F7	0	125	16	0.005	0.005	0.01%	abcdej	1000												

## Index by Model Number

Name	Model	Code	Name	Model	Code	Name	Model	Code
Buchler	3-1014A	CC4	ABC30-0.3M	CC4		JQE55-2M	CC4	
Buchler Instruments			ABC40-0.5M	CC5		JQE55-4.5M	CC7	
Chalco	A1625F7	CC14	ABC100-0.2M	CC3		JQE55-9M	CC10	
Chalco Engineering	F1675F5	CC13	ABC200M	CC2		JQE55-18M	CC7	
	F3348F5	CC12	ABC425M	CC1		JQE75-3M	CC5	
	F3380F7	CC13	ABC1000M	CC1		JQE75-6.5M	CC9	
	F4538F5	CC11	ABC1500M	CC1		JQE75-13M	CC12	
	F4563	CC13	ABC2500M	CC1		JQE100-1M	CC2	
	F6030F5	CC10	BHK500-0.419	CC4		JQE100-2.5M	CC4	
	F6050F7	CC12	BHK1000	CC3		JQE100-5M	CC8	
	V0019F5	CC7	CC7-2M	CC3		JQE100-10M	CC11	
	V0032F7	CC10	CC15-1.5M	CC2		KS8-15M	CC12	
	V5013F5	CC12	CC21-1M	CC1		KS8-25M	CC8	
	V5022F7	CC8	CC40-0.5M	CC5		KS8-50M	CC12	
Christie	SC015-12S	CC14	CC72-0.3M	CC4		KS18-10M	CC10	
Christie Electric Corp.	SC015-50-12S	CC13	CC100-0.2M	CC3		KS18-15M	CC12	
	SC048-40-12S	CC11	CK2-8M	CC10		KS18-25M	CC9	
Deltron	CA/CD	CC4	CK8-5M	CC8		KS18-50M	CC12	
Deltron, Inc.	RP	CC5	CK18-3M	CC5		KS36-5M	CC7	
	SP	CC12	CK36-1.5M	CC3		KS36-10M	CC10	
EMC	C612AM	CC2	CK40-0.8M	CC1		KS36-15M	CC7	
Electronic Measurement Div.	C630CM	CC2	CK60-0.5M	CC6		KS36-30M	CC9	
	C633CM	CC4	HB2AM	CC3		KS60-2M	CC4	
H-P	6177B	CC5	HB4AM	CC5		KS60-5M	CC7	
Hewlett-Packard Co.	6181B	CC4	HB6AM	CC6		KS60-10M	CC11	
	6186B	CC1	HB8AM	CC1		KS60-20M	CC8	
Holt	275	CC11	HB250M	CC2		KS120-1M	CC2	
Holt Instrument			HB525M	CC6		KS120-2.5M	CC4	
Int. Cont. International Contronics	CC200	CC2	JQE6-10M	CC10		KS120-5M	CC8	
			JQE6-22M	CC8		KS120-10M	CC11	
Keithley	225	CC2	JQE6-45M	CC11		PAX7-1HS	CC2	
Keithley Instruments			JQE6-90M	CC14		PAX15-.75HS	CC6	
			JQE7.5-1.5M	CC3		PAX21-0.5HS	CC6	
			JQE15-6M	CC8		PAX36-0.3HS	CC4	
			JQE15-12M	CC12		PAX72-.15HS	CC3	
			JQE15-25M	CC8		PAX100-0.1HS	CC2	
			JQE15-50M	CC12				
			JQE25-4M	CC6		North Hills	CS-11	CC2
			JQE25-9M	CC10		North Hills	CS-12	CC2
			JQE25-18M	CC7		Electronics	CS-111	CC6
			JQE25-36M	CC10			CS-120	CC1
			JQE36-3M	CC5			CS-151	CC1
			JQE36-6M	CC9			CS-152	CC2
			JQE36-13M	CC12			CS-153	CC3
			JQE36-25M	CC9		Plastic	LVC5-250	CC4

# CREATE YOUR OWN POWER SUPPLY SUB-SYSTEMS

## with OFF THE SHELF TDM modules

all on a single panel (we'll assemble it for you)



Transistor Devices' famous TDM and TDMD modules may be grouped together and bolted on a single 5¼" panel to meet your exact requirements in a single package. No expensive cabling, racks, or accessories required. Modules feature front panel voltage and current limit adjustment, test points, and indicator lamps. OV crowbar protection is built in.

### SPECIFICATIONS

- Input 103.5 — 126.5 V, 47 — 63 Hz
- Outputs 0 — 305 V, 0 — 60 A
- Transient Response 50 Usec
- Temperature Coefficient .01% / °C
- 0 — 55°C Ambient at full rating

REGULATION	TDM	TDMD
LINE	.01% + 5 mV	.1% + 10 mV
LOAD	.01% + 5 mV	.1% + 10 mV
RIPPLE	.001% + 200 μV	.01% + 1 mV

6

# TRANSISTOR DEVICES INC.

85 HORSEHILL RD., CEDAR KNOLLS  
N. J. 07927 · (201) 267-1900

INFORMATION RETRIEVAL NUMBER 612

## Index by Model Number (continued)

Name	Model	Code	Name	Model	Code	Name	Model	Code
Plastic Capacitors	LVC5-750	CC9	DCR150-15A	CC7	HR20-10B	CC10		
	LVC12-400	CC6		DCR150-35A		CC11	HR40-3B	CC5
	LVC12-600	CC9		DCR150-70A		CC13	HR40-5B	CC7
	LVC12-800	CC10		DCR300-1.25A		CC2	HR40-7.5B	CC9
	LVC24-400	CC6		DCR300-2.5A		CC5	HR40-750	CC1
	LVC28-400	CC6		DCR300-5A		CC8	HR60-2.5B	CC4
	LVC28-500	CC8		DCR300-18A		CC8	HR60-5B	CC7
	LVC36-300	CC6		DCR300-35A		CC11	HR160-2B	CC4
LVC36-400	CC6	QRC20-8A		CC9		M3P8-250V	CC8	
Power Des Power De- signs, Inc.	3650R	CC7		QRC20-15A		CC12	M5C15-50	CC12
	36100R	CC11		QRC20-20A		CC9	M5C36-30	CC10
	36250A	CC9		QRC40-4A		CC6	M5C60-15	CC7
Sorensen Sorensen Operation, Raytheon Co.	DCR20-125A	CC13		QRC40-8A		CC9	M5C160-5	CC8
	DCR20-250A	CC13		QRC40-15A		CC7	M5P8-500V	CC12
	DCR20-1000	CC14	QRC40-30A	CC9	M5P15-30	CC9		
	DCR40-10A	CC11	Spectro Spectro- magnetic Industries	6003	CC14	M5P36-15	CC7	
	DCR40-20A	CC8		6004	CC13	M5P60-10	CC11	
	DCR40-35A	CC11		6020	CC13	M7C8-1000V	CC14	
	DCR40-60A	CC13		6021	CC10	M7C15-80	CC13	
	DCR40-125A	CC13		6030	CC9	M7C40-50	CC12	
	DCR40-250A	CC14		6121	CC10	M7C60-30	CC10	
	DCR40-500A	CC14		Trygon Trygon Electronics	CR20-150	CC13	M7C160-8	CC10
	DCR60-13A	CC7			CR36-100	SS14	RS20-7.5A	CC9
	DCR60-25A	CC9			CR65-55	CC13	RS20-15A	CC12
	DCR60-40A	CC11			CR110-30	CC10	RS40-5A	CC7
	DCR80-5A	CC8	DL40-1	CC1, CC3, CC5, CC7	RS40-10A	CC11		
DCR80-10A	CC12	HH7-40V	CC6	RS60-7.5A	CC9			
DCR80-18A	CC8		HH15-3	CC5	SHR20-3A	CC1		
DCR80-30A	CC10		HH32-1.5	CC3	SHR40-1.5A	CC3		
DCR150-2.5A	CC5		HR20-1.5	CC3	SHR60-1A	CC2		
DCR150-5A	CC8		HR20-5B	CC7	SHR160-500B	CC5		
DCR150-10A	CC12				T50-2	CC3		

# To the Businessmen of the Nation:

Each of us will be asked to take an active part in the 1970 census, the 19th time at 10-year intervals that our Nation has taken stock of its greatest asset, its people. Census Day will be April 1, 1970.

You will be asked to be your own census taker. Your census form will be delivered by mail, and you are asked to answer the questions about your household. Most of us, those who live in the larger metropolitan areas, will be asked to return the form, with all questions answered, by mail. In other areas census enumerators will call at your home to collect the form.

I ask you to use your position of leadership in your firm and your community to urge your associates also to fill out their census forms, and to follow instructions which tell each head of household whether to return the form by mail or hold it until a census enumerator calls to pick it up.

## IT'S EASY

Most households, four out of five, will have a maximum of 23 questions, requiring about 15 minutes for an average family. Simply use a pencil to fill in the circle which indicates the correct answer for each question. If you don't know the precise answer, your best estimate will be accepted.

## IT'S SECRET

No one but census employees ever will see your answers on a questionnaire and every census worker takes an oath of confidentiality. The information will be used only for statistical purposes. It will never be made available to tax collecting agencies, police or regulatory agencies. This is assured by the Federal Census Law and backed by long tradition of the Census Bureau.

## IT'S IMPORTANT

The statistics produced by a census tell all of us not only how many of us there are in the Nation and each of its parts, but also how we are living: whether we are gaining or losing in our efforts to provide adequate jobs, education, housing, and other elements that we have established as our goals and which segments of our population are being left behind in the attainment of those goals. The information provided by the census will be used to guide governments and businesses in major decisions during the coming years.

In the United States, everyone counts, and the census counts everyone!



*Maurice H. Stans*

MAURICE H. STANS  
Secretary of Commerce



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	Mfr	Model	OUTPUT			REGULATION			Notes	Price \$	Mfr	Model	OUTPUT			REGULATION			Notes	Price \$
			Min Volts	Max kV	Max Amps	Line %	Load %	Ripple mV					Min Volts	Max kV	Max Amps	Line %	Load %	Ripple mV		
HV 1	* Kepco	1520B	0	1.5	0.5	0.05	0.1	3		788	* Soellman	RHR16PN100	0	10	0.01	0.01	0.01	2000	acdj	675
	* Sorensen	DCR1500-1	15	1.5	1.15	±0.075	±0.075	±0.4%	abcdej	995	Fluke	410B	0	10	0.01	0.001	0.001	1		975
	* Kepco	ABC1500M	0	1.5	0.01	0.05	0.05	1		309	* Power Des	1543A	10	10	0.01	0.001	0.001	5	ehj	950
	* Kepco	ABC1500M	0	1.5	0.01	0.05	0.05	1	abcde	309	* NJE	S-328	1000	10	0.01	±0.01	±150mV	15	c	1530
	* H-P	6515A	0	1.6	0.005	0.01	0.01	2	cde	235	* NJE	H-10-25	0	10	0.025	±1	15-25	1%	c	910
	Vector	PM-1K-01A	200	1.8	0.01	0.001	0.001	2		365	* NJE	H-10-50	0	10	0.05	±1	15-25	2%	c	1065
	Grafix	503D	1500	2	3VA	0.005	0.2	0.15%	dfgh	368	* NJE	H-10-100	0	10	0.1	±1	15-25	3.5%	c	1585
	* Kepco	BHK2000-0.1M	0	2	0.1	0.005	0.01	1	abcde	850	* NJE	HH-10-250	0	10	0.25	±1	10	1%	c	2435
											* Spellman	HP10-500SR	0	10	0.5	±0.01	±0.01	2000	acj	req
											Grafix	510	6000	12	20VA	0.005	0.2	0.03%	dgh	405
HV 2	* Kepco	BHK2000-0.1M	0	2	0.1	0.005	0.01	1		850	* Sorensen	1012-50	0	12	0.05	0.2	n/a	0.01%	abcdhj	815
	* H-P	6522A	0	2	0.1	0.005	0.005	1	cde	750	* Sorensen	2012-250	0	12	0.25	±0.2	n/a	0.01%	abcdij	1865
	Power Des	2K10	1	2	0.01	0.002	0.002	1	chj	299	* Hipo	815PL	0	15	0.002	1	6.6	2.5%	cdh	600
	* Kepco	H82050	0	2	0.5	0.02	0.005	3		1733	* NJE	S-330	5000	15	0.002	±0.01	±0.01	15		1980
	Hamner	NV-13	1	2.012	0.01	0.0025	0.0025	1 p-p	a	425	* Spellman	RHR15PN120	0	15	0.006	0.01	0.01	3000	acdj	770
	Keithley	245	0.05	2.1	0.01	0.001	0.002	1	acdjhj	425	* NJE	H-15-10	0	15	0.01	±1	15-25	0.5%	c	925
	Fluke	412B	0	2.1	0.03	0.001	0.001	0.5		410	* NJE	H-15-20	0	15	0.02	±1	15-25	1%	c	1115
	Manroe	156	±1	2.11	0.0005	0.02	0.005	10	djhj	395	Grafix	515	12000	16	20VA	0.005	0.2	0.03%	dgh	498
	ITI	IT-322	-850	2.2	0.002	1	4	4500	df	250	* NJE	H-20-5	0	20	0.005	±1	15-25	1%	c	860
											* NJE	H-20-10	0	20	0.01	±1	15-25	1%	c	950
HV 3	* Kepco	ABC2500M	0	2.5	0.002	0.05	0.05	1		383	* NJE	H-20-20	0	20	0.02	±1	15-25	1%	a	1240
	* Kepco	ABC2500M	0	2.5	0.002	0.05	0.05	1	abcde	383	* Sorensen	1020-30	0	20	0.03	±0.2	n/a	0.01%	abcdhj	865
	Vector	PM-2K-01A	500	2.5	0.01	0.001	0.001	3		480	* NJE	H-20-50	0	20	0.05	±1	15-25	2%	c	1585
	* NJE	S-325	500	2.5	0.01	±0.01	±100mV	5	c	340	* Sorensen	2020-150	0	20	0.15	±0.2	n/a	0.01%	abcdij	2080
	* NJE	H-2.5-50	0	2.5	0.05	±1	15-25	2%	c	770	* Spellman	HP20-200SR	0	20	0.2	±0.01	±0.01	4000	acj	req
	* Kepco	H82500	0	2.5	0.05	0.02	0.005	5		1024	Grafix	520	16000	22	20VA	0.005	0.2	0.03%	dgh	557
	* NJE	H-2.5-100	0	2.5	0.1	±1	15-25	2%	c	825	* NJE	HH-25-100	0	25	0.1	±0.5	10	1%	c	2850
	* NJE	S-326	500	2.5	0.5	±0.01	±100mV	5	c	380	* Spellman	RHR30PN120	0	30	0.004	0.01	0.01	6000	acdj	950
	* NJE	HH2.5-1000	0	2.5	1	±1	10	1%	a	2400	* Sorensen	5030-4	5000	30	0.004	±0.005	±0.025	0.015	abcdhj	1085
	Grafix	503	1500	3	6VA	0.005	0.2	0.15%	dgh	276	* NJE	H-30-5	0	30	0.005	±1	15-25	0.5%	c	975
HV 4	Fluke	415B	0	3	ina	0.0005	0.0005	0.1		525	* NJE	H-30-10	0	30	0.01	±1	15-25	1%	c	1140
	* H-P	6110A	0	3	0.006	0.001	0.001	0.4	cde	495	* Sorensen	1030-20	0	30	0.02	±0.2	n/a	0.01%	abcdhj	895
	* H-P	6516A	0	3	0.006	0.01	0.01	1	cde	295	* NJE	H-30-35	0	30	0.035	±1	15-25	2%	c	1760
	Hamner	NV-19	0	3	0.01	0.001	0.001	ina	aj	460	* Spellman	RHR40PN120	0	40	0.003	0.01	0.01	8000	acdj	1020
	Vector	PM-3K-01A	500	3.5	0.01	0.001	0.001	4		570	Plastic	HVR500-251	ina	50	250µA	0.1	0.1	100V		540
	Keithley	246	0.05	3.1	0.01	0.001	0.002	1	cdhj	475	* NJE	HO-50-5	0	50	0.005	±1	15-25	2%	ci	1370
	Power Des	1544	1	3	0.02	0.001	0.001	1	chj	520	Del	LHRMSeries	0	50	0.01	0.03	0.03	0.03%	acd	615-
	Power Des	1547	1	3	0.04	0.001	0.001	1	chj	575									1980	
	* Sorensen	1003-200	0	3	0.2	0.2	n/a	0.01%	abcdhj	790	* NJE	HO-50-10	0	50	0.01	±1	15-25	3.5%	ci	1560
	* Sorensen	DCR3000-5A	30	3	0.575	±0.075	±0.075	0.4%	abcdj	1250	* NJE	HH050-50	0	50	0.015	±0.5	15-25	3.5%	ci	3090
HV 5	* Sorensen	2003-100	0	3	1	±0.2	n/a	0.01%	abcdij	1865	* NJE	HO-50-15	0	50	0.015	±1	15-25	3.5%	ci	2030
	* ERA	SAR3K/2	3000	3.1	0.002	±0.2	0.3	0.5%	dh	345	* Spellman	RHR60PN120	0	60	0.002	0.01	0.01	12000	acdj	1500
	Grafix	385	0	3.2	3VA	0.2	0.3	1%	adgh	350	* Hipo	860PL	0	60	0.002	1	6.6	2.5%	edh	1050
	Hamner	N-4035	750	3.55	0.035	0.002	0.001	0.5	a	650	* NJE	HO60-10	0	60	0.01	±1	15-25	3.5%	ci	1750
	* H-P	6525A	0	4	0.05	0.005	0.005	1	cde	750	* Sorensen	1061	0	60	0.01	±0.2	n/a	0.01%	abcdhj	1195
	Grafix	266	300	5	0.0001	1	5	0.05%	adgh	358	* Hipo	880PL	0	80	0.002	1	7.6	2.5%	edh	1800
	Hamner	N-4050	500	5	0.002	0.01	0.01	5		705	* Spellman	RHR100PI20	0	100	0.001	0.01	0.01	20000	acd	1800
	* ERA	HV15KM	0	5	0.015	0.01	0.01	5	abcdh	435	* Sorensen	1101	0	100	0.0015	±0.2	n/a	0.01%	abcdhj	1195
	* ERA	HV15KM	0	5	0.015	0.01	0.01	5	ina	435	* Hipo	8120PL	0	120	0.002	1	8.3	2.5%	edh	2500
	* NJE	S327	500	5	0.01	±0.01	±100mV	5	c	490	* NJE	HO-120-5	0	120	0.005	±1	15-25	2%	ci	2010
HV 6	* Spellman	RHR5PN50	0	5	0.01	0.01	0.01	1000	acdj	525	* Sorensen	1121	0	120	0.005	±0.2	n/a	0.01%	abcdhj	1595
	Vector	PM-5K-01A	500	5	0.01	0.001	0.001	5		690	* Sorensen	2120-30	0	120	0.03	±0.2	n/a	0.01%	abcdij	2800
	* NJE	H-5-25	0	5	0.025	±1	15-25	1	c	770	* Spellman	RHR150P300	0	150	0.002	0.01	0.01	30000	acd	req
	* NJE	H-5-50	0	5	0.05	±1	15-25	2%	c	825	* Sorensen	1151	0	150	0.005	±0.2	n/a	0.01%	abcdhj	1795
	* NJE	H-5-100	0	5	0.1	±1	15-25	3.5%	c	1015	* NJE	HO-150-5	0	150	0.005	±1	15-25	2%	ci	2335
	* NJE	H-5-200	0	5	0.2	±1	15-25	3.5%	c	1510	* NJE	HO-150-10	0	150	0.01	±0.5	15-25	4%	ci	3200
	* NJE	H-5-500	0	5	0.5	±1	15-25	1%	c	1850	* NJE	HH0-150-200	0	150	0.02	±0.5	15-25	3.5%	ci	2790
	* Spellman	HPS-1000SR	0	5	1	±0.01	±0.01	1000	req	1850	* NJE	HO-200-5	0	200	0.005	±0.5	15-25	3.5%	ci	4290
	* ERA	SAR5K/2	5000	5.1	0.002	±0.2	0.3	0.5%	dh	395	* NJE	HH0-250-5	0	250	0.005	±1	15-25	3.5%	ci	5525
	Grafix	505	3000	6	6VA	0.005	0.2	0.15%	dgh	298	* Spellman	RHR300P300	0	300	0.001	0.01	0.01	60000	acd	req
HV 7	Power Des	1556A	10	6	0.02	0.001	0.001	1.0	chj	625	Uni-Volt	BRE	500	600	10	0.01-	0.02-	0.005%	ehj	1000-
	Fluke	408B	0	6	0.02	0.001	0.001	1		665					0.1	0.1	0.01%		75k	
	* Sorensen	1006-100	0	6	0.1	0.2	n/a	0.01%	abcdhj	790										
	* Sorensen	DCR6000-.25A	60	6	0.287	±0.075	±0.075	0.4%	abcdj	1495										
	* Sorensen	2006-500	0	6	0.5	±0.2	n/a	0.01%	abcdij	1865										
	Grafix	3145	0	10	20VA	0.05	5</													



# Index by Model Number

Name	Model	Code	Name	Model	Code	Name	Model	Code
Bertan	602	HV7		HH-2.5-100	HV3		1101	HV5
Bertan Associates	615	HV7		HH-10-250	HV1		1121	HV6
				HH-25-100	HV3		1151	HV6
Del	LHRM series	HV4		HO-50-5	HV4		2003-100	HV5
Del Electronics				HO-50-10	HV4		2006-500	HV7
				HO-50-15	HV5		2012-250	HV2
ERA	HV15KM	HV5		HO-60-10	HV5		2020-150	HV3
Electronic Research Associates	SAR3K/2	HV5		HO-120-5	HV5		2120-30	HV6
	SAR5K/2	HV6		HO-150-5	HV6		5010-8	HV7
				HO-150-10	HV6		5030-4	HV3
Fluke	408B	HV7		HO-200-5	HV6		DCR1500-1A	HV1
John Fluke Manufacturing	410B	HV1		HHO-50-50	HV4		DCR3000-.5A	HV4
	412B	HV2		HHO-150-20	HV6		DCR6000-.25A	HV7
	415B	HV4		HHO-250-5	HV6	Spellman	HP5-1000SR	HV6
Grafix	266	HV5		S-325	HV3	Spellman	HP10-500SR	HV1
Grafix, Inc.	314S	HV7		S-326	HV3	High-Voltage	HP20-200SR	HV3
	385	HV5		S-327	HV5		RHR5PN50	HV6
	503	HV3		S-328	HV1		RHR10PN100	HV1
	503D	HV1	Plastic	S-330	HV2		RHR15PN120	HV2
	505	HV6	Plastic	HVR500-251	HV4		RHR30PN120	HV3
	510	HV1	Capacitors				RHR40PN120	HV4
	515	HV2					RHR60PN120	HV5
	520	HV3					RHR100P120	HV5
Hamner	N-4035	HV5	Power Des	2K10	HV2		RHR150P300	HV6
Hamner Electronics	N-4050	HV5	Power Designs, Inc.	1543A	HV1		RHR300P300	HV6
	NV-13	HV2		1544	HV4			
	NV-19	HV5		1547	HV4	Uni-Volt	BRE	HV7
H-P	6110A	HV4		1556A	HV7	Universal		
Hewlett Packard Co.	6515A	HV1	Sorensen	1003-200	HV4	Voltronics		
	6516A	HV4	Sorensen	1006-100	HV7	Vector	PM-2K-01A	HV3
	6522A	HV2	Operation, Raytheon Co.	1012-50	HV2	Vector Engineering, Inc.	PM-3K-01A	HV4
	6525A	HV5		1020-30	HV3		PM-5K-01A	HV6
Hipo	815P	HV2		1030-20	HV4			
Hipotronics, Inc.	860PL	HV5		1061	HV5			
	880PL	HV5						
	8120PL	HV5						
ITI	IT-322	HV2						
ITI Electronics, Inc.								
Keithley	245	HV2						
Keithley Instruments, Inc.	246	HV4						
Kepeco	1520B	HV1						
Kepeco, Inc.	ABC1500M	HV1						
	ABC2500M	HV3						
	BHK2000-0.1M	HV1, HV2						
	HB2050	HV2						
	HB2500	HV2						
Monroe	151	HV7						
Monroe Electronics	156	HV2						
NJE	H-2.5-50	HV3						
NJE Corp.	H-2.5-100	HV3						
	H-5-25	HV6						
	H-5-50	HV6						
	H-5-100	HV6						
	H-5-200	HV6						
	H-5-500	HV6						
	H-10-5	HV7						
	H-10-25	HV1						
	H-10-50	HV1						
	H-10-100	HV1						
	H-15-10	HV2						
	H-15-20	HV2						
	H-20-5	HV2						
	H-20-10	HV2						
	H-20-20	HV3						
	H-20-50	HV3						
	H-30-5	HV3						
	H-30-10	HV4						
	H-30-35	HV4						



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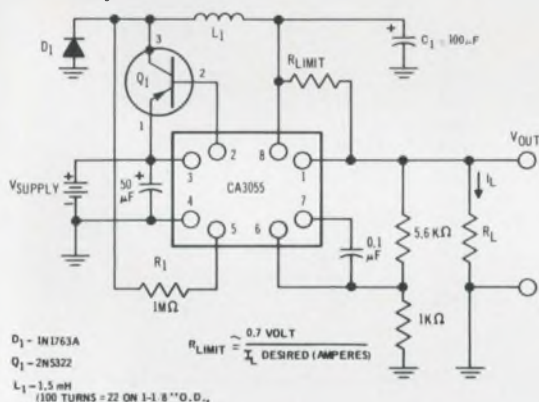


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# RCA Solid-State Data for Designers

## Switching regulator offers high efficiency

Where space and weight are important factors, the switching regulator has some impressive advantages. Here's why:



SWITCHING REGULATOR USING RCA-CA3055

The switching regulator is basically a relaxation oscillator (positive feedback is introduced via  $R_L$ ) and, unlike conventional Class A dc regulators, it's either in the "Off" state—with essentially zero internal dissipation—or saturated in the "On" state with low dissipation. Thus the operating efficiency is high.

The regulator's state is determined by the voltage difference between the internal reference (pin 5) and the sense input (pin 6). When the sense input is more negative than the reference, the regulator is on. Conversely, if the reference is more negative, the regulator is off.

The RCA-CA3055 makes an excellent switching regulator. Its load and line regulation capability is 0.025% and it can deliver up to 100 mA. It has an input voltage range of 7.5 V to 40 V and an adjustable output from 1.8 V to 34 V.

Circle Reader Service No. 641.

### Typical operating characteristics:

Output Impedance	<0.15 $\Omega$
Line Regulation	.03%
Efficiency	76.5%
Rise Time	1 $\mu$ s
Switching Frequency	60 kHz
Output Voltage	11 V
Output Current	400 mA

## No trade-off on power capability with two new high voltage types

RCA's 2N5804 and 2N5805 are two new triple-diffused silicon n-p-n transistors that offer the best in high-voltage, high power characteristics ( $P_T = 110$  W)—in an economical TO-3 package. Especially useful in efficient power conversions, the 2N5804 and 2N5805 will find design applica-

tion in switching inverters, series regulators, linear amplifiers, deflection amplifiers, and motor controls.



Designed primarily for use in the industrial and military markets, these devices round out a line that already makes RCA the silicon power leader in the industry.

The 2N5804 features  $V_{CE0}$  (sus) of 225 V (max.), while 2N5805 offers  $V_{CE0}$  (sus) of 300 V (max.). Both silicon power transistors have a current capability of 8 A and are beta controlled at 5 A.

Circle Reader Service No. 642.

## New COS/MOS 4-Bit Full Adder is significantly faster than P-MOS adders

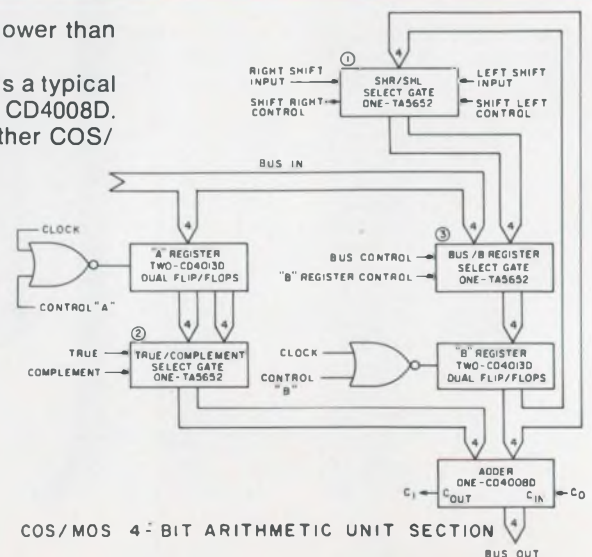
RCA's CD4008D is a new generation 4-Bit Full Adder featuring a fast look-ahead carry capability. The CD4008D combines low quiescent power dissipation—5  $\mu$ W (typ)—with high-speed operation where sum propagation delay is typically 400 ns and carry-in to carry-out delay is 50 ns. This rapid carry feature is especially valuable in assembling multiple adder stages such as a 16-bit full adder where all sum outputs will settle to final values in 660 ns.

The new COS/MOS adder will operate with a single power supply over a wide voltage range—6 to 15 V—and with power consumption sev-

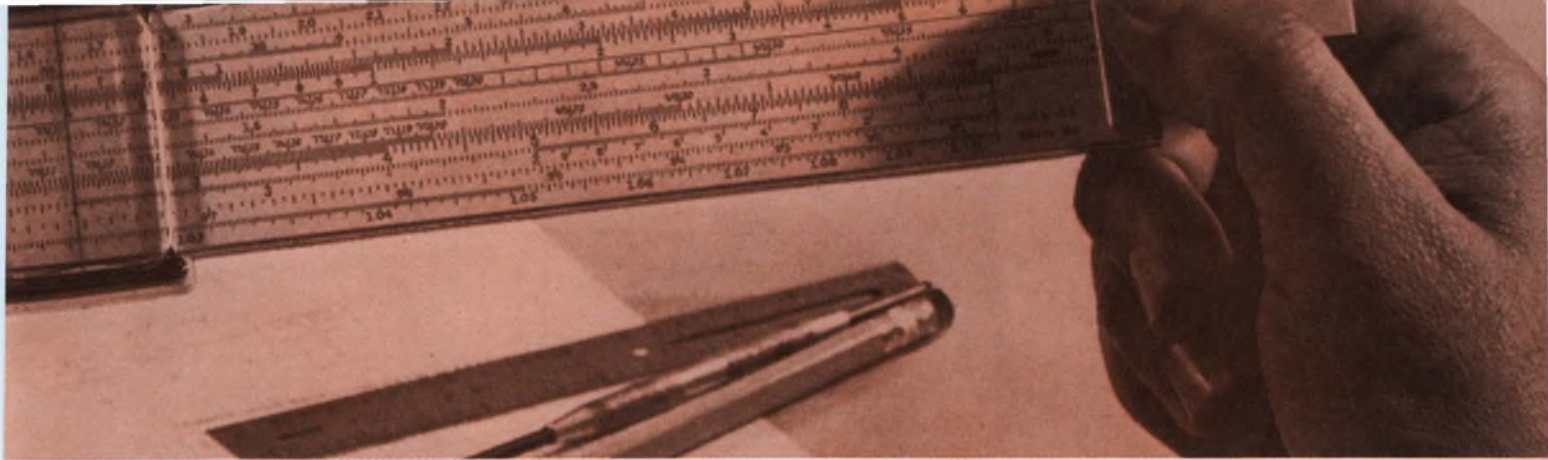
eral orders of magnitude lower than bipolar adders.

The circuit shown here is a typical computer application of a CD4008D. It also incorporates two other COS/MOS integrated circuit types—the CD4013D Dual D-Type Set/Reset Flip/Flop and the Developmental TA5652 Quad AND/OR Select Gate.

Registers "A" and "B" are each 4-bits long. The true complement select gate gates information from the "A" register to the four "A" inputs of the adder. The Bus/B register select gate



COS/MOS 4-BIT ARITHMETIC UNIT SECTION



③ feeds the "B" register with information from either the Bus line or the SHR/SHL select gate ① and the "B" register, in turn, passes this information to the four "B" inputs of the adder. The select gate ① provides a means for shifting the "B" register information one position either left or right, thus permitting multiplication or division by two.

The CD4008D adder's output is the sum of its "A" and "B" inputs. When the "A" input from true/complement select gate ② is true, the adder's output is "A" plus "B"; conversely, when the "A" input from the true/complement select gate is the complement, the adder's output is "B" minus "A".

Circle Reader Service No. 643.

### Ultra reliable: RCA's radiation-hard transistors

Reliability was the hallmark of the successful lunar landing of Apollo 12's "Intrepid" and the redocking maneuver with the "Yankee Clipper." One of Apollo's most important systems—the Rendezvous Radar—uses an ultra-high-reliability version of RCA's 2N2857 family of radiation-tolerant, low-noise UHF amplifiers.

For applications demanding radiation-tolerant devices, RCA's pioneering low-noise, ultra-high frequency 2N2857 family has demonstrated its

tolerance to a severe radiation environment consisting of steady-state fast-neutron radiation with near-fission spectrum ( $E > 0.1$  MeV); fluence  $1.2 \times 10^{14}$  n/cm<sup>2</sup> accompanied by reactor gamma radiation ( $E \approx 1.0$  MeV); gamma dose  $1.5 \times 10^7$  rads. Peak primary photo current (lpp) for a dosage rate of  $10^9$  rad/sec is about 0.006 ampere.



The following table depicts the survivability of the 2N2857 family:

Device unbiased during irradiation				
Parameter	Test Condition	Pre-Irradiation	Post-Irradiation	
$h_{Fe}$	$V_{CE}=1$ V, $I_C=3$ mA	80	20	
$h_{fe}$	$V_{CE}=6$ V, $I_C=5$ mA $f=100$ MHz	18	18	
$I_{CBO}$	$V_{CB}=15$ V, $I_E=0$	0.008 nA	0.35 nA	
$V_{(BR)CBO}$	$I_C=1$ $\mu$ A, $I_E=0$	33 V	36 V	
$V_{(BR)CEO}$	$I_C=3$ mA, $I_E=0$	20 V	27 V	
$V_{CE}$	$I_C=10$ mA, $I_B=1$ mA	0.16 V	0.37 V	
$G_{PE}$	$V_{CE}=6$ V, $I_C=1.5$ mA $f=450$ MHz	13.4 dB	13.0 dB	
NF	$V_{CE}=6$ V, $I_C=1.5$ mA $f=450$ MHz	4.4 dB	4.5 dB	
$C_{obo}$	$V_{CB}=10$ V, $f=1$ MHz	1.1 pF	1.1 pF	

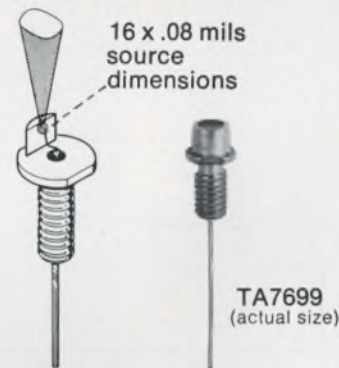
Contact your local RCA Representative who will be pleased to work with you on your high-reliability requirements.

For further data on the 2N2857 family, circle Reader Service No. 644.

For price and availability information on all solid-state devices, see your local RCA Representative or your RCA Distributor. For specific technical data, write RCA Electronic Components, Commercial Engineering, Section B18-2/UM4, Harrison, N.J. 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

### The key to intrusion alarms—RCA GaAs laser diodes

Alarms using RCA's developmental type TA7699 (or its TA7699R reverse polarity counterpart) gallium arsenide (GaAs) laser diodes disclose many intruders. These laser diodes are designed into protective systems for both military and commercial applications.



Single laser diode assembly

The TA7699 and TA7699R are "Close Confinement" laser diodes. (Close Confinement is a manufacturing technique that limits radiation to the junction area and results in lower threshold currents and greater efficiency.) They operate in the near infrared region (9050 angstroms), and are capable of 15 watts (minimum) output.

Here are three big reasons for using the TA7699 and TA7699R: 1) operating range in excess of 1000 feet; 2) readily available silicon photodetectors can be used for receivers; 3) relatively low drive current required—so battery life can be a year or more.

Also available are selected RCA GaAs "CC" diodes that have outputs up to 25 watts at the same low drive current as the TA7699—as well as the following "CC" diode types:

Characteristics	TA7606	TA7608	TA7610
High Radiant Peak Power Output (Watts)	1 (min.) 2 (typ.)	5 (min.) 6 (typ.)	10 (min.) 13 (typ.)
Source Dimension (Mils)	3	6	9
Typical Threshold Current, $I_{th}$ (Amperes)	4	7	10
Low Drive Current, $I_{FM}$ (Amperes)	10	25	40

Circle Reader Service No. 645.

	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
LT 1	*Kepco Int Cont Power Des	ABC2-1M	0-2	1	0.05	0.05	0.25	abcde	131	*Trygon	HR20-1.5	0-20	1.5	0.01	0.05	0.15	e	169
		CV100	2-6	1	0.008	0.03	1		160	*H-P	6201B	0-20	1.5	0.01	0.01	0.2	abcde	169
		630	0-6	3	0.01	0.01	1	abcd	150	Power Des	2015R	0-20	1.5	0.03	0.03	0.45	abcde	175
	*H-P	6203B	0-7.5	3	3mV	5mV	0.2	abcde	169	*H-P	6200B	0-20	1.5	0.01	0.01	4	abcde	189
	*Trygon	LQS6-33	4.5-7.8	1.9	0.01	0.01	0.5		135	*Trygon	LQS24-1.5	18.5-27.5	1.5	0.01	0.01	0.5		135
	*Power/Mate	BP-8C	0-8	1.5	0.01	0.01	0.25	abcdej	89	*Trygon	LQS18-1.9	13.5-20.5	1.9	0.01	0.01	0.5		135
	*Kepco	ABC10-0.75M	0-10	0.75	0.05	0.05	0.25	abcde	131	*NJJE	LVCII-20-2	0-20	2	0.01	0.01	0.25	abcde	171
	*H-P	6214A	0-10	1	0.01	0.01	0.2	cde	115	*NJJE	PVC-20-2	0-20	2	0.01	0.01	0.25	abcde	195
	*Trygon	EAL0-10	0-10	1	0.01	0.2	0.5		99	*H-P	6253A	0-20	3	0.01	0.01	0.2	abcdef	445
	*H-P	6213A	0-10	1	0.01	0.01	0.2	cde	90	Hyp	HY-VS-20-3	0-20	3	0.01	0.01	0.25	abcdej	199
LT 2	*Mid-East	PMA10-1.5	0-10	1.5	±0.01	0.02	1	abcd	165	*H-P	6284A	0-20	3	0.01	0.01	0.2	abcde	210
	*H-P	6113A	0-10	2	0.001	0.001	0.04	abcd	375	*Soren-sen	QRD20-4	0-20	4.4	±0.005	±0.005	0.2	abcde	278
	*NJJE	PVC-10-2	0-10	2	0.01	0.01	0.25	abcde	148	*Soren-sen	QRS20-4	0-20	4.4	±0.01	±0.01	0.4	abcdej	255
	Prec Stan	103	0-10	2	0.005	0.01	0.1	abcde	169	North Hills	VS-36	21.1	0.1	0.0025	0.0025	0.02%	bd	1450
	*NJJE	LVCII-10-2	0-10	2	0.01	0.01	0.25	abcde	124	Wanless	PSS1-24	24	2.5	±0.005	±0.01	0.75	s	275
	Int Cont	CV100	6.5-10.5	1	0.008	0.03	0.28		160	*H-P	6224B	0-24	3	0.01	0.01	0.2	abcde	325
	*Trygon	LQS10-3	8.5-11.5	3	0.01	0.01	0.5		139	*H-P	6215A	0-25	0.4	0.01	0.01	0.2	cde	90
	P/N	PR-30	±15	±0.03	±0.05	±0.05	3 p-p		98	*H-P	6216A	0-25	0.4	0.01	0.01	0.2	cde	115
	Endevco	4203	1-15	0.2	0.01	0.01	0.1 p-p	bd	180	EPL	PSR-12-25	0-25	0.5	0.01	0.01	100	c	110
	P/N	PR-300	±15	±0.3	±0.005	±0.005	0.25		250	*H-P	6220B	0-25	1	0.01	0.01	0.2	abcdef	250
LT 3	*Trygon	HH15-3	0-15	0.3	0.01	0.01	0.5	c	169	*H-P	6227B	0-25	2	1mV	0.01	0.25	abcde	450
	*Heath	1P-18	1-15	0.5	50mV	50mV	5	ae	22kit	Power Des	6050	0-25	2	0.01	0.01	1	abcd	195
	*Kepco	ABC15-1M	0-15	1	0.05	0.05	0.25	abcde	175	*Soren-sen	QSB18-1.5	13-26	1.6	±0.005	±0.005	0.25	abcdej	115
	*Kepco	CDT15-1.5M	0±15	±1.5	0.005	0.01	0.25	abcde	399	Rosemont	SPS-2089-L-A	1-28	0.5	25mV	25mV	1		98
	*Soren-sen	QRS15-2	0-15	2.2	±0.01	±0.01	0.4	abcdej	145	Endevco	4204	1-30	0.1	0.01	0.01	0.1 p-p	bd	180
										*H-P	721A	0-30	0.15	15mV	30mV	150	cde	145
	*Soren-sen	QRD15-2	0-15	2.2	±0.005	±0.005	0.2	abcdej	178	*Acopian	K55	1.25-30	0.3	10mV	±0.5	1	cdj	98
	Beco	303	0-15	2.4	0.01	0.1	0.2	des	reg	*Kepco	ABC30-0.3M	0-30	0.3	0.05	0.05	0.25	abcde	131
	*Trygon	LQS12-2.5	11-15	2.5	0.01	0.01	0.5		135	AUL	RS-30A	1-30	0.5	20mV	20mV	3		45
	Power Des	6050	0-15	3	0.01	0.01	1	abcd	195	Tapaz Prec Stan	151	0-30	0.5	±0.02	5mV	1		reg
LT 4	*Soren-sen	QRD15-2-7.5-3	0-7.5-15	2.2-3.3	±0.005	±0.005	0.2	abcdefj	396	AUL	PS-30	0-30	1	0.01	0.01	1		63
	*Soren-sen	QRD15-2-7.5-3	0-7.5-15	2.2-3.3	±0.005	±0.005	0.2	abcdefj	198	*H-P	6206B	0-30	1	0.01	0.01	0.2	abcde	169
	P/N	NPS-300A	12-18	±0.3	±0.05	±0.05	1		135	AUL	PSS-30	0-30	1	0.01	0.01	1	n	120
	Tapaz	91PQ	5-18	0.5	±0.05	5mV	1		reg	*Heath	1P-28	1-30	1	25mV	50mV	5	abcde	48kit
	*Kepco	ABC18-0.5M	0-18	0.5	0.05	0.05	0.25	abcde	131	*Soren-sen	QRS30-1	0-30	1.1	±0.01	±0.01	0.4	abcdej	145
	*Power/Mate	BP-18C	0-18	1	0.01	0.01	0.25	abcdej	89	Soren-sen	QRD30-1	0-30	1.1	±0.005	±0.005	0.2	abcdej	178
	Wanless	LAB11	0-18	1.25	±0.05	±0.05	0.75	def	150	Beco	304	0-30	1.2	0.01	0.1	0.2	dep	reg
	*Soren-sen	QSB12-2	9-18	2.2	±0.005	±0.005	0.25	abcdej	115	*Power/Mate	BP-30E	0-30	2.5	0.01	0.01	0.25	abcdej	210
	*Power/Mate	BP-18D	0-18	2.5	0.01	0.01	0.25	abcdej	129	R-S	NGN	0-30	2.5	-15-+10	±0.5	2.5	cfj	610
	*Kepco	CK18-3M	0-18	3	0.005	0.01	0.5	abcde	321	Prec Stan	114	0-30	3	0.005	0.01	0.18	abcde	269
LT 5	*RCA	WP703A	0-20	0.5	7mV	10mV	0.2	cd	59	*Trygon	HH32-1.5	0-32	1.5	0.01	0.01	0.5	c	165
	*RCA	WP-702A	0-20	0.2	30mV	50mV	0.5	cdf	87	*Trygon	LQS28-1.4	22-33	1.4	0.01	0.01	0.5	abcde	135
	*RCA	WP-700A	0-20	0.2	30mV	50mV	0.5		48	*Power/Mate	BP-89	0-34	0.5	0.01	0.01	0.25	abcde	89
	*Trygon	EAL20-500	0-20	0.5	0.01	0.2	0.5	c	99	*Power/Mate	BP-34C	0-34	0.5	0.01	0.01	0.25	abcdej	89
	*H-P	6823A	-20 to +20	0.5	0.02	0.02	2	z	194	*Power/Mate	BP-118	0-34	1.5	0.01	0.01	0.25	abcde	118
	*H-P	6204B	0-20	0.6	0.01	0.01	0.2	abcde	144	*Power/Mate	BP-34D	0-34	1.5	0.01	0.01	0.25	abcdej	129
	*Soren-sen	QHS20-1.0	0-20	1	1ppm	5ppm	0.1	abcdej	345	*Soren-sen	QSB28-1	18-36	1.1	±0.005	±0.005	0.25	abcdej	115
	*H-P	6111A	0-20	1	0.001	0.001	0.04	abcde	375									
	*NJJE	LVCII-20-1	0-20	1	0.01	0.01	0.25	abcde	124									
	*H-P	6101A	0-20	1	0.001	0.001	0.04	abcde	265									
LT 6	*Mid-East	PMA20-1.0	0-20	1	±0.01	0.02	1	abcd	165	*Kepco	CK36-1.5M	0-36	1.5	0.005	0.01	0.5	abcde	321
	*NJJE	PVC-20-1	0-20	1	0.01	0.01	0.25	abcde	148	*Kepco	BOP36-1.5M	0-36	±1.5	0.1mV	1mV	3	acd	525
	*Trygon	SHR20-3A	0-20	1	0.01	0.01	0.5	e	239	*ERA	SL36-2/2M	0-36	2	±0.01	±0.01	1	abcdef	465
	Prec Stan	102	0-20	1	0.005	0.01	0.15	abcde	169	*ERA	SL36-2M	0-36	2	±0.01	±0.01	1	abcde	235
	*Soren-sen	QHS20-1.0L	0-20	1	1ppm	5ppm	0.1	abcdej	265	*Soren-sen	QSB28-2	18-36	2.2	±0.005	±0.005	0.25	abcdej	170
										*Kepco	JQE36-3M	0-36	3	0.0005	0.005	0.2	abcde	289

# New precision dc power supplies with 0.1% + 1mV accuracy \$345<sup>00</sup>



The QHS Series is composed of three instruments, each having: ■ direct voltage programming to 6 digits ■ 11 $\mu$ V resolution ■ 0.1% + 1mV calibration accuracy ■ constant voltage regulation of 1ppm + 30 $\mu$ V for 20% line voltage fluctuations ■ constant voltage regulation of 5ppm + 50 $\mu$ V for 100% load changes ■ 100 $\mu$ V p-p ripple (10Hz—500kHz) ■ 10ppm + 100 $\mu$ V stability for 8 hours ■ reset-ability of 30ppm or 200 $\mu$ V ■ optional overvoltage protection ■ 250 hour factory pre-aging.

The QHS 20-1 (0-20 Vdc @ 1A), QHS 40-.5 (0-40 Vdc @ .5A) and QHS 100-.2 (0-100Vdc @ .2A) are available for immediate delivery in a 3½" x 8¼" x 12¾" modular package suitable for rack mounting.

For more information contact your local Sorensen representative or; Raytheon Company, Sorensen Operation, Richards Avenue, Norwalk, Connecticut 06856.

Tel: 203-838-6571;  
TWX: 710-468-2940;  
TELEX: 96-5953



	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
LT 7	Plastic	LV36-300	35.3-36.7	3	0.05	0.05	3	abdfghj	150	Power Des	5015T	0-50	1.5	0.01	0.01	0.75	abcd	235
	Int Cont	CPS400-1	0.1-38	1	0.05	0.05	5	t	395	*Kepco	JQE55-2M	0-55	2	0.0005	0.005	0.2	abcde	300
	*RCA	WP704A	0-40	0.25	7mV	20mV	0.5	cd	59	*NJE	PVC-50-2	0-50	2	0.01	0.01	0.25	abcde	295
	*H-P	6204B	0-40	0.3	0.01	0.01	0.2	abcde	144	*Trygon	T50-2	0-50	2	0.05	0.05	0.5	e	249
	*Mid-East	PMA40-.5	0-40	0.5	±0.01	0.02	1	abcd	175	Prec Stan	106	0-50	2	0.005	0.01	0.2	abcde	269
	*Kepco	ABC40-0.5M	0-40	0.5	0.05	0.05	0.25	abcde	175	Prec Stan	112	0-50	3	0.001	0.01	0.2	abcde	370
	*H-P	6112A	0-40	0.5	0.001	0.001	0.04	abcde	375	*Trygon	LQS48-.67	32-53	0.67	0.01	0.01	0.5		139
	*Soren-sen	QHS40-.75	0-40	0.5	1ppm	5ppm	0.1	abcdej	345	*Trygon	LQS48-1.9	32-53	1.9	0.01	0.01	0.5		185
	*Kepco	CDT40-0.5M	0-±40	±0.5	0.005	0.01	0.25	abcden	399	*Mid-East	PMA60-.35	0-60	0.35	±0.01	0.02	1	abcd	175
	*Soren-sen	QHS40-.5L	0-40	0.5	1ppm	5ppm	0.1	abcdej	265	*Kepco	CK60-0.5M	0-60	0.5	0.005	0.01	0.5	abcde	321
LT 8	*H-P	6102A	0-40	0.5	±0.001	±0.001	0.04	abcde	265	*H-P	6206B	0-60	0.5	0.01	0.01	0.2	abcde	169
	*ERA	TR040M	0-40	0.5	±0.15	0.03	0.8	abcdeg	130	AUL	RSD-30A	2-60	0.5	20mV	20mV	3	f	85
	*H-P	6205B	0-20-40	0.3-0.6	0.01	0.01	0.2	abcdeg	235	*Soren-sen	QRD60-.5	0-60	0.55	±0.005	±0.005	0.2	abcdej	185
	*H-P	6202B	0-40	0.75	0.01	0.01	0.2	abcde	169	*Soren-sen	QRS60-.5	0-60	0.55	±0.01	±0.01	0.4	abcdej	155
	*Trygon	HR40-750	0-40	0.75	0.01	0.05	0.15	e	169									
	*H-P	6200B	0-40	0.75	0.001	0.001	0.04	abcde	189									
	*Kepco	CK40-0.8M	0-40	0.8	0.005	0.01	0.5	abcde	281									
	*Soren-sen	QRD40-.75	0-40	0.825	±0.005	±0.005	0.2	abcdej	178									
	*Soren-sen	QRS40-.75	0-40	0.825	±0.01	±0.01	0.4	abcdej	145	Beco	305	0-60	0.6	0.01	0.1	0.2	dep	reg
										*Power/Mate	BP-60D	0-60	0.75	0.01	0.01	0.25	abcdej	129
LT 9	*H-P	6255A	0-40	1.5	0.01	0.01	0.2	abcdef	445	*ERA	SL601-2M	0-60	1	±0.01	±0.05	1	abcde	440
	*Soren-sen	QRD40-.75-20-1.5	0-20-40	0.75-1.5	±0.005	±0.005	0.2	abcdefj	396	*Trygon	SHR60-1A	0-60	1	0.01	0.01	0.5	e	239
	*Trygon	SHR40-1.5A	0-40	1.5	0.01	0.01	0.5	e	239	*Soren-sen	QRD60-.5-30-1	0-30-60	0.5-1	±0.005	±0.005	0.2	abcdefj	205
	*H-P	6289A	0-40	1.5	0.01	0.01	0.2	abcde	210	*H-P	6294A	0-60	1	0.01	0.01	0.2	abcde	210
	Wan-less	MP-40	0-40	1.6	±0.01	±0.01	0.25	dev	225	*ERA	SL60-1M	0-60	1	±0.01	±0.05	1	abcde	220
	Wan-less	PDC-40	0-40	1.6	±0.005	±0.005	0.5		375	AUL	PSD-30	0-60	1	0.01	0.01	1	f	120
	*Soren-sen	QRD40-.75-20-1.5	0-20-40	0.825-1.65	±0.005	±0.005	0.2	abcdefj	198	*ERA	LC Series	4-60	1-12.5	±0.01	0.05	0.8	abdegj	95-225
	*Trygon	DL40-1	0-20-40	0.5-2	0.01	0.01	0.25	f	249	Prec Stan	116	0-60	1.5	0.005	0.01	0.24	abcde	269
	*Mid-East	HW40-2	0-40	2	0.01	0.01	1	abcde	225	*Soren-sen	QRD60-1.5-30-3	0-30-60	1.65-3.3	±0.005	±0.005	0.2	abcdefj	305
	*Soren-sen	QRD40-2	0-40	2.2	±0.005	±0.005	0.2	abcdej	278	*Soren-sen	QRD60-1.5	0-60	1.65	±0.005	±0.005	0.2	abcdej	285
LT 10	*Soren-sen	QRS40-2	0-40	2.2	±0.01	±0.01	0.4	abcdej	255	*Soren-sen	QRS60-1.5	0-60	1.65	±0.01	±0.01	0.4	abcdej	265
	*H-P	6265B	0-40	3	0.01	0.01	0.2	abcde	350	*Power/Mate	BP-60F	0-60	1.75	0.01	0.01	0.25	abcdej	245
	*Techni	LA40-3M	0-40	3	±0.01	±0.15	0.2%	abcde	320	*Kepco	KS60-2M	0-60	2	0.005	0.01	1	abcde	552
	*Trygon	HR40-3B	0-40	3	0.01	0.01	0.5	e	325	North Hills	TC-602CR	60	2	0.0001	0.0001	0.05	abcd	1750
	*H-P	6290A	0-40	3	0.01	0.01	0.5	abcde	350	*Trygon	HR60-2.5B	0-60	2.5	0.01	0.01	0.5	e	355
	*Soren-sen	QRD40-2-20-4	0-20-40	2.2-4.4	±0.005	±0.005	0.2	abcdefj	298	Prec Stan	118	0-60	2.5	0.005	0.01	0.24	abcde	370
	Plastic	LV48-300	47-49	3	0.05	0.05	3	abdfghj	215	*Power/Mate	BP-60G	0-60	2.5	0.01	0.01	0.25	abcdej	300
	*H-P	6217A	0-50	0.2	0.01	0.01	0.2	cde	90	*H-P	6296A	0-60	3	0.01	0.01	0.5	abcde	395
	*Trygon	EAL50-250	0-50	0.25	0.01	0.2	5	c	99									
	LT 11	*H-P	6218A	0-50	0.2	0.01	0.01	0.2	cde	115	*Mid-East	HW60-3	0-60	3	0.01	0.01	1	
*EPL		PSR-12-50	0-50	0.25	0.01	0.01	100	c	110	*H-P	6271B	0-60	3	0.01	0.01	0.2	abcde	435
Prec Stan		101	0-50	0.4	0.005	0.01	0.2	abcde	169	*Kepco	BOP721.5M	±72	±1.5	0.1mV	1mV	3	abcdz	1125
*NJE		LVCII-50-.5	0-50	0.5	0.01	0.01	0.25	abcde	124	*Kepco	JQE75-1.5M	0-75	1.5	0.0005	0.005	0.2	abcde	300
*H-P		6220B	0-50	0.5	0.01	0.01	0.2	abcdef	250	*Kepco	SM75-2M	0-75	2	0.01	0.05	1	bcde	447
*NJE		PVC-50-.5	0-50	0.5	0.01	0.01	0.25	abcd	148	*Kepco	ABC7.5-2M	0.75	2	0.05	0.05	0.25	abcde	175
Power Des		50055	0-50	0.5	0.005	0.005	1	abcd	150	*Kepco	JQE75-3M	0-75	3	0.0005	0.005	0.2	abcde	520
*NJE		LVCII-50-1	0-50	1	0.01	0.01	0.25	abcde	171	*Techni	LA80-1.5M	0-80	1.5	±0.01	±0.15	0.2%	abcde	325
*H-P		6228B	0-50	1	1mV	0.01	0.25	abcde	450									
Power Des		6050	0-50	1	0.01	0.01	1	abcd	195									
LT 12	*H-P	6130B	0-±50	1	2mV	2mV	1	o	150	*Kepco	PR80-2.5	0-80	2.5	±1	2	0.7%	cde	357
	*NJE	PVC-50-1	0-50	1	0.01	0.01	0.25	z	195	*Techni	LA80-3M	0-80	3	±0.01	±0.15	0.2%	abcde	355
	*H-P	6B24A	-50 to +50	1	0.02	0.02	10	cde	350	*Trygon	LQS65-1.3	50-83	1.3	0.01	0.01	0.5		199
	*Heath	1P-27	0.5-50	1.5	0.05	15mV	0.25	z	80kit	AUL	RST-30A	3-90	0.5	20mV	20mV	3	m	125
	*H-P	6226B	0-50	1.5	0.01	0.01	0.2	abcde	325	*H-P	6106A	0-100	0.2	0.001	0.001	0.04	abcde	265
									*Trygon	LHS65-2.8	50-83	2.8	0.001	0.001	0.5		320	

	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
LT 13	*Mid-East	PMA100-.2	0-100	0.2	±0.01	0.2	1	abcd	190	*Kepco	HB250M	0-250	1	0.01	0.01	1	abcde	595
	North Hills	TC-100.2BR	100	0.2	0.0001	0.0001	0.04	abcd	2200	Lambda	LPD-400	0-±250	1.7, 3.4	0.01	0.01	1.5	abcdefg	290
	*Kepco	ABC100-0.2M	0-100	0.2	0.05	0.05	0.25	abcde	197	Lambda	LR-600	0-250	1.8	0.0005	0.0005	0.1	abcdeg	265
	*Kepco	CDT100-0.2M	0-±100	±0.2	0.005	0.01	0.25	abcde	399	Lambda	LP-400	0-250	2	0.01	0.01	1.5	abcdeg	140
	Prec Stan	117	0-100	0.2	0.005	0.01	0.4	abcde	185	Lambda	LS-500	0-250	2.8	0.0005	0.0005	0.1	abcdeg	430
	*H-P	6116A	0-100	0.2	0.001	0.001	0.04	abcde	375	R-S	NGU	0-300	0.1	±10	±0.1	0.2	195	125
	*Soren-sen	QHS100-.2	0-100	0.2	1ppm	5ppm	0.1	abcde	345	*Trygon	FT300-500	300	0.5	±1	10	700	400	
	*Soren-sen	QHS100-.2L	0-100	0.2	1ppm	5ppm	0.1	abcde	265	*Soren-sen	DCR300-1.25A	0-300	1.44	±0.075	±0.075	0.4%	abcdej	600
	*H-P	6131B	0-100	0.5	2mV	2mV	5	o	1500	*Soren-sen	DCR300-2.5A	0-300	2.88	±0.075	±0.075	0.4%	abcdej	378
	*H-P	6299A	0-100	0.75	0.01	0.01	0.2	abcde	225	*Kepco	PR310-0.6M	0-310	0.6	±1	2	0.5%	cde	473
LT 14	*Kepco	JQE100-1M	0-100	1	0.0005	0.005	0.2	abcde	300	*Kepco	PR310-2M	0-310	2	±1	2	0.5%	cde	473
	Prec Stan	115	0-100	1	0.005	0.01	0.4	abcde	269	*H-P	6209B	0-320	0.1	0.02	0.02	1	abcde	235
	*Kepco	PVS100-1M	0-100	1	0.0005	0.001	0.1	abcde	875	*H-P	890A	0-320	0.6	0.007	0.007	1	abcde	445
	*Mid-East	HW100-2	0-100	2	0.01	0.01	1	abcde	360	*Trygon	RS320-1.5B	0-320	1.5	0.01	0.01	0.5	abcde	625
	*Kepco	JQE100-2.5	0-100	2.5	0.0005	0.005	0.2	abcde	520	Assoc	3	200-325	0.1	1	1	10	e	80
	Deltron	RP	0-100	3	0.005	0.005	0.2	abcde	159-	Spec								
	Deltron	SP	0-100	50	0.005	0.005	0.5	abcde	195-925	*Kepco	HB2AM	0-325	0.2	0.01	0.01	1	abcde	325
	*ERA	SR Series	5-110	0.1-0.2	±0.1	±0.1	0.01%	abdegj	95-125	*Kepco	HB4AM	0-325	0.4	0.01	0.01	1	abcde	365
	North Hills	VS-35	111.1	0.1	0.0025	0.0025	0.02%	bd	1250	*Kepco	SM325-0.5AM	0-325	0.5	0.01	0.05	1	bcde	462
	Lambda	LL-900	0-120	1	0.01	0.01	1	cdg	75	*Kepco	HB6AM	0-325	0.6	0.01	0.01	1	abcde	395
LT 15	*Kepco	KS120-1M	0-120	1	0.005	0.01	1	abcde	578	*Kepco	HB8AM	0-325	0.8	0.01	0.01	1	abcde	435
	*Kepco	KS120-2.5M	0-120	2.5	0.005	0.01	1	abcde	730	*Kepco	SM325-1AM	0-325	1	0.01	0.05	1	bcde	583
	*H-P	6443B	0-120	2.5	60mV	120mV	240	abcde	360	*Kepco	SM325-2AM	0-325	2	0.01	0.05	1	bcde	709
	Lambda	LH	0-120	9	0.015	0.015	1	abcdeg	170	*Kepco	HV350-1	0-350	1	0.005	0.01	1	abd	605
	*NJE	SVC-125-1.6M	0-±25	1.6	0.01	0.01	1	abcde	515	*Mid-East	HV350-2	0-350	2	0.005	0.01	1	abd	725
	*Soren-sen	DCR150-2.5A	0-150	2.88	±0.075	±0.075	0.4%	abcdej	360	*Kepco	400B	0-400	0.15	0.1	0.025	3	kit	310
	*Kepco	PR155-1M	0-155	1	±1	2	0.6%	cde	357	*Kepco	ABC425M	0-425	0.05	0.05	0.05	0.5	abcde	220
	*H-P	6207B	0-160	0.2	0.02	0.02	0.5	abcde	235	*Kepco	BHK500-0.4M	0-500	0.4	0.005	0.01	1	abcde	825
	*Trygon	SHR160-500B	0-160	0.5	0.01	0.01	0.5	e	329	*Kepco	HB525M	0-525	0.5	0.01	0.01	1	abcde	550
	*Techni	LA160-0.75M	0-160	0.75	±0.01	±0.15	0.2%	abcde	335	*Kepco	615B	0-600	0.5	0.1	0.02	3	394	
LT 16	*Kepco	SM160-1AM	0-160	1	0.01	0.05	1	bcde	447	*Kepco	605	0-600	0.5	0.1	0.02	3	473	
	*Trygon	RS160-1A	0-160	1	0.01	0.01	0.5	e	550	*H-P	6448B	1-600	1.5	600mV	600	600	abcde	550
	*Techni	LA160-1.5M	0-160	1.5	±0.01	±0.15	0.2%	abcde	365	*Kepco	2400B	0-800	.005-0.3	0.1	0.025	1-6	†	625
	*Kepco	SM160-2AM	0-160	2	0.01	0.05	1	bcde	552	*Kepco	430D	0-900	0.3-0.6	0.1	0.025	3-6	†	762
	*Trygon	HR160-2B	0-160	2	0.01	0.01	0.5	e	510	*Kepco	ABC1000M	0-1000	0.01	0.05	0.05	1	abcde	309
	*Techni	LA160-3M	0-160	3	±0.01	±0.15	0.2%	abcde	440	Keithley	241	0-1000	0.02	±0.005	±0.005	1	hij	885
	*Trygon	RS160-3A	0-160	3	0.01	0.01	0.5	e	685	*H-P	6521A	0-1000	0.2	0.005	0.005	1	cde	750
	*Trygon	LQS158-67	115-161	0.67	0.01	0.01	0.5	199	Buchler	3-1014A	1000	0.2	±1	±1	1%	cdj	595	
	*Trygon	LHS150-1.9	115-161	1.9	0.01	0.01	0.5	320	*Kepco	BHK1000-0.2M	0-1000	0.2	0.005	0.01	1	abcde	825	
	*Trygon	L3R150-3	115-161	3	±0.005	0.005	0.5	530	*Kepco	1250B	0-1000	0.5	0.05	0.01	3	730		
LT 17	*Kepco	ABC200M	0-200	0.1	0.05	0.05	0.5	abcde	220	Fluke	341A	0-1100	0.025	0.0005	0.0005	0.1	1195	
	Assoc	13	75-200	0.1	1	1	5	c	89.50	Fluke	343A	0-1100	0.025	0.0005	0.0005	0.05	1695	
	Spec									Fluke	335A	0-1100	0.05	0.0002	0.0002	0.04	2485	
	*Mid-East	HW-200-1	0-200	1	0.01	0.01	1		395	Fluke	332B	0-1100	0.05	0.0002	0.0002	0.04	2295	
	*Kepco	PR220-3M	0-220	3	±1	2	0.5%	cde	473	Fluke	3330A	0-1100	0.1	0.0005	0.0005	0.15	2995	
										Keithley	240A	0-1200	0.01	±0.005	±0.005	1	dhj	360
									*Kepco	800B	0-1200	0.2-0.4	0.1	0.02	3-6	†	657	

- a. Remote programming
- b. Remote sensing
- c. Price includes meters
- d. Solid state
- e. Automatic crossover from constant current to constant voltage.
- f. Dual output
- g. This model designation covers a series of modular supplies. These supplies are listed in the tables according to their output voltage.
- h. Control section and high voltage tank enclosed in one unit.
- j. Reversible polarity.
- m. Triple output.

- n. Dual tracking
- o. Digitally Controlled Voltage Source.
- p. 310 series for remote programming and sensing.
- s. Dual output available
- t. Multi output type
- u. Select any voltage by selecting the desired voltage and current after letter series. Constant current models available.
- v. IC Power Supply
- y. Line & load regulation combined
- z. Power supply/amplifier.

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## HIGH POWER/SCR REGULATED

12 Models: 4V @ 2000A; 8V @ 1000A; 18V @ 500A; 36V @ 300A; 64V @ 150A; 110V @ 100A; 220V @ 50A; 300V @ 35A; 600V @ 15A. \$1275 to \$3500.



## Index by Model Number

Name	Model	Code
Acopian	K55	LT3
Acopian Corp.		
Assoc Spec	3	LT14
Associated	13	LT17
Specialties Co.		
AUL	PS-30	LT4
AUL, Inc.	PSD-30	LT9
	PSS-30	LT4
	RS-30A	LT3
	RSD-30A	LT8
	RST-30A	LT12
Beco	303	LT3
Beco Solid State Systems	304	LT4
	305	LT8
Buchler	3-1014A	LT16
Buchler Instruments		
Deltron	RP	LT14
Deltron, Inc.	SP	LT14
EPL	PSR-12-25	LT2
Electro-Product Labs	PSR-12-50	LT11
ERA	SL36-2M	LT6
Electronic Research Associates	SL36-2/2M	LT6
	SL60-1M	LT9
	SL601-2M	LT9
	TR040M	LT8
Endevco	4204	LT3
Fluke	332B	LT17
John Fluke Manufacturing Co.	335A	LT17
	341A	LT17
	343A	LT17
	3330A	LT17
H-P	721A	LT3
Hewlett-Packard Co.	890A	LT13
	895A	LT14
	6101A	LT5
	6102A	LT8
	6106A	LT12
	6111A	LT5
	6112A	LT7
	6113A	LT2
	6130B	LT12
	6131B	LT13
	6200B	LT1
	6200B	LT8
	6201B	LT1
	6202B	LT8
	6203B	LT1
	6204B	LT5
	6204B	LT7
	6205B	LT8
	6206B	LT4
	6206B	LT8
	6209B	LT13
	6213A	LT1
	6214A	LT1
	6215A	LT2
	6216A	LT2
	6217A	LT10
	6218A	LT11
	6220B	LT2
	6220B	LT11
	6224B	LT2
	6226B	LT12
	6227B	LT3
	6228B	LT11
	6253A	LT1
	6255A	LT9
	6265B	LT10
	6271B	LT11
	6284A	LT2
	6289A	LT9
	6290A	LT10
	6294A	LT9

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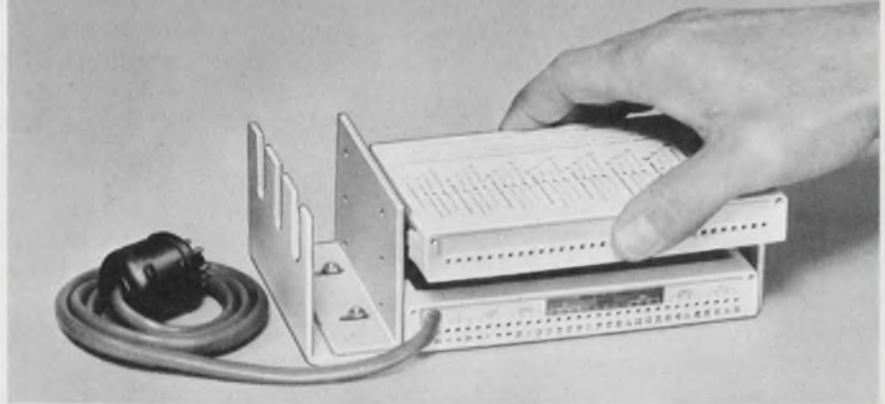
City .....State.....Zip.....

Name	Model	Code
	6296A	LT10
	6299A	LT13
	6443B	LT15
	6448B	LT15
	6521A	LT16
	6823A	LT5
	6824A	LT12
Heath	1P-17	LT15
Heath Co.	1P-18	LT3
	1P-27	LT12
	1P-28	LT4
Hyp	HY-VS-20-3	LT1
Hyperion		
Int Cont	CPS400-1	LT7
International	CV100	LT1, LT2
Contronics		
Keithley	240A	LT17
Keithley		
Instruments		
Kepeco	ABC2-1M	LT1
Kepeco, Inc.	ABC2-1M	LT1
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	605	LT15
	615B	LT15
	800B	LT17
	1250B	LT16
	2400B	LT15
Lambda	LH	LT15
Lambda	LL-900	LT14
Electronics	LP-400	LT13

Name	Model	Code
	LPD-400	LT13
	LR-600	LT13
	LS-500	LT13
Mid-East	HV350-1	LT14
Mid-Eastern	HV350-2	LT14
Industries	HV350-3	LT15
	HW40-2	LT9
	HW60-1.5	LT9
	HW60-3	LT11
	HW100-2	LT14
	HW200-1	LT17
	PMA10-15	LT2
	PMA20-1.0	LT6
	PMA40-.5	LT7
	PMA60-.35	LT7
	PMA100-.2	LT13
NJE	LVCII-10-2	LT2
NJE Corp.	LVCII-20-1	LT5
	LVCII-20-2	LT1
	LVCII-50-.5	LT11
	LVCII-50-1	LT11
	PVC-10-2	LT2
	PVC-20-1	LT6
	PVC-20-2	LT1
	PVC-50.5	LT11
	PVC-50-1	LT12
	PVC-50-2	LT7
	SVC-12-1.6M	LT15
North Hills	TC-100.2BR	LT13
North Hills	TCR-602CR	LT10
Electronics	VS-36	LT2
P/N	NPS-300A	LT4
Philbrick/	PR-30	LT2
Nexus	PR-300	LT2
Plastic	LV36-300	LT7
Plastic	LV48-300	LT10
Capacitors		
Power Des	630	LT1
Power	2015R	LT1
Designs,	5005S	LT11
Inc.	5015T	LT7
	6050	LT3, LT7, LT11
Power/Mate	BP-8C	LT1
Power/Mate	BP-18C	LT4
Corp.	BP-18D	LT4
	BP-30E	LT4
	BP-34C	LT5
	BP-34D	LT5
	BP-60D	LT8
	BP-60E	LT8
	BP-60F	LT10
	BP-60G	LT10
	BP-89	LT5
	BP-118	LT5
Prec Stan	101	LT11
Precision	102	LT6
Standards	103	LT2
Corp.	106	LT7
	112	LT7
	113	LT3
	114	LT4
	115	LT14
	116	LT9
	117	LT13
	118	LT10
RCA	WP700A	LT5
	WP702A	LT5
	WP703A	LT5
	WP704A	LT7
R-S	NGN	LT4
Rohde &	NGU	LT13
Schwarz		
Rosemont	SPS-2089-L-A	LT3
Rosemont		
Plug-In Inc.		

Name	Model	Code
Sorensen	DCR150-2.5A	LT15
Sorensen	DCR300-1.25A	LT13
Operation,	DCR300-2.5A	LT13
Raytheon	QHS20-1.0	LT5
Co.	QHS20-1.06	LT6
	QHS40-.5L	LT7
	QHS-.75	LT7
	QHS100-.2	LT13
	QHS-.2L	LT13
	QRD15-2	LT3
	QRD15-2-7.5-3	LT4
	QRD20-4	LT2
	QRD30-1	LT4
	QRD40-.75	LT8
	QRD40-2	LT9
	ORD40-2-20-4	LT10
	QRD60-.5	LT8
	QRD60-.5-30-1	LT9
	QRD60-1.5-30-3	LT9
	QRD60-1.5	LT9
	QRS15-2	LT3
	QRS20-4	LT2
	QRS30-1	LT4
	QRS40-.75	LT8
	QRS40-2	LT10
	QRS60-.5	LT8
	QRS60-.1.5	LT9
	QSB12-2	LT4
	QSB18-1.5	LT3
	QSB28-1	LT5
	QSB28-2	LT6
<b>Techni</b>	LA40-3M	LT10
<b>Technipower,</b>	LA80-1.5M	LT11
<b>Inc.</b>	LA80-3M	LT12
	LA160-0.75M	LT15
	LA160-1.5M	LT16
	LA160-3M	LT16
<b>Topaz</b>	91PQ	LT4
<b>Topaz, Inc.</b>	151	LT3
<b>Trygon</b>	DL40-1	LT9
<b>Trygon</b>	EAL0-10	LT1
<b>Electronics</b>	EAL20-500	LT5
	EAL50-250	LT10
	FT300-500	LT13
	HH15-3	LT3
	HH32-1.5	LT5
	HR20-1.5	LT1
	HR40-3B	LT10
	HR40-750	LT8
	HR60-2.5B	LT10
	HR160 2B	LT16
	L3R150-3	LT16
	LHS65-2.8	LT12
	LHS150-1.9	LT16
	LQS6-33	LT1
	LQS10-3	LT2
	LQS12-2.5	LT3
	LQS18-1.9	LT1
	LQS24-1.5	LT1
	LQS28-1.4	LT5
	LQS48-.67	LT7
	LQS48-1.9	LT7
	LQS65-1.3	LT12
	LQS158-67	LT16
	RS160-1A	LT16
	RS160-3A	LT16
	RS320-1.5B	LT14
	SHR20-3A	LT6
	SHR40-1.5A	LT9
	SHR60-1A	LT9
	SHR160-500B	LT15
	T50-2	LT7
<b>Wanlass</b>	LAB11	LT4
<b>Wanlass</b>	MP-40	LT9
<b>Electric Co.</b>	PDC-40	LT9
	PSSS1-24	LT2

## The Breadboard Is Obsolete Now There's A New Design Technique That's Faster, Easier And More Economical!



### The New Heath "Stack-n-Patch"

**Old Methods Can't Solve New Problems.** Critical specs, higher density circuits, costly devices, tight schedules... these are today's design problems. Conventional breadboarding can't solve them. A more efficient method is needed. That method is here... the Heath EU-53A "Stack-n-Patch"... a totally new technique for circuit design and teaching.

**A Better Way.** The "Stack-n-Patch" eliminates soldering... just insert hookup wire or component leads into the special connectors. Because there's no soldering, there's no waste... no need to dike out components and throw them away. Expensive FET's can't be damaged from heat... limited quantity samples can be reused. The problems of the multi-layered rat's nest of breadboarding are also eliminated... the 177 patch connectors on the Component Patch Card are laid out according to common circuit board practice and closely simulate the circuit density and "stray" interaction of today's printed circuits.

**Your Design—Stack It... Patch It.** Included in the "Stack-n-Patch" are the Desk-Top Chassis, the Power Patch Card for bringing power from your choice of supply and the Component Patch Card. Designing is fast and simple. Pick your supply and connect it to the Power Patch Card... stack the Component & Power Patch Cards in the chassis... patch power to the Component Card and you're ready to go.

**Pick A Card... Any Card.** For IC work and other types of design that can't be built conveniently on the Component Card, Heath offers a wide variety of factory assembled cards to stack in the Chassis... Dual & Quad J-K Flip Flops, And-Or-Invert, Nand Gate, Dual Monostable, Op Amp... even a Dual Inline IC socket card and a blank circuit card ready to etch. Pick the one that meets your needs... stack it... patch it.

**There Is A Better Way To Design.** Order your Heath "Stack-n-Patch" now... and discover it!

**Assembled EU-53A, 6 lbs. .... \$37.50**

#### What You Get



Desk-Top Chassis



Power Patch Card



Component Patch Card

#### Pick Your Power Supply



EU-801-11 delivers 5 V @ 2 A max; 170 V @ 40 mA max; Plus and Minus 15 V @ 150 mA max. \$75.00, 8 lbs.



EU-41A delivers 0-15 V @ 0-750 mA. \$50.00, 6 lbs.

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EK-279



# Let Power/Mate's wide range UniPower

## SPECIFICATIONS

**INPUT** — 105-125V, 47-420 CPS.

**OUTPUT VOLTAGE** — 0-30 volts for all units except Uni-76 (0-34V); Uni-88 (0-34V); and UniTwin 164 (0-25V dual output).

**OUTPUT VOLTAGE RANGE** — Set in overlapping ranges by means of internal quick disconnect taps.

**REGULATION** — Uni-76 and Uni-88 better than  $\pm 0.005\%$  or 1MV for line and load. All other units better than  $\pm 0.01\%$  or 1MV for line and load.

**RIPPLE** — Less than 250 microvolts.

**RESPONSE TIME** — Less than 20 microseconds.

**TEMPERATURE COEFFICIENT** — Better than 0.01%/°C.

**LONG TERM STABILITY** — Better than 0.025% for 8 hours.

**OVERLOAD & SHORT CIRCUIT PROTECTION** — Solid state short circuit and overload protected. Instantaneous recovery, and automatic reset. Unit cannot be damaged by prolonged short circuits or overloads.

**POLARITY** — May be either positive, negative or floating up to 300 volts.

**AMBIENT OPERATING TEMPERATURE** — Continuous duty from  $-20^{\circ}\text{C}$  to  $+71^{\circ}\text{C}$  ambient.

**STORAGE TEMPERATURE** —  $-55^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ .

**OUTPUT CURRENT vs. TEMPERATURE** — Unit is rated for full current output at temperatures between  $-20^{\circ}\text{C}$  and  $+45^{\circ}\text{C}$  and is linearly derated from  $+45^{\circ}\text{C}$  to 70% of the full output at  $+71^{\circ}\text{C}$ .

**REMOTE-LOCAL SENSING** — Provision is included to permit remote sensing of the output voltage directly at the load for improved over-all regulation. Unit may be connected for local sensing if desired.

**REMOTE-LOCAL VOLTAGE ADJUST** — Output voltage may be remotely adjusted, or internally adjusted with coarse and fine controls. Both are accessible through holes in the terminal end of the supply.

### OUTPUT VOLTAGE vs. OUTPUT CURRENT FOR VARI-RATED UNI SERIES

MODEL	VOLTAGE															
	0-3	5	6	8	10	12	14	15	16	18	20	22	24	26	28	30
UNI-76	0.5 amp throughout range															
UNI-88	1.5 amps throughout range															
UNI-30C	4	4	4	4	4	3.75	3.6	3.5	3.4	3.25	3.0	2.9	2.75	2.5	2.5	2.1
UNI-30D	6	6	6	5.6	5.2	5.0	4.7	4.5	4.3	4.2	4.1	3.7	3.5	3.4	3.3	3.1
UNI-30E	12	12	11	10.5	9.5	9.3	8.5	8.0	7.7	7.5	7.0	6.5	6.0	5.7	5.5	5.2
UNI-30F	15	15	15	14.2	12.8	12.0	11.5	11.0	10.0	9.9	9.4	8.9	8.7	8.5	8.0	7.6
UNI-30G	24	22	21	20	18	17	16.5	16.0	15.5	15	14	13.5	13	12.5	12	11.5
UNI-30H	34	32	31	29	25	23	22	21	20	19	17	16.5	16	15.5	15	14.3

#### Racks and Accessories:

Power/Mate offers a complete line of racks and accessories to complement the UniPower Series.



### UNI-76

0-34 volts, 0.5 amp over entire voltage range. Regulation: Better than  $\pm 0.005\%$  or 1 Mv for line and load.

**\$76.00**

3 $\frac{1}{16}$ "W x 3 $\frac{7}{8}$ "H x 5 $\frac{1}{8}$ "D

WEIGHT: Net 3 $\frac{3}{4}$  lbs., Shipping 4 $\frac{3}{4}$  lbs.



### UNI-88

0-34 volts, 1.5 amps over entire voltage range. Regulation: Better than  $\pm 0.005\%$  or 1 Mv for line and load.

**\$99.00**

3 $\frac{1}{16}$ "W x 3 $\frac{7}{8}$ "H x 6 $\frac{7}{8}$ "D

WEIGHT: Net 5 $\frac{1}{4}$  lbs., Shipping 6 $\frac{3}{4}$  lbs.



### UniTwin-164

**DUAL OUTPUT**  
0-25 volts, 0.75 amps over entire voltage range. Regulation: Better than  $\pm 0.005\%$  or 1 Mv for line and load.

**\$164.00**

3 $\frac{1}{16}$ "W x 4 $\frac{3}{16}$ "H x 6 $\frac{7}{8}$ "D

WEIGHT: Net 5 $\frac{3}{4}$  lbs., Shipping 7 $\frac{1}{2}$  lbs.



#### POWER/MATE CORP.

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Phone: (201) 343-6294 / TWX: 710-990-5023

**SAME DAY SHIPMENT**

# Series fill all your Power Supply needs.



**UNI-30C** 0-30 volts, 4 amps.  
Regulation: Better than  $\pm 0.01\%$  or 1 Mv for line and load.

**\$134.00**

5 $\frac{3}{32}$ "W x 3 $\frac{5}{16}$ "H x 7 $\frac{5}{8}$ "D

WEIGHT: Net 8 $\frac{1}{4}$  lbs., Shipping 10 $\frac{1}{4}$  lbs.



**UNI-30D** 0-30 volts, up to 6 amps (see chart). Regulation:  $\pm 0.01\%$  or 1 Mv for line and load.

**\$151.00**

5 $\frac{3}{32}$ "W x 3 $\frac{5}{16}$ "H x 9 $\frac{3}{8}$ "D

WEIGHT: Net 11 $\frac{1}{2}$  lbs., Shipping 14 lbs.



**UNI-30E** 0-30 volts, up to 12 amps (see chart). Regulation:  $\pm 0.01\%$  or 1 Mv for line and load.

**\$174.00**

5 $\frac{3}{32}$ "W x 5 $\frac{3}{32}$ "H x 9 $\frac{3}{8}$ "D

WEIGHT: Net 15 $\frac{1}{2}$  lbs., Shipping 19 lbs.



**UNI-30F** 0-30 volts, up to 15 amps (see chart). Regulation:  $\pm 0.01\%$  or 1 Mv for line and load.

**\$205.00**

7 $\frac{1}{2}$ "W x 5 $\frac{3}{32}$ "H x 9 $\frac{3}{8}$ "D

WEIGHT: Net 20 $\frac{1}{4}$  lbs., Shipping 24 $\frac{1}{4}$  lbs.



**UNI-30G** 0-30 volts, up to 24 amps (see chart). Regulation:  $\pm 0.01\%$  or 1 Mv for line and load.

**\$265.00**

7 $\frac{1}{2}$ "W x 5 $\frac{3}{32}$ "H x 11 $\frac{7}{8}$ "D

WEIGHT: Net 25 $\frac{3}{4}$  lbs., Shipping 30 $\frac{1}{4}$  lbs.



**UNI-30H** 0-30 volts, up to 34 amps (see chart). Regulation:  $\pm 0.01\%$  or 1 Mv for line and load.

**\$315.00**

7 $\frac{1}{2}$ "W x 5 $\frac{3}{32}$ "H x 16 $\frac{1}{2}$ "D

WEIGHT: Net 34 $\frac{1}{2}$  lbs., Shipping 39 $\frac{1}{2}$  lbs.

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All of your laboratory and systems needs are sure to be met by these new, high-performance economical Bench Pacs. Twenty-three different models cover voltages from 0 to 60, and currents up to 15 amperes.

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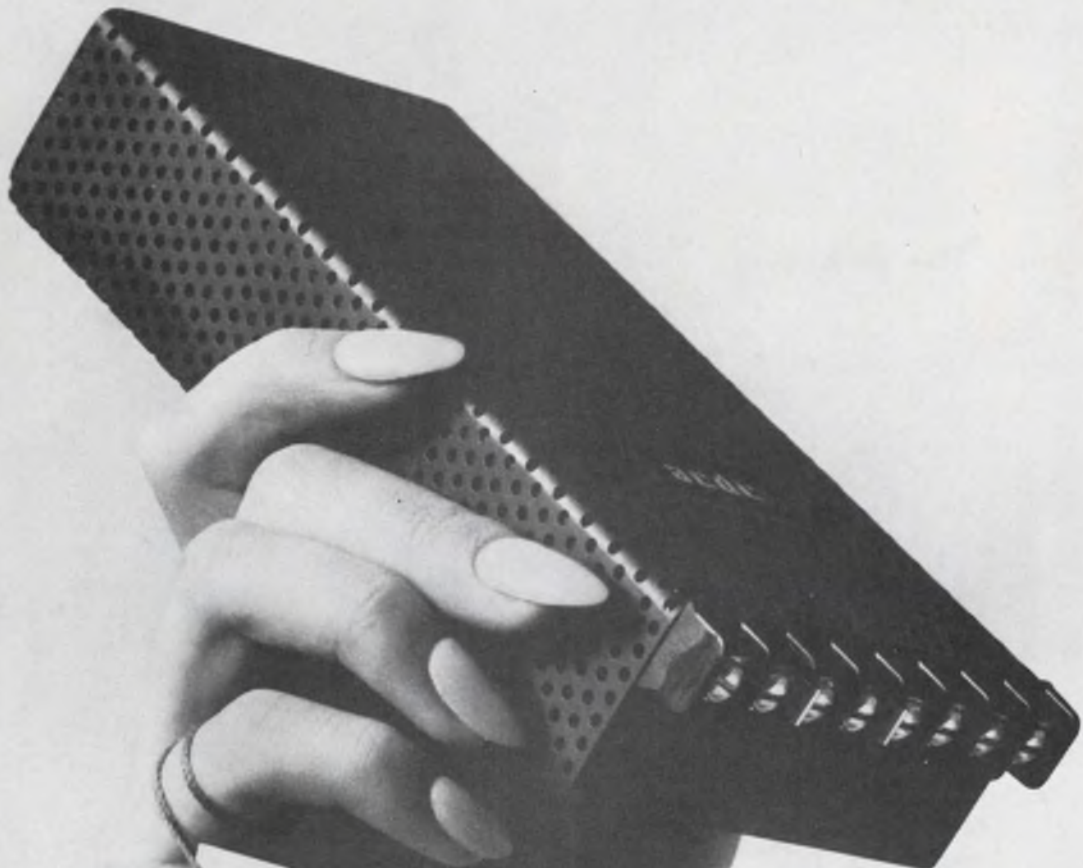
INFORMATION RETRIEVAL NUMBER 626

	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
M 1	Dynage	D Series	0.5-1.2	0.2-1	±0.025	±0.025	1	abdgu	90-101	Valar	CG4 Series	3.5-5	8, 15	5mV	0.05	0.5	abdg	165, 197
	*Acopian	1J10	0.75-1.25	0.1	±0.05	±0.25	0.5	abdj	70	Dynage	D Series	4.7-5.2	0.2-1	±0.025	±0.025	1	abdgu	90-101
	Dynage	D Series	1.2-1.8	0.2-1	±0.025	±0.025	1	abdgu	101	Dynage	H Series	3.1-5.3	11.3-46	±0.025	±0.025	1	abdgu	195-435
	*Acopian	1.5J Series	1-2	0.2-0.75	±0.05	±0.4-±0.7	1	abdfj	70-85	*Techni	HFT-5-100	2.5-5.3	100	±0.1	±0.3	30	dju	1095 req
	Dynage	D Series	1.8-2.3	0.2-1	±0.025	±0.025	1	abdgu	90-101	*Nucar	NPS Series	4.7-5.3	1.5	0.05	0.05	2	dju	reg
Dynage	D Series	2.3-2.7	0.2-1	±0.025	±0.025	1	abdgu	90-101	*Nucar	NPS Series	4.7-5.3	3-12	0.05	0.05	3	dju	reg	
M 2	Valor	CG2 Series	1.75-3	8, 15	5mV	0.05	0.5	abdg	165, 197	Elasco	MS 5	4.5-5.5	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
	*Acopian	2.5J Series	2-3	0.2-0.75	±0.05	±0.4-0.7	1	abdfj	70-85	*Acopian	5L200	4.5-5.5	2	±0.5	±0.5	5	abdj	140
	Dynage	H Series	0.5-3.1	11.3-46	±0.025	±0.025	1	abdgu	195-435	Abbott	R5T20	4.5-5.5	20	±0.05	±0.05	5	bdgj	462
	Dynage	D Series	2.7-3.1	0.2-1	±0.025	±0.025	1	abdgu	90-101	*Techni	HF80 Series	2.8-5.5	3-50	±0.05	±0.05	0.2%	u	150-480
	Dynage	H Series	0.5-3.5	3.3-6.4	±0.025	±0.025	1	abdgu	124-147	Dynage	D Series	5.2-5.8	0.2-1	±0.025	±0.025	1	abdgu	90-101
M 3	*Acopian	3J Series	2.5-3.5	0.2-4.0	±0.05	±0.3-0.7	1	abdfj	70-165	SCI	P2.6.25	±6	0.025	0.2	0.2	2	bdj	20
	Elasco	MS3	2.8-3.5	0.1-0.5	0.05	0.05	0.01%	dsu	70-90	SCI	2.6.200	±6	±0.05	0.01	0.05	1	bdj	59
	Dynage	D Series	3.1-3.5	0.2-1	±0.025	±0.025	1	abdgu	101	SCI	1.6.100	6	0.1	0.01	0.05	1	bd	38
	Dynage	D Series	3.5-3.9	0.2-1	±0.025	±0.025	1	abdgu	90-101	Acme	PS-65424	6	10	±1	±2	1%	ina	ina
	SCI	1.4.100	4	0.1	0.01	0.05	1	bd	38	Acme	PS-65426	6	15	±1	±2	1%	ina	ina
	SCI	1.4.200	4	0.2	0.01	0.05	1	bd	49	Acme	PS-65500	6	30	±1	±2	1%	ina	ina
	SCI	1.4.200	4	0.2	0.01	0.05	1	bd	49	ACDC	JRSk10	3-6	10	0.1	0.1	3	abd	250
	SCI	1.4.200	4	0.2	0.01	0.05	1	bd	49	Acopian	5J Series	4-6	0.2-5	±0.05	±0.2-0.7	1	abd	70-180
	SCI	1.4.200	4	0.2	0.01	0.05	1	bd	49									
	SCI	1.4.200	4	0.2	0.01	0.05	1	bd	49									
M 4	*Kepco	PAR-4	4	11	0.005	0.01	0.25	s	205	Valor	CG5 Series	4.75-6	7, 8, 14	5mV	0.05	0.5	abdgu	165, 197
	*Acopian	4J Series	3-4	0.2-4	±0.05	±0.2-0.5	1	abdfj	70-165	Power Des	UPM-16	5, 6	5	0.01	0.01	1	abd	169
	Valor	CG3 Series	2.75-4	8, 15	5mV	0.05	0.5	abdg	165, 197	Power Des	UPMD-56	5, 6	10	0.01	0.01	1	abd	225
	Dynage	D Series	3.9-4.3	0.2-1	±0.025	±0.025	1	abdgu	90-101	Power Des	UPMD-6	3, 4, 5, 6	10	0.01	0.01	1	abd	245
	Elasco	MS4	3.5-4.5	0.1-0.75	0.05	0.05	0.01%	dsu	70-95	CP	PM728	4.8-6.3	3	±0.05	±0.05	1	s	99.60
Dynage	D Series	4.3-4.7	0.2-1	±0.025	±0.025	1	abdgu	90-101	Dynage	D Series	5.8-6.4	0.2-1	±0.025	±0.025	1	abdgu	90-101	
M 5	CP	PM705	5	0.5	0.05	0.05	1	s	49.90	Dynage	H Series	3.5-6.4	2.9-6.4	±0.025	±0.025	1	abdgu	124-147
	CP	PM703	5	0.5	±0.5	±0.5	1	s	44.90	Rose-mount	SPS-2055	1-6.5	0.3	15mV	15mV	1.5	bd	68
	P/N	2205	5	0.5	±0.1	±0.1	2		48	Rose-mount	SPS-2062P	1-6.5	0.6	15mV	10mV	1.5	bd	72
	CP	PM707	5	1	±0.5	±0.5	1	s	49.90	*Sorensen	QSA5-14.6	3-6.5	17.6	±0.01	±0.01	0.3	abdegj	209
	CP	PM709	5	1	0.05	0.05	1	s	54.90	*Sorensen	QSA18-2	3-6.5	20.5	±0.01	±0.01	0.3	abdegj	249
	Elasco	LIC5-1A	5	1	0.5	0.5	10	v	29	Wanlass	30-OEM-1	3-6.9	2.5	±1	±1	0.1%	46	
	SCI	1.5.1000	5	1	0.05	0.1	2	bd	35	Valar	CS7-1.0	0-7	1	2mV	0.05	0.05	abd	60
	SCI	C1.5.2000	5	2	0.05	0.1	2	bd	75									
	*ACDC	IC5N2.7	5	2.7	0.05	0.05	2	abd	98									
M 6	Arnold	PHU-10(CT)	±5	4	0.1	1	10	df	291	*Kepco	PAX7-1	0-7	1	0.05	0.05	0.25		94
	Arnold	PHU-5	5	5	0.1	1	10	d	220	*Kepco	PCX7-2	0-7	2	0.0005	0.005	0.1		111
	Wanlass	111-OEM5-5	5	5	±0.1	±0.1	1	abd	90	*Kepco	PAT7-2	0-7	2	0.0005	0.005	0.1		121
	Atlas	P3310	5	7	±5	±5	50	d	323	Valar	CS7-3.0	0-7	3	2mV	0.05	0.5	abd	98
	Elasco	LIC5-7A	5	7	±25mV	±25mV	10	v	55	Lambda	LM-F	0-7	25	0.01	0.02	0.5	abd	450
	Wanlass	P60HP-7.51C-5	5	7.5	±0.01	1mV	0.1	abd	220	Lambda	LM-G	0-7	35	0.01	0.02	0.5	abd	575
	Wanlass	P60-7.51C-5	5	7.5	±0.02	±0.02	0.3	abd	195	Lambda	LM-H	0-7	52	0.01	0.02	0.5	abd	875
									*Power/Mate	RD-5	3-7	1	0.6	1.4	8	abd	55	
M 7	Arnold	PHU-5WW	5	8	0.1	1	10	d	290	*Power/Mate	RC-5	3-7	1	0.3	0.7	4	abd	65
	*ACDC	IC5N9.5	5	9.5	0.05	0.05	2	abd	134	*Sorensen	QSA5-6.4	3-7	7	±0.01	±0.01	0.3	abdegj	149
	*ACDC	IC5N13.5	5	13.5	0.05	0.05	2	abd	186	Elasco	MS6	5-7	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
	Wanlass	P120-151C-5	5	15	±0.02	±0.02	0.3	abd	240	*Acopian	6L Series	5-7	2	±0.5	±0.5	5	abd	50-140
	Wanlass	P120HP-151C-5	5	15	±0.01	1mV	0.1	abd	265	*Acopian	6J Series	5-7	5	±0.05	±0.05-0.7	1	abdfj	60-180
	*ACDC	IC5N25.0	5	25	0.05	0.05	2	abd	258									
	*ACDC	IC5N70	5	70	0.05	0.05	2	abd	529									
	*ACDC	IC5N100	5	100	0.05	0.05	2	abd	835									

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Additional features explained on p. D65.



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# Modular dc Power Supplies

	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
M 8	Valar	CG6Series	5.75-7	7, 14	5mV	0.05	0.5	abdg	165, 197	Atlas	P2763	±10	0.6	±0.1	±0.2	5	def	429
	Dynage	D Series	6.4-7	0.2-1	±0.025	±0.025	1	abdgu	90-101	Acme	PS-47509	10	4	±1	±2	1%	ina	398
	*Kepco	PAR-7	7	10	0.005	0.01	0.25		205	Arnold	PHU-10	10	4	0.1	1	20	d	173
	SCI	372	0.7-5	2	0.01	0.01	1	cd	100	GE	9T66Y8	10	16	±1	5	1%	d	65-
	Dynage	D Series	7-7.7	0.15-1	±0.025	±0.025	1	abdgu	90-101	*Techni	P80Series	0.5-10.3	0.2-25	±0.5	±0.5	5	su	475
	Litton	541430	3-8	15	±0.25	±0.25	75		reg	*Techni	PM95Series	0.5-10.3	0.2-25	±0.5	±0.5	5	su	100-
	*Techni	HF80Series	4-8	2-30	±0.05	±0.05	0.2%	u	145-460	*Techni	PL80Series	2.8-10.3	0.2-6	±0.5	±0.5	1	su	60-
	*Acopian	7L Series	6-8	2	±0.5	±0.5	5	abdfj	45-140	*Techni	F115Series	2.8-10.3	0.375-25	±0.05	±0.05	1	su	150-
*Acopian	7L Series	6-8	3	±0.5	±0.05-0.5	1	abdfj	60-165	*Techni	MCS65 Series	2.8-10.3	0.5-30	±0.5	±0.5	5	su	70-	
Valar	CG7Series	6.75-8	7, 14	5mV	0.05	0.5	abdg	165, 197	*Nucar	NPS Series	9.3-10.3	0.2-1.5	0.05	0.05	2	djv	reg	
									*Nucar	NPS Series	9.3-10.3	3-12	0.05	0.05	3	dju	reg	
M 9	Dynage	H Series	5.3-8.5	9-40	±0.025	±0.025	1	abdgu	195-435	Dynage	D Series	9.4-10.3	0.15-0.75	±0.025	±0.025	1	abdgu	90-101
	Dynage	D Series	7.7-8.5	0.15-1	±0.025	±0.025	1	abdgu	90-101	*Techni	HFT10-50	4.5-10.5	50	±0.1	±0.3	30		995
	Wanlass	60-OEM-1	3.6-9	5	±1	±1	0.1%		58	*Techni	HFT10-100	4.5-10.5	100	±0.1	±0.3	30		1250
	Wanlass	120-OEM-1	3.6-9	10	±1	±1	0.1%		86	*Techni	HF80Series	5-11	2-30	±0.05	±0.1	0.2%	su	140-
	Rose-mount	SPS-2056P	5-9	0.25	15mV	5mV	1.5	bd	68	*Techni	HF80Series	5.5-11	2-30	±0.05	±0.05	0.2%	su	140-
	Rose-mount	SPS-2063P	5-9	0.45	15mV	10mV	1.5	bd	72	*Power/Mate	RC 9	7-11	1	0.1	0.3	4	abdj	65
	Elasco	MSB	7-9	0.1-0.75	0.05	0.05	0.01%	dsu	70-95	*Power/Mate	RD-9	7-11	1	0.2	0.6	8	abdj	55
	*Acopian	8L Series	7-9	2	±0.5	±0.5	5	abdfj	45-150	Dynage	K-10/10	9-11	0.175-0.6	±0.05	±0.05	2	abdfg	117-
*Acopian	8J Series	7-9	3	±0.05	±0.05-0.25	0.5-1.0	abdfj	60-170	Elasco	MS10	9-11	0.1-0.75	0.05	0.05	0.01%	dsu	155	
Valar	CG8Series	7.75-9	7, 13	5mV	0.05	0.5	abdgu	165, 197	*Acopian	10L Series	9-11	2	±0.5	±0.5	5	abdfj	70-95	
																	45-150	
M 10	SCI	1.9.100	9	0.1	0.01	0.05	1	bd	38	*Acopian	10J Series	9-11	3	0.05	0.05-0.25	0.5-0.1	abdfj	60-
	Rose-mount	SPS-2017P	9	0.175	4mV	9mV	1	bd	51	Dynage	KH 10/10	9-11	2-4	±0.05	±0.05	2	abdfg	170
	Atlas	P2764	±9	0.75	0.1	0.2	5	def	429	Dynage	H Series	6.4-11.4	2.1-5.5	±0.025	±0.025	1	abdgu	225-
	Dynage	D Series	8.5-9.4	0.15-1	±0.025	±0.025	1	abdgu	90-101	Dynage	D Series	10.3-11.4	0.1-0.75	±0.025	±0.025	1	abdgu	325
	CEA	CEA6DX101R	3.5-9.9	0.1	0.0001	0.0004	0.0003%	rs	215	Dynage	D Series	10.3-11.4	0.1-0.75	±0.025	±0.025	1	abdgu	124-
	CEA	CEA6CX101R	3.5-9.9	0.1	0.0005	0.002	0.0005%	rs	145	*Acopian	11L200	10.5-11.5	2	±0.5	±0.5	5	abdfj	152
	CEA	CEA6BX101	3.5-9.9	0.1	0.002	0.008	0.001%	rs	95	Valar	CG10Series	10-11.5	6, 13	5mV	0.05	0.5	abdgu	90-101
	CEA	CEA6AX101	3.5-9.9	0.1	0.01	0.04	0.01%	rs	85	SCI	P2.12.50/6.50	-6, +12	0.05	0.01	0.05	1	df	150
CEA	CEA6AX252	3.5-9.9	2.5	0.01	0.04	0.01%	rs	150								65		
CEA	CEA6BX252	3.5-9.9	2.5	0.002	0.008	0.001%	rs	160										
M 11	CEA	CEA6CX252R	3.5-9.9	2.5	0.0005	0.002	0.0005%	rs	210	SCI	2.12.50/6.50	-6, +12	0.05	0.01	0.05	1	bdf	39
	CEA	CEA6CX502R	3.5-9.9	5	0.0005	0.002	0.0005%	rs	235	SCI	2.12.100/6.100	-6, +12	0.1	0.01	0.05	1	bdf	49
	CEA	CEA6BX502	3.5-9.9	5	0.002	0.008	0.001%	r	185	SCI	P2.12.100/6.100	-6, +12	0.1	0.01	0.05	1	df	75
	CEA	CEA6AX502	3.5-9.9	5	0.01	0.04	0.01%	r	175									
	CEA	CEA6AX253	3.5-9.9	25	0.01	0.04	0.01%	r	360	Valar	CG11Series	10.5-12	6, 12	5mV	0.05	0.5	abdgu	165, 197
	CEA	CEA6BX253	3.5-9.9	25	0.002	0.008	0.001%	r	370	*Acopian	11J Series	10-12	3	±0.05	±0.05-0.25	0.5-0.1	abdfj	60-
	*Sorensen	QSA10-1.4	0-10	1.5	±0.005	±0.005	0.3	abdegj	89	SCI	P2.12.25	±12	0.025	0.2	0.2	2	bdf	170
	*Sorensen	QSA10-2.2	0-10	2.4	±0.005	±0.005	0.3	abdegj	109								20	
*Sorensen	QSA10-3.7	0-10	4	±0.005	±0.005	0.3	abdegj	129										
*Techni	RA10-12	0-10	12	±0.1	±0.15	0.2%		260										
M 12	*Techni	RA10-25	0-10	25	±0.1	±0.15	0.2%		310	SCI	2.12.50J	±12	0.05	0.01	0.05	1	bdf	35
	Elasco	VS Series	3-10	0.1-0.75	0.05	0.05	0.01%	dsu	80-100	SCI	P2.12.50J	±12	0.05	0.01	0.05	1	df	55
	*Techni	SCR10-0-50	5-10	50	±0.5	±0.5	1%		475	SCI	2.12.50	±12	0.05	0.01	0.05	1	bdf	30
	*Acopian	9L Series	8-10	2	±0.5	±0.5	5	abdfj	45-150	Rose-mount	SPS-2073DP	±12	0.075	3mV	6mV	1	bdf	83
	*Acopian	9J Series	8-10	3	±0.05	±0.05-0.3	0.5-1.0	abdfj	60-170	SCI	P2.12.100	±12	0.1	0.01	0.05	1	df	60
	Valar	CG9Series	8.75-10	6, 7, 13	5mV	0.05	0.5	abdgu	165, 197	SCI	2.12.100J	±12	0.1	0.01	0.05	1	bdf	53
	SCI	P2.10.50J	±10	0.05	0.01	0.05	1	df	53	SCI	2.12.100	±12	0.1	0.01	0.05	1	bdf	48
	SCI	P1.10.100J	10	0.1	0.01	0.05±	1	d	43	SCI	1.12.100	12	0.1	0.01	0.05	1	bd	38
SCI	P1.10.100	10	0.1	0.01	0.05	1	bd	38	Rose-mount	SPS-2120P	±12	0.175	5mV	10mV	1.5	bdf	102	
SCI	P2.10.100J	±10	0.1	0.01	0.05	1	df	58	Rose-mount	SPS-2010P	12	0.175	6mV	12mV	1	bd	51	
									SCI	C2.12.200	±12	0.2	0.05	0.1	1	bdf	80	

Reader service numbers for literature and application notes, see page D6.

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	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
M 13	SCI	2. 12. 200J	±12	0.2	0.01	0.05	1	bdf	70	Valor	CG13Series	12.5-14	6, 12	5mV	0.05	0.5	abd	165, 197
	SCI	2. 12. 200	±12	0.02	0.01	0.05	1	bdf	65									
	SCI	1. 12. 200	12	0.02	0.01	0.05	1	bd	49	Valor	CS15-0.4	0-15	0.4	2mV	0.05	0.05	abd	60
	SCI	C2. 12. 200	±12	0.3	0.05	0.1	1	bdf	98	Deltron	OS/PS	0-15	0-0.6	0.02	0.02	0.5	dfg	49-89
	SCI	C1. 12. 300	12	0.3	0.05	0.1	1	bd	65									
	SCI	C2. 12. 500	±12	0.5	0.05	0.1	1	bdf	119	*Kepco	PAX15-0.7	0-15	0.75	0.05	0.05	0.25		94
	Atlas	P2762	±12	0.5	±0.1	±0.2	5	df	429	*Kepco	PAT15-1.5	0-15	1.5	0.0005	0.005	0.1		121
	SCI	P2. 12. 60	±12	0.06	0.01	0.05	1	df	50	Valor	CS15-2.0	0-15	2	2mV	0.05	0.5	abd	98
	SCI	C1. 12. 600	12	0.6	0.05	0.1	1	bd	70	R-S	NGG15/15	0.3-15	15	±10	0.01	1	cd	380
	SCI	C1. 12. 1000	12	0.6	0.05	0.1	1	bd	85									
M 14	Atlas	P2761	12	0.75	0.1	0.2	5	df	429	*ERA	DVSeries	4-15	0.06-1	0.05	0.05	0.8	bdef	105-189
	SCI	E2. 12. 1000	±12	1	0.01	0.01	1	bdf	148									
	Acme	PS47623	12	3	±1	±2	1%	ina		Litton	541400	3-15	6	±0.25	±0.25	50	reg	140-420
	Arnold	PHU-12	12	3.3	0.1	1	20	d	235	*Techni	HF80	7.5-15	1.5-25	±0.05	±0.1	0.2%	su	420
	Wanlass	111-OEM12-5	12	5	±0.1	±0.1	1	abd	90									
	Wanlass	P60HP-51C-12	12	5	±0.01	1mV	0.1	abd	220	Elasco	MS14	13-15	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
	GE	9T66Y51	12	5	±1	5	1%	d	147	*Acopian	14LSeries	13-15	2	±0.5	±0.5	5	abdf]	45-150
	Wanlass	P60-51C-12	12	5	±0.02	±0.02	0.3	abd	195									
	Acme	PS-65428	12	5	±1	±2	1%	ina	195	*Acopian	14JSeries	13-15	3	±0.05	±0.05-0.25	1	abdf]	65-170
	*Kepco	PAR-12	12	7	0.005	0.01	0.25		205									
M 15	Wanlass	P120HP101 C-12	12	10	±0.01	1mV	0.1	abd	265.	Valor	CG14Series	13.5-15	6, 11	5mV	0.05	0.5		165, 197
	Wanlass	P120-10C-12	12	10	±0.02	±0.02	0.3	abd	240	SCI	P2. 15. 25	±15	0.025	0.02	0.2	2	bdf	20
	Acme	PS65430	12	10	±1	±2	1%	ina		P/N	PR-30C	±15	±0.03	±0.05	±0.5	3p-p	98	
	GE	9T66Y53	12	15	±1	5	1%	d	178	SCI	2204	±15	±0.05	±0.03	±0.015	1		46
	Acme	PS65432	12	15	±1	±2	1%	ina		SCI	2. 15. 50J	±15	0.05	0.01	0.05	1	bdf	35
	GE	9T66Y978	12	20	±1	5	1%	d	194	SCI	P2. 15. 50J	±15	0.05	0.01	0.05	1	df	55
	Lambda	LM-H	12	150	0.01	0.02	0.5	abd	995	SCI	2. 15. 50	±15	0.05	0.01	0.05	1	bdf	30
	*Nucor	NPSSeries	11.4-12.5	10.1-1.5	0.05	0.05	2	dju	reg	Burr-Brown	527	±15	0.05	±0.2	±0.2	1	df	39
	*Nucor	NPSSeries	11.4-12.5	13-12	0.05	0.05	3	dju	reg	SCI	P2. 15. 60	±15	0.06	0.01	0.05	1	df	50
	Dynage	D Series	11.4-12-6	0.1-0.75	±0.025	±0.025	1	abdgu	76-105	Rose-mount	SPS-2074D-S	±15	0.065	3mV	6mV	1	bdf	83
M 16	*Power/Mate	RC-12	11-13	1	0.075	0.1	4	abdj	65	P/N	2203	±15	±0.1	±0.03	±0.03	1		57
	*Power/Mate	RD-12	11-13	1	0.15	0.2	8	agdj	55	SCI	P2. 15. 100	±15	0.1	0.01	0.05	1	df	60
	Rose-mount	SPS-2077P	9-13	0.05	3mV	6mV	1.5	bd	48	SCI	2. 15. 100J	±15	0.1	0.01	0.05	1	bdf	53
	Rose-mount	SPS-2057P	9-13	0.2	2mV	5mV	0.5	bd	61	SCI	2. 15. 100	±15	0.1	0.01	0.05	1	bdf	48
	Rose-mount	SPS-2064P	9-13	0.35	5mV	10mV	0.5	bd	68	SCI	1. 15. 100	15	0.1	0.01	0.05	1	bd	38
										Elasco	2Q15-100-PC	15	0.1	0.1	0.1	2	df	36
	*Acopian	12L Series	11-13	2	±0.5	±0.5	5	abdfj	45-150	Rose-mount	SPS-2018P	15	0.125	6mV	12mV	1	bd	51
	*Acopian	12J Series	11-13	3	±0.05	±0.05-0.25	1	abdfj	60-170	Rose-mount	SPS-2121P	±15	0.15	5mV	10mV	1.5	bdf	102
	Dynage	KH 12/12	11-13	1.8-3.6	±0.05	±0.05	2	abdfg	225-325	SCI	C2. 15. 200	±15	0.2	0.05	0.1	1	bdf	80
	Dynage	K-12/12	11-13	0.15-0.5	±0.05	±0.05	2	abdfg	117-155	SCI	2. 15. 200J	±15	0.2	0.01	0.05	1	bdf	70
Elasco	MS12	11-13	0.1-0.75	0.05	0.05	0.01%	dsu	70-95	SCI	2. 15. 200	±15	0.2	0.01	0.05	1	bdf	65	
M 17	Valor	CG12Series	11.5-13	6, 12	5mV	0.05	0.5	abd	165, 197	SCI	C1. 15. 300	15	0.3	0.05	0.1	1	bd	65
	Abbott	T12D-12.3A	11.6-13	9.72	±0.2	±0.5	0.2%	dgj	285	CP	PM731	15	0.3	±0.1	±0.1	1	s	32
	Dynage	H Series	8.5-13.9	7-32.8	±0.025	±0.025	1	abdgu	195-435	CP	PM733	15	0.3	±0.02	±0.02	1	s	37
	*Sorensen	QSA12-1.3	8-14	1.4	±0.005	±0.005	0.3	abdegj	89	SCI	C2. 15. 500	±15	0.5	0.05	0.1	1	bdf	119
	*Sorensen	QSA12-2.1	8-14	2.3	±0.005	±0.005	0.3	abdegj	109	CP	PM743	15	0.5	±0.02	±0.02	1	s	41
	*Sorensen	QSA12-3.8	8-14	4.2	±0.005	±0.005	0.3	abdegj	129	Burr-Brown	516	±15	0.5	±0.1	±0.1	2		75
	*Sorensen	QSA12-9.3	8-14	11	±0.005	±0.005	0.3	abdegj	199	CP	PM741	15	0.5	±0.1	±0.1	1	s	36
	*Sorensen	QSA12-13	8-14	15.4	±0.005	±0.005	0.3	abdegj	249	SCI	C1. 15. 600	15	0.6	0.05	0.1	1	bd	70
	*Acopian	13LSeries	12-14	2	±0.5	±0.5	5	abdfj	45-150	Power Des	UPMD-11	±15	1	0.1mV	0.15mV	0.15	abdf	275
	*Acopian	13JSeries	12-14	3	±0.05	±0.05-0.25	0.5-0.1	abdfj	65-170									

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# Modular dc Power Supplies

	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$		Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV						Range Volts	Max Amps	Line %	Load %	Ripple mV		
M 18	SCI	C1.15.100U	15	1	0.05	0.1	1	bd	85	*Nucor	NPS Series	16.5-18.5	0.1-1.5	0.05	0.05	2	dju	req	
	SCI	E2.15.100U	±15	1	0.01	0.01	1	bdf	148	*Nucor	NPS Series	16.5-18.5	3-12	0.05	0.05	3	dju	req	
	Burr-Brown	503A	±15	1	±0.1	±0.1	1		325	Valor	CG17 Series	16.5-18	5, 10	5mV	0.05	0.5	abdg	165, 197	
	Burr-Brown	506/16	±15	1	±0.1	±0.1	1	q	340	SCI	P2.18.50	±18	0.05	0.01	0.05	1	df	65	
	Lambda	LCD-4-152	15±5%	1.5	0.01	0.01	1	abdg	220	SCI	2.18.50	±18	0.05	0.01	0.05	1	bdf	49	
Power Des	UPMD-15	15	2	0.01	0.01	1	abdf	265	Rose-mount	SPS-2019P	18	0.1	7mV	14mV	1	bd	51		
Acme	PS47508	15	2	±1	±2	1%		ina	SCI	1.18.100	18	0.1	0.01	0.05	1	bd	49		
									SCI	2.18.100	±18	0.1	0.01	0.05	1	bdf	55		
M 19	*Kepco	PAR-15	15	6	0.005	0.01	0.25		205	GE	9T66Y61	18	5	±1	4	1%	d	134	
	*Nucor	NPS Series	13.7-15.2	0.1-1.5	0.05	0.05	2	dju	req	Acme	PS-65434	18	5	±1	±2	1%	ina	76-	
	Dynage	D Series	13.9-15.3	0.075-0.75	±0.025	±0.025	1	abdgu	105	Acme	PS-65436	18	10	±1	±2	1%	ina	105	
	*TDI	TDMD	1-15.5	1.7-12	0.01	0.01	0.2	abdfgj	129-530	GE	9T66Y966	18.5	6	±1	4	1%	d	139	
	*Nucor	NPS Series	13.7-15.6	3-12	0.05	0.05	3	dj	req	GE	9T66Y967	18.5	12	±1	5	1%	d	166	
Power Des	UPM-11	0-16	1	0.01	0.01	1	abdf	199	GE	9T66Y965	18.5	24	±1	5	1%	jd	391		
SCI	402	0-16	1	0.01	0.01	1	cdf	199	Dynage	D Series	16.9-18.7	0.075-0.75	±0.025	±0.025	1	abdgu	76-105		
									Elasco	MS18	17-19	0.1-0.75	0.05	0.05	0.01%	dsu	70-95		
M 20	SCI	371	0-16	1	0.01	0.01	1	cd	100	*Acopian	18L Series	17-19	2	±0.5	±0.5	5	abdfj	50-150	
	Power Des	UPM-33	0-16	2	0.01	0.01	1	abd	143	*Acopian	18J Series	17-19	2	±0.05	±0.05	1	abdfj	60-160	
	*Power/Mate	RC-15	13-16	0.5	0.075	0.1	4	abdj	65	Valor	CG18 Series	17.5-19	5, 10	5mV	0.05	0.5	abdg	165, 197	
	*Power/Mate	RD-15	13-16	0.5	0.15	0.2	8	abdj	55	*Techni	RA20-6	0-20	6	±0.1	±0.15	0.2%	245		
	*ACDC	QA12/15D0.5	14-16	0.5	0.01	0.01	0.5	abd	119	*Techni	RA20-12	0-20	12	±0.1	±0.15	0.2%	275		
Dynage	K-15/15	14-16	0.15-0.5	±0.05	±0.05	2	abdfg	117-155	*Techni	RA20-25	0-20	25	±0.1	±0.15	0.2%	340			
									*Mid-Eastern	DB Series	6-20	0.075	±0.02	0.1	0.5	dfg	69-85		
M 21	*ACDC	QA12/15D1.1	14-16	1.1	0.01	0.01	0.5	abd	149	Rose-mount	SPS-2100P	10-20	0.125	10mV	15mV	1	bd	62	
	*Acopian	15L Series	14-16	2	±0.5	±0.5	5	abdfj	45-150	Rose-mount	SPS-2110P	10-20	0.2	15mV	15mV	1	bd	69	
	*Acopian	15J Series	14-16	3	±0.01-0.05	±0.05-0.25	1	abdfj	60-170	*Techni	SC.R20.0-25	10-20	25	±0.5	±0.5	1%	u	420	
	Dynage	KH 15/15	14-16	1.6-3.2	±0.05	±0.05	2	abdfg	225-325	*Techni	SC.R20.0-50	10-20	50	±0.5	±0.5	1%	abdg	595	
	*ACDC	QA12/15D3.7	14-16	3.7	0.01	0.01	0.5	abd	195	Valor	CG19 Series	18.5-20	5, 10	5mV	0.05	0.5	abdg	165, 197	
									*Acopian	19L Series	18-20	0.4	±0.5	±0.5	5	abdfj	123		
M 22	Deltran	D	4.5-16	0.4-1.5	0.02	0.02	1	abdgj	118-179	*Acopian	19J Series	18-20	2	±0.05	±0.05-0.2	0.5-1.0	abdfj	70-160	
	Valor	CG15 Series	14.5-16	5, 6, 11	5mV	0.05	0.5	abdgu	165, 197	SCI	2.20.50	±20	0.05	0.01	0.05	1	bdf	49	
	Abbott	V24D-15.7A	14.8-16.6	15.36	±0.2	±0.5	0.2%	dgj	350	SCI	1.20.100	±20	0.1	0.01	0.05	1	bd	49	
	Dynage	D Series	15.3-16.9	0.075-0.75	±0.025	±0.025	1	abdgu	76-105	SCI	2.20.100	±20	0.1	0.01	0.05	1	bdf	55	
	Wanlass	30-OEM-2	9-17	2.5	±1	±1	0.1%		46	Rose-mount	SPS-2047P	20	0.1	6mV	12mV	1	bd	51	
Wanlass	60-OEM-2	9-17	5	±1	±1	0.1%		58	*Techni	PL80 Series	10.3-20.2	0.1-6	±0.5	±0.5	1	su	60-195		
Wanlass	120-OEM-2	9-17	10	±1	±1	0.1%		86											
M 23	Rose-mount	SPS-2078P	13-17	0.04	3mV	6mV	1.5	bd	48	*Techni	P80 Series	10.3-20.2	0.1-25	±0.5	±0.5	5	su	65-470	
	Rose-mount	SPS-2058P	13-17	0.175	2mV	5mV	0.5	bd	61	*Techni	F115 Series	10.3-20.2	0.1-25	±0.05	±0.05	1	su	130-1355	
	Rose-mount	SPS-2065P	13-17	0.275	4mV	8mV	0.5	bd	68	*Techni	PM95 Series	10.3-20.2	0.2-25	±0.5	±0.5	5	su	90-635	
	Elasco	MS16	15-17	0.1-0.75	0.05	0.05	0.01%	dsu	70-95	*Techni	MCS65 Series	10.3-20.2	0.25-30	±0.5	±0.5	5	su	65-455	
	*Acopian	16J Series	15-17	2	±0.05	±0.05-0.2	1	abdfj	60-160	Dynage	H Series	11.4-20.6	1.3-3.8	±0.025	±0.025	1	abdgu	124-154	
M 24	*Acopian	16L Series	15-17	2	±0.5	±0.5	1	abdfj	45-150	Dynage	D Series	18.7-20.6	0.075-0.75	±0.025	±0.025	1	abdgu	76-105	
	Valor	CG16 Series	15.5-17	5, 11	5mV	0.05	0.5	abdg	165, 197	*Kepco	PAX21-0.5	0-21	0.5	0.05	0.05	0.25		94	
	P/N	NPS-300	12-18	±0.3	±0.05	±0.05	1		135	*Kepco	PAT21-1	0-21	1	0.0005	0.005	0.1		121	
	*Power/Mate	PT-99	12-18	0.4	0.05	0.05	0.25	abdfgj	99	*Kepco	PCX21-1	0-21	1	0.0005	0.05	0.1		111	
	*ACDC	JR15k4	12-18	4	0.1	0.1	3	abd	250	*Kepco	PCX15-1.5	0-21	1.5	0.0005	0.005	0.1		111	
	*Acopian	17L10	16-18	0.1	±0.5	±0.5	5	abdfj	50	*Power/Mate	RC-19	16-21	0.5	0.075	0.1	4	abdj	65	
	*Acopian	17J Series	16-18	2	±0.05	±0.05-0.2	0.5-1.0	abdfj	65-160	*Power/Mate	RD-19	16-21	0.5	0.15	0.2	8	abdj	55	

Reader service numbers for literature and application notes, see page D6. Companies advertising in the power supply section are marked by an asterisk. Additional features explained on p. D65.

Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
		Range Volts	Max Amos	Line %	Load %	Ripple mV		
M 25	Rose-mount SPS-2079P	17-21	0.03	3mV	6mV	1.5	bd	48
	Rose-mount SPS-2059P	17-21	0.15	2mV	5mV	0.5*	bd	61
	Rose-mount SPS-2071P	17-21	u.2	4mV	8mV	0.5	bd	68
	Elasco MS20	19-21	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
	*Acopian 20J Series	19-21	2	±0.05	±0.05-0.2	1	abdfj	60-160
M 26	*Acopian 20L Series	19-21	2	±0.5	±0.5	5	abdfj	50-150
	Valor CG20 Series	19.5-21	5, 9	5mV	0.05	0.05	abdg	165-197
	*Sorensen QSA 18-1.1	14-22	1.2	±0.005	±0.005	0.3	abdegj	89
	*Sorensen QSA 18-1.9	14-22	2.1	±0.005	±0.005	0.3	abdegj	109
	*Sorensen QSA 18-3.0	14-22	3.3	±0.005	±0.005	0.3	abdegj	129
	*Sorensen QSA 18-10.1	14-22	14.0	±0.005	±0.005	0.3	abdegj	249
	*Sorensen QSA 13-6.8	14-22	7.9	±0.005	±0.005	0.3	abdegj	199
*Acopian 21J Series	20-22	1	±0.05	±0.05-0.15	0.5-1.0	abdfj	70-100	
M 27	*Acopian 21L Series	20-22	2	±0.5	±0.5	5	abdfj	55-150
	Valor CG21 Series	20.5-22	4, 5, 9	5mV	0.05	0.5	abdgu	165, 197
	Acme PS57352	22	25	±1	±2	1%	ina	140-425
	*Techni HF80 Series	11.3-22.5	1-15	±0.05	±0.1	0.2%	su	140-425
	Rose-mount SPS-2026P	22.5	0.09	4mV	12mV	1	bd	51
M 28	Dynage H Series	13.9-22.7	5.2-26.6	±0.025	±0.025	1	abdgu	195-435
	Dynage D Series	20.6-22.7	0.05-0.75	±0.025	±0.025	1	abdgu	76-105
	Elasco MS22	21-23	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
	*Acopian 22L Series	21-23	2	±0.5	±0.5	5	abdfj	50-150
	*Acopian 22J Series	21-23	2	±0.05	±0.05-0.2	0.5-1.0	abdfj	60-160
M 29	Valor CG22 Series	21.5-23	4, 9	5mV	0.05	0.5	abdg	165, 197
	Rose-mount SPS-2076D-P	±24	0.04	3mV	6mV	1	bdf	84
	SCI 2.24.50	±24	0.05	0.01	0.05	1	bdf	49
	SCI P2.24.50	±24	0.05	0.01	0.05	1	df	65
	Rose-mount SPS-2011P	24	0.09	5mV	12mV	1	bd	51
	SCI C2.24.100	±24	0.1	0.05	0.1	1	bdf	80
	SCI 2.24.100	±24	0.1	0.01	0.5	1	bdf	55
	SCI 1.24.100	24	0.1	0.01	0.05	1	bdf	49
	SCI C2.24.200	±24	0.2	0.05	0.1	1	bdf	90
M 30	SCI C1.24.200	24	0.2	0.05	0.1	1	bd	70
	SCI C1.24.300	24	0.3	0.05	0.1	1	bd	75
	SCI C1.24.600	24	0.6	0.05	0.1	1	bd	85
	Wanlass P60HP-2.51C-24	24	2.5	±0.01	1mV	0.1	abdg	220
	Wanlass III-OEM24-2.5	24	2.5	±0.1	±0.1	1	abdg	90
	Wanlass P60-2.51C-24	24	2.5	±0.02	±0.02	0.3	abdg	195
	Power Des UPMD-10	24	3	0.04	0.04	2	abd	180
M 31	*Kepco PAR-24	24	4	0.005	0.01	0.25		205
	Wanlass PI20-51C-24	24	5	±0.02	±0.02	0.3	abdg	240
	Wanlass PI20HP-51C-24	24	5	±0.01	1mV	0.1	abdg	265
	GE 9T66Y988	24	6	±1	3	1%	d	150
	GE 9T66Y989	24	10	±1	3	1%	d	174
M 32	GE 9T66Y990	24	20	±1	3	1%	d	228
	GE 9T66Y991	24	50	±1	3	1%	d	402
	Acme PS Series	24	2-100	±1	±2	1%	g	ina
	*Acopian 23J Series	22-24	1	±0.05	±0.05-0.15	0.5-1.0	abdfj	70-100
	*Acopian 23L Series	22-24	2	±0.5	±0.5	5	abdfj	55-150
M 33	Valor CG23 Series	22.5-24	4, 8	5mV	0.05	0.5	abdg	165, 197
	*Power/Mate Elasco VS Series	10-25	0.1-0.75	0.05	0.05	0.01%	dsu	80-100
	Rose-mount SPS-8006P	21-25	0.025	3mV	6mV	1.5	bd	48
	Rose-mount SPS-2060P	21-25	0.125	2mV	5mV	0.5	bd	61
	Rose-mount SPS-2072P	21-25	0.175	4mV	6mV	0.5	bd	63
	Dynage D Series	22.7-25	0.05-0.5	±0.025	±0.025	1	abdgu	80-108
	Elasco MS24	23-25	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
	*Acopian 24L Series	23-25	2	±0.5	±0.5	5	abdfj	50-150
	*Acopian 24J Series	23-25	2	±0.05	±0.05-0.2	0.5-1.0	abdfj	60-160
	Valor CG24 Series	23.5-25	4, 8	5mV	0.05	0.5	abdg	165, 197
M 34	*H-P SLOT Series	5.8-26	1.5-35	0.05	0.05	1	abde	72-197
	*Power/Mate RC-24	21-26	0.5	0.075	0.1	4	abdj	65
	*Power/Mate RD-24	21-26	0.5	0.15	0.2	8	abdj	55
	*Acopian 25L Series	24-26	0.75	±0.5	±0.5	5	aabdfj	55-80
	*Acopian 25J Series	24-26	2	±0.05	±0.05-0.2	0.5-1.0	abdfj	65-165
M 35	Valor CG25 Series	24.5-26	4, 8	5mV	0.05	0.5	abdg	165, 197
	SCI 2.26.50	±26	0.05	0.01	0.05	1	bdf	49
	SCI 2.26.100	±26	0.1	0.01	0.05	1	bdf	55
	Burr-Brown 507/16	±26	0.6	±0.1	±0.1	1	q	380
	Acme PS-47202	26	4	±1	±2	1%	ina	ina
M 36	Acme PS-47603	26	8	±1	±2	1%	ina	ina
	Abbott U10D-24.7A	23.3-26.1	4.04	±0.2	±0.5	0.2%	dgj	337
	Elasco MS26	25-27	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
	*Acopian 26J Series	25-27	2	±0.05	±0.05-0.2	0.5-1.0	abdfj	65-175
	*Acopian 26L Series	25-27	2	±0.5	±0.5	5	abdfj	55-165
	Valor CG26 Series	25.5-27	4, 8	5mV	0.05	0.5	abdg	165, 197
	Dynage D Series	25-27.6	0.05-0.5	±0.025	±0.025	1	abdgu	80-103
	*ACDC BX2-28N 5.0	2-28	5	0.01	0.01	0.5	abdgk	184
	*ACDC BX2-28N 10	2-28	10	0.01	0.01	0.5	abdgk	274
	*ACDC BX2-28N 20	2-23	20	0.01	0.01	0.5	abdgk	395
M 37	Deltron LA	3-23	1.7-39	0.005	0.005	1	abdgj	109-299
	*Acopian 27L Series	26-28	0.75	±0.5	±0.5	5	abdfj	60-80
	*Acopian 27J Series	26-28	2	±0.05	±0.05-0.2	0.5-1.0	abdfj	70-175
M 38	SCI 2.28.50	±28	0.05	0.01	0.05	1	bdf	49

Reader service numbers for literature and application notes, see page D6.  
 Companies advertising in the power supply section are marked by an asterisk.  
 Additional features explained on p. D65.

	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
M 32	Rose-mount SCI	SPS-2021P	28	0.08	6mV	14mV	1	bds	51	*Techni	HF80 Series	15-30	0.75-12	±0.05	±0.1	0.2%	su	145-430
	SCI	1.28.100	28	0.1	0.01	0.05	1	bd	49	Wanlass	30-OEM-3	17-30	2.5	±1	±1	0.1%		46
	SCI	2.28.100	28	0.1	0.01	0.05	1	bdf	55	Wanlass	60-OEM-3	17-30	5	±1	±1	0.1%		58
	Wanlass	C214-OEM	28	2.5	±2	±2	0.1		46	Wanlass	120-OEM-3	17-30	10	±1	±1	0.1%		86
	*Kepco	PAR-28	28	3.7	0.005	0.01	0.25		205	Rose-mount	SPS-2101P	20-30	0.1	10mV	10mV	1	bd	62
	GE	9T66Y83	28	8	±1	3	1%	d	318	Rose-mount	SPS-2111P	20-30	0.175	15mV	15mV	1	bd	69
	GE	9T66Y85	28	20	±1	3	1%	d	472	*ACDC	JR25k2	22-30	2	0.1	0.1	3	abd	250
	Acme	PS Series	28	8-30	±1	±2	1%	g	ina									
	GE	9T66Y6	28	50	±1	3	1%	d	450									
M 33	Valor	CG27 Series	26.5-28	4.8	5mV	0.05	0.5	abdg	165, 197	*Sorensen	GSA28-6.0	22-30	6.8	±0.005	±0.005	0.3	abdegj	209
	Valor	CG28 Series	27.5-29	4.8	5mV	0.05	0.5	abdg	165, 197	*Sorensen Power Des	GSA28-8.8	22-30	10.2	±0.005	±0.005	0.3	abdegj	249
	Rose-mount	SPS-2061P	27-29	0.12	6mV	15mV	1	bd	63	*Acopian	UPM-6	24-30	1.5	0.01	0.01	1	abd	158
	*ACDC	BX28N0.3	27-29	0.3	0.01	0.01	0.5	abd	76	*Acopian	29L Series	28-30	0.4	±0.5	±0.5	5	abdfj	60-70
	*ACDC	BC28N0.3	27-29	0.3	0.5	0.5	5	abd	73	*Acopian	29J Series	28-30	1	±0.05	±0.05-0.1	0.5-1.0	abdfj	70-105
	*Elasco	MS28	27-29	0.1-0.75	0.05	0.05	0.01%	dsu	70-95	Valor	CG29 Series	28.5-30	4.8	5mV	0.05	0.5	abdg	165-197
M 34	*ACDC	BX28N1.2	27-29	1.2	0.01	0.01	0.5	abd	116	SCI	P2.30.50	27-30	0.05	0.01	0.05	1	df	65
	*ACDC	BC28N1.2	27-29	1.2	0.5	0.5	5	abd	111	Dynage	D Series	27.6-30.4	0.05-0.5	±0.025	±0.025	1	abdg	80-111
	*Acopian	28L Series	27-29	2	±0.5	±0.5	5	abdfj	55-165	*Acopian	R Series	2.75-30.5	10	±0.05	±0.2-1.0	1	abdj	195
	*Acopian	28J Series	27-29	2	±0.05	±0.05-0.2	0.5-1.0	abdfj	175-184	*Acopian	K Series	2.75-30.5	10	±0.05	±0.2-1.0	1	abdj	205
	*ACDC	BC28N2.5	27-29	2.5	0.5	0.5	5	abd	132	Valor	CG30 Series	29.5-30.5	4.8	5mV	0.05	0.5	abdg	165, 197
	*ACDC	BX28N2.5	27-29	2.5	0.01	0.01	0.5	abd	137									
M 35	*ACDC	BC28N5.0	27-29	5	0.5	0.5	5	abd	178	*Power/Mate	RD-28	26-31	0.5	0.12	0.2	8	abdj	55
	*ACDC	BX28N5.0	27-29	5	0.01	0.01	0.5	abd	184	*Power/Mate	RC-28	26-31	0.5	0.06	0.1	4	abdj	65
	Abbott	R2855	27-29	5	±0.05	±0.05	5	bdfj	225	*Acopian	30J Series	29-31	2	±0.05	±0.05-0.2	0.5-1.0	abdfj	60-175
	*ACDC	BC28N10	27-29	10	0.5	0.5	5	abd	265	*Acopian	30L Series	29-31	2	±0.5	±0.5	5	abdfj	60-165
	*ACDC	BX28N10	27-29	10	0.01	0.01	0.5	abd	274	Elasco	MS30	29-31	0.1-0.75	0.05	0.05	0.01%	dsu	70-100
	*ACDC	BC28N20	27-29	20	0.5	0.5	5	abd	384									
	*ACDC	BX28N20	27-29	20	0.01	0.01	0.5	abd	395									
	*Techni	PL80 Series	20.2-29.2	0.1-3	±0.5	±0.5	1	su	60-170									
	*Techni	MCS65 Series	20.2-29.2	0.125-15	±0.5	±0.5	5	su	70-405									
*Nucor	NPS Series	26.8-29.2	0.1-1.5	0.05	0.05	2	dju	26										
M 36	*Nucor	NPS Series	26.8-29.2	3-12	0.05	0.05	3	dju	req	*ACDC	BX30N0.3-5.0	29-31	0.3-5	0.01	0.01	5	abdgk	92-257
	CEA	CEA6AY101	10-29.9	0.1	0.01	0.04	0.01%	rs	85	SCI	370	0-32	0.3	0.01	0.01	1	cd	90
	CEA	CEA6BY101	10-29.9	0.1	0.002	0.008	0.001%	rs	95	SCI	401	0-32	0.3	0.01	0.01	1	cdf	195
	CEA	CEA6CY101	10-29.9	0.1	0.0005	0.002	0.005%	rs	145	R-5	NGR30/30	0-32	30	±10	0.001	0.3	cd	750
	CEA	CEA6DY101	10-29.9	0.1	0.0001	0.0004	0.0005%	rs	215	R-5	NGRM30/40	0-32	40	±10	0.001	0.5	cd	750
	CEA	CEA6AY252	10-29.9	2.5	0.01	0.04	0.01	rs	175	Scint	PC Series	2-32	1.5	0.05	0.05	1	bdfj	66
	CEA	CEA6BY252	10-29.9	2.5	0.002	0.008	0.001%	rs	185	*Powertec	7B Series	3.6-32	1.4-7.5	0.03-0.2	0.03-0.05	3p-p	su	492
	CEA	CEA6CY252	10-29.9	2.5	0.0005	0.002	0.005%	rs	235									
	CEA	CEA6AY502	10-29.9	5	0.01	0.04	0.01%	r	220									
M 37	CEA	CEA6BY502	10-29.9	5	0.002	0.008	0.001%	r	230	*Powertec	7C Series	3.6-32	3.8-17	0.03-0.2	0.03-0.05	3p-p	su	593
	CEA	CEA6C502R	10-29.9	5	0.0005	0.002	0.0005%	r	280	*Powertec	7D Series	3.6-32	7.5-34	0.03-0.2	0.03-0.05	3p-p	su	789
	CEA	CEA6AY253	10-29.9	25	0.01	0.04	0.01%	r	375	*Acopian	31L20	30-32	0.2	±0.5	±0.5	5	abdfj	65
	CEA	CEA6BY253	10-29.9	25	0.002	0.008	0.001%	r	385	*Acopian	31J Series	30-32	1	±0.05	±0.05-0.1	0.5-1.0	abdfj	65-105
	AUL	MS Series	0-30	0.25-3	0.1	0.01	1		35-38	*Nucor	NPS Series	29.2-32.7	0.05-1.5	0.05	0.05	2	dju	req
	*Power/Mate	UNI Series	0-30	0.5-34	0.005	0.005	0.25	abdgj	134-315									
	Litton	541420	3-30	5	±0.25	±0.25	50	req	180									
*Powertec	9D Series	3-30	1-6	±0.05	±0.1	2.5-10	su											
M 38	Litton	541410	3-30	6	±0.25	±0.25	50	req	111-121	*ERA	WR Series	1-33	0.6-9.6	±0.01	0.05	0.8	abdeg	130-305
	*Trygon	TPSA Series	3.2-30	1.25	0.02	0.05	1	su	147	Elasco	SVS-10A	3-33	10	0.05	0.05	0.01%	dsu	300-335
	*Trygon	TPSC Series	3.2-30	5	0.02	0.05	1	su	125-147	*Acopian	32J Series	31-33	1.5	±0.05	±0.05-0.15	0.5-1.0	abdfj	65-175
	Elasco	Q Series	5-30	0.015-0.065	0.1	0.1	2	dsu	60	*Acopian	32L Series	31-33	2	±0.5	±0.5	5	abdj	60-165
	Valor	CS30-0.3	10-30	0.3	2mV	0.05	0.05	abdg	60	*ACDC	BX32N0.3-5.0	31-33	0.3-5	0.01	0.01	5	abdgk	112-248
	Valor	CS30-1.0	10-30	1	2mV	0.05	0.5	abdg	98									
Scint	PR Series	10-30	6	0.01	0.01	0.5	bdfj	145-185										

Reader service numbers for literature and application notes, see page D6.  
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# Modular dc Power Supplies

	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
M 39	Dynage	D Series	30.4-33.6	0.05-0.5	±0.025	±0.025	5	abdgu	80-111	Dynage	D Series	37-40.8	0.05-0.3	±0.025	±0.025	5	abdgu	80-111
	*Power/Mate	UNI Series	0-34	0.5-1.5	0.005	0.005	0.25	abdgi	76-99	*Acopian	40L10	39-41	0.1	±0.5	±0.5	5	abdj	60-65
	*Sorensen	OSA28-.7	22-35	0.77	±0.005	±0.005	0.3	abdegj	89	*Acopian	40J Series	39-41	1	±0.05	±0.05-0.2	1	abdfj	125-125
	*Sorensen	OSA28-1.3	22-35	1.4	±0.005	±0.005	0.3	abdegj	109	*ACDC	BX40N0.3-5	39-41	0.3-5	0.01	0.01	5	abdgk	118-257
	*Sorensen	OSA28-2.0	22-35	2.2	±0.005	±0.005	0.3	abdegj	129	*Acopian	41L10	40-42	0.1	±0.5	±0.5	5	abdj	60
	*Acopian	34L10	33-35	0.1	±0.5	±0.5	5	abdj	60	*Acopian	41J Series	40-42	0.4	±0.05	±0.05-0.1	1	abdfj	70-95
M 40	*ACDC	BX34N0.3-5.0	33-35	0.3-5	0.01	0.01	5	abdgk	118-247	*Power/Mate	RD-40	37-43	0.5	0.01	0.02	8	abdj	55
	*Kepco	PAX36-0.3	0-36	0.3	0.05	0.05	0.25		94	*Power/Mate	RC-40	37-43	0.5	0.05	0.1	4	abdj	65
	Litton	541440	4-36	30	±0.25	±0.25	225		req	*Acopian	42J Series	41-43	0.6	±0.05	±0.05-0.15	0.5-1.0	abdfj	70-115
	*Acopian	35L10	34-36	0.1	±0.5	±0.5	5	abdj	60	*Acopian	42L10	41-43	0.1	±0.5	±0.5	5	abdj	60
	*Acopian	35J Series	34-36	1	±0.05	±0.05-0.2	0.5-1.0	abdfj	65-125	*ACDC	BX42N0.3-5	41-43	0.3-5	0.01	0.01	5	abdgk	118-257
	*Kepco	PAR-36	36	2.8	0.005	0.01	0.25		205	*Acopian	43L10	42-44	0.1	±0.5	±0.5	5	abdj	60
M 41	*Power/Mate	RD-34	31-37	0.5	0.1	0.2	8	abdj	55	*Acopian	43J Series	42-44	0.3	±0.05	±0.05	0.5-1.0	abdfj	70-95
	*Acopian	X Series	4-37	0.2	±0.05	±0.05	0.25-0.5	abdj	75-110	Acme	PS-57356	44	25	±1	±2	1%	ina	80-111
	Dynage	H Series	20.6-37	0.8-2.3	±0.025	±0.025	1	abdgu	124-162	Dynage	D Series	40.8-45	0.05-0.3	±0.025	±0.025	5	abdgu	80-111
	Dynage	H Series	22.7-37	3.3-19	±0.025	±0.025	±0.025	abdgu	195-470	Elasco	VS Series	20-45	0.05-0.5	0.05	0.05	0.01%	dsu	75-95
	Dynage	D Series	33.6-37	0.05-0.5	±0.025	±0.025	5	abdgu	80-111	*Techni	HF Series	22.5-45	0.5-8	±0.05	±0.1	0.2%	su	145-435
	M 42	*Acopian	36L10	35-37	0.1	±0.5	±0.5	5	abdj	60	*Acopian	44J Series	43-45	0.6	±0.05	±0.05-0.15	0.5-1.0	abdfj
*Acopian		36J Series	35-37	1.5	±0.5	±0.05-0.2	0.5-1.0	abdfj	65-175	*ACDC	BX44N0.3-5.0	43-45	0.3-5	0.01	0.01	5	abdgk	118-257
*ACDC		BX36N0.3-5.0	35-37	0.3-5	0.01	0.01	5	abdgk	118-257	*Acopian	45L10	44-46	0.1	±0.5	±0.5	5	abdfj	60
*Acopian		37J Series	36-38	1	±0.05	±0.05-0.1	0.5-1.0	abdfj	65-125	*Acopian	45J Series	44-46	0.6	±0.05	±0.05-0.15	0.5-1.0	abdfj	70-125
*Acopian		38L10	37-39	0.1	±0.5	±0.5	5	abdj	60	*Acopian	46L10	45-47	0.1	±0.5	±0.5	5	abdj	60
*Acopian		38J Series	37-39	1	±0.05	±0.05-0.2	0.5-1.0	abdfj	65-125	*Acopian	46J Series	45-47	0.6	±0.05	±0.05-0.15	0.5-1.0	abdfj	70-125
M 43	*ACDC	BX38N0.3-5.0	37-39	0.3-5	0.01	0.01	5	abdgk	118-257	*ACDC	BX46N0.3-5	45-47	0.3-5	0.01	0.01	5	abdgk	118-257
	Elasco	MS Series	31-39	0.1-0.75	0.05	0.05	0.01%	dsu	70-100	*Power/Mate	OEM-A	3-48	1.25	0.01	0.01	0.25	abdj	79
	Scint	ACF Series	7.2-39.5	1.5	0.01	0.03	0.5	bdgj	70	*Power/Mate	OEM-B	3-48	2.5	0.01	0.01	0.25	abdj	102
	*Kepco	PAT40-0.5	0-40	0.5	0.0005	0.005	0.1		121	*Power/Mate	OEM-C	3-48	4	0.01	0.01	0.25	abdj	137
	*Kepco	PCX40-0.5	0-40	0.5	0.0005	0.005	0.1		111	*Power/Mate	OEM-D	3-48	8	0.01	0.01	0.25	abdj	154
	Deltron	B	0-40	0.2-1.2	0.02	0.02	0.5	abdgj	59-69	Deltron	OEM	3-48	0.7-9	0.05	0.05	1	abdgj	75-85
M 44	*Techni	RA40-3	0-40	3	±0.1	±0.15	0.2%		235	*Power/Mate	OEM-E	3-48	12	0.01	0.01	0.25	abdj	177
	*Techni	RA40-6	0-40	6	±0.1	±0.15	0.2%		265	*Power/Mate	OEM-F	3-48	18	0.01	0.01	0.25	abdj	208
	*Techni	RA40-12	0-40	12	±0.1	±0.15	0.2%		320	*Power/Mate	OEM-G	3-48	24	0.01	0.01	0.25	abdj	260
	*Techni	RA40-25	0-40	25	±0.1	±0.15	0.2%		395	*Power/Mate	OEM-H	3-48	34	0.01	0.01	0.25	abdj	318
	Litton	541220	4-40	2	±1	±1	15p-p	req		Deltron	N	3-48	0.21-36	0.005	0.005	0.5	abdgj	79-299
	Litton	541200	4-40	2	±1	±1	15p-p	req		*Powertec	3B Series	3.6-48	0.05-0.35	0.075-0.3	0.075-0.3	1	su	34
Litton	541210	4-40	2	±1	±1	15p-p	req		*Powertec	3C Series	3.6-48	0.18-1.5	0.075-0.3	0.075-0.3	1	su	42	
M 45	*Techni	PL80 Series	29.2-40	0.05-1.5	±0.5	±0.5	1	su	55-155	*Powertec	5B Series	3.6-48	0.5-2.5	±0.05	±0.05	0.01	su	229
	*Techni	MCS65 Series	29.2-40	0.065-15	±0.5	±0.5	5	su	65-510	*Powertec	3D Series	3.6-48	0.3-3.5	0.075-0.3	0.075-0.3	1	su	49
	*Acopian	39L10	38-40	0.1	±0.5	±0.5	5	abdj	60	*Powertec	5C Series	3.6-48	1-5	±0.05	±0.05	0.01	su	259
	*Acopian	39J Series	38-40	1	±0.05	±0.05-0.2	0.5-1.0	abdfj	65-125									
	Rose-mount	SPS-2102P	30-40	0.075	10mV	10mV	1	bd	62									
	Rose-mount	SPS-2112P	30-40	0.15	15mV	15mV	1	bd	71									

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	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
M 46	*Powertec	3E Series	3.6-48	0.8-5	0.075-0.3	0.075-0.3	1	su	89	Wanlass	200HP Series	3.6-60	25	±0.05	±0.05	5	d	250
	*Powertec	3F Series	3.6-48	1.6-10	0.075-0.3	0.075-0.3	1	su	119	Wanlass	200IC Series	3.6-60	25	±0.25	±0.25	5	d	200
	*Powertec	5D Series	3.6-48	2-10	±0.05	±0.05	0.01	su	299	Scint Power Des	RC Series	±9-60	1	0.05	0.05	1	bdfg]	79
	*Powertec	5E Series	3.6-48	4-20	±0.05	±0.05	0.01	su	379	UPM-22	UPM-22	16-60	0.5	0.01	0.01	1	abdf]	199
	*Powertec	3G Series	3.6-48	3.2-20	0.075-0.3	0.075-0.3	1	su	169	UPM-44	UPM-44	16-60	1	0.01	0.01	1	abd	148
			3.6-48	6.4-35	0.075-0.3	0.075-0.3	1	su	249	Wanlass	30-OEM-4	30-60	2.5	±1	±1	0.1%		46
M 47	*Techni	F115 Series	20.2-48	0.05-12	±0.05	±0.05	1	su	135-2850	*Techni	HF80 Series	30-60	0.375-6	±0.05	±0.1	0.2%	su	145-440
	*Techni	P80 Series	20.2-48	0.05-25	±0.5	±0.5	5	su	70-475	Wanlass	60-OEM-4	30-60	5	±1	±1	0.1%		58
	*Techni	PM95 Series	20.2-48	0.05-25	±0.5	±0.5	5	su	90-630	Wanlass	120-OEM-4	30-60	10	±1	±1	0.1%		86
	*Acopian	47L10	46-48	0.1	±0.5	±0.5	5	abd]	60	*Sorensen	QSA48-.4	35-60	0.44	±0.005	±0.005	0.3	abdeg]	89
	*Acopian	47J Series	46-48	0.3	±0.05	±0.05	0.5-1.0	abdf]	70-95	*Sorensen	QSA48-.8	35-60	0.88	±0.005	±0.005	0.3	abdeg]	119
	*Kepco	PAR-48	48	2.3	0.005	0.01	0.25		205	*Sorensen Dynage	QSA48-1.2	35-60	1.3	±0.005	±0.005	0.3	abdeg]	129
										H Series	37-60	0.5-1.4	±0.025	±0.025	1	abdgu	135-179	
M 48	GE	9T66Y93	48	4	±1	3	1%	d	139	Dynage	D Series	54.5-60	0.05-0.2	±0.025	±0.025	5	abdgu	80-96
	GE	9T66Y94	48	10	±1	2	1%	d	191	Burr-Brown	508/16	±60	0.5	±0.1	±0.1	1	q	480
	Acme	PS Series	48	4-25	±1	±2	1%	g	ina	*Kepco	PAR-60	60	2	0.005	0.01	0.25		205
	*Acopian	48L10	47-49	0.1	±0.5	±0.5	5	abd]	60	*Acopian	60J Series	59-61	0.4	±0.05	±0.05	1	abdf]	75-140
	Elasco	MS Series	39-49	0.1-0.5	0.05	0.05	0.01%	dsu	70-100	*NJE	HT Series	0-62	0.12-10	0.05	0.05	1	abd	69-207
	*Acopian	48J Series	47-49	0.6	±0.05	±0.05-0.15	0.5-1.0	abdf]	70-130									
*ACDC	BX48N0.3-5.0	47-49	0.3-5	0.01	0.01	5	abdgk	118-257										
M 49	Dynage	D Series	45-49.9	0.05-0.3	±0.025	±0.025	5	abdgu	80-111	*NJE	SC Series	2-62	0.12-12	0.05	0.05	1	abd	77-219
	*Trygon R-S	LVW Series	0-50	1.4	0.01	0.01	0.5	su	122	*ERA	ST Series	1-63	1-2	±0.01	0.05	0.8	abdefg	165-195
	*ERA	NGR50/20	0-50	20	±0.001	0.3	0.05	cd	700	Elasco	VS Series	50-65	0.05-0.25	0.05	0.05	0.01%	dsu	85-100
		SV Series	5-50	0.015	0.5	0.5	0.05	abdeg	65-75	*ACDC	BX60N0.1-1.2	55-65	0.1-1.2	0.01	0.01	5	abdgk	93-193
	Dynage	H Series	37-50	3.1-14	±0.025	±0.025	1	abdgu	195-470	*Acopian	65J Series	64-66	0.3	±0.05	±0.05	1	abdf]	75-125
*Power/Mate	RD-48	43-50	0.5	0.01	0.02	8	abd]	55										
M 50	*Acopian	49J Series	48-50	0.3	±0.05	±0.05	0.5-1.0	abdf]	70-95	Dynage	D Series	60-66.1	0.075-0.2	±0.025	±0.025	5	abdgu	95-125
	*Acopian	49L10	48-50	0.1	±0.5	±0.5	5	abd]	60	Elasco	MS Series	59-69	0.05-0.25	0.05	0.05	0.01%	dsu	75-85
	Elasco	SVS-1A	3-51	1	0.05	0.05	0.01%	dsu	105-140	*Acopian	70J Series	69-71	0.3	±0.05	±0.05	1	abdf]	75-125
	Elasco	SVS-2A	3-51	2	0.05	0.05	0.01%	dsu	135-165	*Kepco	PAX72-0.15	0-72	0.15	0.05	0.05	0.25		94
	Elasco	SVS-3.5A	3-51	3.5	0.05	0.05	0.01%	dsu	145-210	*Kepco	PCX72-0.3	0-72	0.3	0.0005	0.005	0.1		111
	Elasco	SVS-5A	3-51	5	0.05	0.05	0.01%	dsu	185-290	*Kepco	PAT72-0.3	0-72	0.3	0.0005	0.005	0.1		121
M 51	*Acopian	50L10	49-51	0.1	±0.5	0.5	5	abd]	60	*Techni	MCS65 Series	40-72	0.065-15	±0.5	±0.5	5	su	75-570
	*Acopian	50J Series	49-51	0.5	±0.5	±0.05-0.1	0.5-1.0	abdf]	70-135	Dynage	D Series	66.1-72.8	0.05-0.2	±0.025	±0.025	5	abdgu	95-125
	*ACDC	BX50N0.3-5.0	49-51	0.3-5	0.01	0.01	5	abdgk	118-257	*ACDC	BX70N0.1-1.2	65-75	0.1-1.2	0.01	0.01	5	abdgk	93-193
	Dynage	D Series	49.5-54.5	0.05-0.3	±0.025	±0.025	5	abdgu	80-111	*Acopian	75J Series	74-76	0.2	±0.05	±0.05	1	abdf]	85-125
	Elasco	VS Series	40-55	0.05-0.25	0.05	0.05	0.01%	dsu	85-100	Elasco	MS Series	69-78	0.05-0.25	0.05	0.05	0.01%	dsu	75-85
	*Acopian	55J Series	54-56	0.5	±0.05	±0.05	1	abdf]	65-140	CEA	CEA6AY103	10-79.9	10	0.01	0.04	0.01%	r	375
M 52	Elasco	MS Series	49-59	0.05-0.25	0.05	0.05	0.01%	dsu	75-100	CEA	CEA6BY103	10-79.9	10	0.002	0.008	0.001%	r	385
	*Techni	PL80 Series	40-59	0.05-1.5	±0.5	±0.5	1	su	65-170	CEA	CEA6CY10R	30-79.9	0.1	0.0005	0.002	0.0005%	rs	160
	Lambda	LCD-3	0-60	0.7	0.01	0.01	1	abdfg	150	CEA	CEA6BY101	30-79.9	0.1	0.002	0.008	0.001%	rs	110
	Lambda	LCS-3	0-60	1.2	0.01	0.01	1	abdfg	90	CEA	CEA6AY101	30-79.9	0.1	0.01	0.04	0.01%	rs	100
	Wanlass	60IC Series	3.6-60	7.5	±0.25	±0.25	5	d	125	CEA	CEA6DY10R	30-79.9	0.1	0.0001	0.0004	0.0003%	rs	230
	Wanlass	60HP Series	3.6-60	7.5	±0.05	±0.05	5	d	150	CEA	CEA6CY	30-79.9	2.5	0.0005	0.002	0.0005%	rs	330
	Wanlass	120IC Series	3.6-60	15	±0.25	±0.25	5	d	170	CEA	CEA6BY252	30-79.9	2.5	0.002	0.008	0.001%	rs	280
	Wanlass	120HP Series	3.6-60	15	±0.05	±0.05	5	d	195	CEA	CEA6AY252	30-79.9	2.5	0.01	0.04	0.01%	rs	270
										CEA	CEA6AY502	30-79.9	5	0.01	0.04	0.01%	r	335
										CEA	CEA6BY502	30-79.9	5	0.002	0.008	0.001%	r	345

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	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
M 53	CEA	CEA6CY 502R	30-79.9	5	0.0005	0.002	0.0005%	r	395	Dynage	D Series	97.1-106.8	0.025-0.1	±0.025	±0.025	5	abdgu	95-125
	R-S	NGGS80/5	0-80	5	±10	0.05	0.5	cd	500	*Acopian	105J Series	104-106	0.2	±0.05	±0.05	1	abdfj	115-145
	*Techni	RA80 Series	0-80	1.5-25	±0.1	±0.15	0.2%	u	240-525	*ERA	ME Series	0-110	0.05-2	±0.01	0.05	0.8	abdeg	ina
	*Techni	SCR80 Series	40-80	6-25	±0.5	±0.5	1%	u	415-780	*ERA	TR Series	5-110	0.1-0.2	±0.05	0.5	0.05%	bd	70-90
M 54	Dynage	D Series	72.8-80.1	0.05-0.15	±0.025	±0.025	5	abdgu	95-125	*ACDC	BX100N0.2-1.2	90-110	0.2-1.2	0.01	0.01	5	abdgk	148-249
	*Acopian	80J Series	79-81	0.2	±0.05	±0.05	1	abdfj	85-125	*Acopian	110J Series	109-111	0.2	±0.05	±0.05	1	abdfj	115-145
	Elasco	VS Series	70-85	0.05-0.25	0.05	0.05	0.01%	dsu	85-100	*Acopian	115J Series	114-116	0.2	±0.05	±0.05	1	abdfj	125-155
	*ACDC	BX80N0.1-1.2	75-85	0.1-1.2	0.01	0.01	5	abdgk	93-193	Dynage	D Series	106.8-117.2	0.025-0.1	±0.025	±0.025	5	abdgu	95-125
	*Acopian	85J Series	84-86	0.2	±0.05	±0.05	1	abdfj	90-135	Elasco	MS Series	99-118	0.05-0.1	0.05	0.05	0.01%	dsu	105-110
*Techni	PL80 Series	59-88	0.05-0.75	±0.5	±0.5	1	su	80-175	Lambda	M.1-E-CS-1	10-120	0.2	0.01	0.01	1	abdg	115	
M 55	Dynage	D Series	80.1-88.2	0.05-0.15	±0.025	±0.025	5	abdgu	95-125	Lambda	M.1-E-CD-2	0-120	0.25	0.01	0.01	1	abdg	230
	Elasco	MS Series	79-89	0.05-0.1	0.05	0.05	0.01%	dsu	80-85	Lambda	LCS-1	0-120	0.275	0.01	0.01	1	abdg	70
	*Sorensen	QSA75-.5	60-90	0.55	±0.005	±0.005	3	abdegj	119	Lambda	LCD-2	0-120	0.3	0.01	0.01	1	abdfg	125
	*Sorensen	QSA75-.8	60-90	0.88	±0.005	±0.005	0.3	abdegj	139	Lambda	M.1-E-CS-2	0-120	0.45	0.01	0.01	1	abdg	130
	GE	9T66Y985	90	10	±1	3	1	d	265	Lambda	LCS-2	0-120	0.55	0.01	0.01	1	abdg	80
	*Acopian	90J Series	89-91	0.2	±0.05	±0.05	1	abdfj	95-135	Lambda	LCD-A	0-120	1	0.01	0.01	1	abdg	155
	*ACDC	BX90N0.1-1.2	85-95	0.1-1.2	0.01	0.01	5	abdgk	93-249	Lambda	LCD-4	0-120	1.8	0.01	0.01	1	abdg	190
	Lambda	LM-A	0-120	2	0.01	0.02	0.05	abdfg	79	M 56	*Techni	HF80 Series	70-120	0.2-3	±0.05	±0.1	0.2%	su
*Techni	F115 Series	48-96	0.05-6	±0.05	±0.05	1	su	165-2380	Lambda		LCS-4	0-120	3.3	0.01	0.01	1	abdg	130
*Techni	P80 Series	48-96	0.05-12	±0.5	±0.5	5	su	80-535	*Kepco		PRM 180F Series	5.2-120	1.5-25	±1	0.7-3.8	0.003-0.04	su	179
*Techni	PM95 Series	48-96	0.05-12	±0.5	±0.5	5	su	725-95	*Kepco		PRM 120 Series	5.2-120	1-15	±1	0.5-4.6	0.3-0.4	su	104
*Acopian	95J Series	94-96	0.2	±0.05	±0.05	1	abdfj	95-135	*Kepco		PRM 180 Series	5.2-120	1.5-25	±1	0.5-2.2	0.3-0.4	su	125
M 57	Dynage	H Series	60-97.1	0.38-1	±0.025	±0.025	1	abdgu	139-181	Elasco	VS Series	100-120	0.05-0.1	0.05	0.05	0.01%	dsu	115-120
	Dynage	D Series	88.2-97.1	0.05-0.15	±0.025	±0.025	5	abdgu	95-125	SCI	C2.120.50	±120	0.05	0.05	0.1	1	bdf	135
	Elasco	MS Series	89-99	0.05-0.1	0.05	0.05	0.01%	dsu	80-85	Burr-Brown	509/16	±120	0.25	±0.1	±0.1	1	q	480
	*Kepco	PAX100-0.1	0-100	0.1	0.05	0.05	0.25	94	*Acopian	120J Series	119-121	0.2	±0.05	±0.05	1	abdfj	135-155	
M 58	*Kepco	PAT100-0.2	0-100	0.2	0.0005	0.005	0.1	121	GE	9T66Y970	125	4	±1	2	1%	d	194	
	*Kepco	PCX100-0.2	0-100	0.2	0.0005	0.005	0.1	111	Acme	PS Series	125	2-6	±1	±2	1%	ina		
	Deltron	CD/CA	0-100	0.15-2	0.01	0.01	0.25	abdegj	99-119	*Acopian	125J Series	124-126	0.2	±0.05	±0.05	1	abdfj	135-155
	R-S	NGRS100/3	30-100	3	±10	0.001	0.5	cd	670	*Dynage	D Series	117.2-128.7	0.025-0.1	±0.025	±0.025	5	abdgu	95-125
	Scint	1113 Series	2-100	5	0.05	0.05	0.5	bdg	100	*Acopian	J Series	2-130	2.0	±0.05-0.5	±0.05-1.0	1.0-5.0	abdj	70-160
M 59	Abbott	R Series	4.5-100	20	±0.05	±0.05	0.02%	bdgj	86-397	*TDI	SCR	6-130	2.5-15	0.5	0.5	0.3	bdg	99-360
	*Mid-Eastern	Ht-HTA Series	6-100	4	0.025	0.02	1	abdg	169	*Acopian	130J Series	129-131	0.2	±0.05	±0.05	1	abdfj	125-155
	Scint	RS5 Series	9-100	0.6	0.05	0.05	1	dgj	66-89	Elasco	MS Series	118-138	0.05-0.1	0.05	0.05	0.01%	dsu	105-110
	Elasco	VS Series	80-100	0.05-0.25	0.05	0.05	0.01%	dsu	85-100	CEA	CEA6AY500	80-139	0.05	0.01	0.04	0.01%	rs	125
Power Des	UPMD-X9	100	0.25	0.03	0.03	1	abdf	260	CEA	CEA6BY500	80-139	0.05	0.002	0.008	0.001%	rs	135	
Acme	PS47718	100	4	±1	±2	1%	ina	95-145	CEA	CEA6CY 500R	80-139	0.05	0.0005	0.002	0.0005%	rs	185	
*Acopian	100J Series	99-101	0.2	±0.05	±0.05	1	abdfj	95-145	CEA	CEA6DY 500R	80-139	0.05	0.0001	0.0004	0.0003%	rs	255	
*Techni	MCS65 Series	72-105	0.065-8	±0.5	±0.5	5	su	100-695	CEA	CEA6AY252	80-139	2.5	0.01	0.04	0.01%	rs	400	
*Nuvar	NPS Series	96-105	0.05-1.5	0.05	0.05	4	dju	req										

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	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
M 60	CEA	CEA6BY252	80-139	2.5	0.002	0.008	0.001%	rs	410	*Trygon	LVS Series	2.5-161	2.1	0.01	0.01	0.5	su	86-111
	CEA	CEA6CY 252R	80-139	2.5	0.0005	0.002	0.0005%	rs	460	CP	PM722	170	0.035	±0.5	20.5	15	s	43.90
	CEA	CEA6A502	80-139	5	0.01	0.04	0.01	r	440	Elasco	MS Series	158-178	0.05-0.1	0.05	0.01%	0.01%	dsu	130-135
	CEA	CEA6B502	80-139	5	0.002	0.008	0.001%	r	450	Dynage	D Series	156.1-172.1	0.05-0.075	±0.025	±0.025	5	abdgu	115-146
	CEA	CEA6C502R	80-139	5	0.0005	0.002	0.0005%	r	500	Elasco	V5Series	160-180	0.05-0.1	0.05	0.05	0.01%	dsu	140-145
	SCI	415	0-140	0.1	0.01	0.01	1	edf	235	CP	PM723	180	0.04	±0.5	±0.5	15	s	43.90
	Elasco	V5Series	120-140	0.05-0.1	0.05	0.05	0.01%	dsu	115-120	Dynage	D Series	172.1-189-6	0.025-0.075	±0.025	±0.025	5	abdgu	125-150
	*Acopian	140JSeries	139-141	0.2	±0.05	±0.05	1	abdfj	145-155	*Techni	PM95 Series	144-192	0.05-3	±0.5	±0.5	5	su	185-725
	Dynage	D Series	128.7-141.6	0.05-0.1	±0.025	±0.025	5	abdgu	107-132	Elasco	MSSeries	178-198	0.05-0.1	0.05	0.05	0.1%	dsu	130-135
	*Techni	P80Series	96-144	0.05-6	±0.5	±0.5	5	su	120-655	Deltron	L	0.5-200	0.5-72	0.005	0.005	0.5	abdgj	190-924
M 61	*Techni	PM95 Series	96-144	0.05-6	±0.5	±0.5	5	su	150-870	D-B	155	3-200	0.75	0.01	0.01	1	abd	70
	*Techni	F115Series	96-144	0.05-3	±0.05	±0.05	1	su	260-2180	D-B	205	3-200	1.4	0.01	0.01	1	d	85
	Lambda	LM-B	0-150	3.8	0.01	0.02	0.05	abdg	109	D-B	305	3-200	3.1	0.01	0.01	1	abd	118
	Lambda	LM-C	0-150	5.3	0.01	0.02	0.05	abdg	139	D-B	415	3-200	6	0.01	0.01	1	abd	138
	Lambda	LM-D	0-150	13.1	0.01	0.02	0.05	abdg	180	Arnold	PIL	3-200	8	0.01	0.03	5	df	360
	Lambda	LM-E	0-150	22	0.01	0.02	0.05	abdg	249	Arnold	PIG	3-200	8	0.01	0.03	5	d	310
	Lambda	LM-EE	0-150	33	0.01	0.01	0.05	abdg	320	Arnold	PIB	3-200	8	0.01	0.03	5	d	260
	D-B	301	3-150	3.8	0.01	0.02	0.5	abdg	117-137	D-B	515	3-200	12-9	0.01	0.01	1	abd	198
	D-B	401	3-150	5.3	0.01	0.02	0.5	abdg	157	D-B	615	3-200	24	0.01	0.01	1	abd	265
	D-B	501	3-150	11	0.01	0.02	0.5	abdg	117-197	Assoc Spec	12	75-200	0.1	1	1	5	abd	74.50
M 62	D-B	601	3-150	13.1	0.01	0.02	0.5	abdg	207-237	*Sorensen	QSA175-.25	150-200	0.28	±0.01	±0.01	0.3	abdegj	160
	D-B	701	3-150	22	0.01	0.02	0.5	abdg	267-297	Elasco	V5 Series	180-200	0.05-0.1	0.05	0.05	0.01%	dsu	140-145
	D-B	801	3-150	33	0.01	0.02	0.5	abdg	318-348	Acme	PS-41427	200	1	±1	±2	1%	ina	125-135
	D-B	901	3-150	48	0.01	0.02	0.5	abdg	448-528	*Acopian	200L Series	199-201	0.1	±0.5	±0.5	5	abdj	125-135
	*Sorensen	QSA120-.5	90-150	0.55	±0.01	±0.01	0.3	abdegj	149	Elasco	MS Series	198-203	0.05-0.1	0.05	0.05	0.01%	dsu	130-135
	Acme	PS-41426	150	2	±1	±2	1%	ina	179	Dynage	D Series	189.6-208	0.025-0.05	±0.025	±0.025	5	abdgu	125-150
	Lambda	LM-OC	150	11	0.01	0.02	0.05	abdg	450	*Techni	F115Series	144-210	0.05-3	±0.5	±0.5	1	su	315-1960
	Lambda	LM-F	150	48	0.01	0.02	0.5	abdg	575	Elasco	MS Series	198-203	0.05-0.1	0.05	0.05	0.01%	dsu	130-135
	Lambda	LM-G	150	95	0.01	0.02	0.5	abdg	575	Dynage	D Series	189.6-208	0.025-0.05	±0.025	±0.025	5	abdgu	125-150
	*Acopian	150JSeries	149-151	0.2	±0.05	±0.05	1	abdfj	145-160	*Techni	P80Series	144-210	0.05-3	±0.5	±0.5	5	su	140-565
M 63	*Nucor	NPS Series	145-155	0.05-1.5	0.05	0.05	4	dju	reg	*Techni	P80Series	144-210	0.05-3	±0.5	±0.5	5	su	140-565
	Dynage	H Series	97.1-156.1	0.2-0.65	±0.025	±0.025	1	abdgu	139-2-3	*ACDC	BX200 NO. 1-0.6	190-210	0.1-0.6	0.01	0.01	5	abdgc	158-249
	Dynage	D Series	141.6-156.1	0.05-0.075	±0.025	±0.025	5	abdgu	115-146	Dynage	D Series	208-228.5	0.025-0.05	±0.025	±0.025	5	abdgu	130-155
	Elasco	MS Series	138-158	0.05-0.1	0.05	0.05	0.01%	dsu	105-135	*Mid-Eastern	PM Series	5-240	3	±0.01	0.02	1	abdg	130-225
	*Techni	RA160 Series	0-160	0.75-12	±0.1	±0.15	0.2%	abdg	250-545	*Mid-Eastern	LA Series	5-240	3	±0.01	0.02	1	abdg	130-225
	*Techni	SCR-160 Series	80-160	3-12	±0.5	±0.5	1%	abdg	425-810	Deltron	C	3-250	0.026-36	0.003	0.003	0.5	abdgc	75-470
	*Techni	PL80Series	88-160	0.05-0.375	±0.5	±0.5	1	su	100-195	*Techni	HF80 Series	150-250	0.05-1.5	±0.05	±0.1	0.2%	su	125-450
	*Techni	MCS65 Series	105-160	0.065-4	±0.5	±0.5	5	su	125-555	Acme	PS 41428	250	1	±1	±2	1%	ina	125-450
	Elasco	V5 Series	140-160	0.05-0.1	0.05	0.05	0.01%	dsu	115-145									
	*ACDC	BX150-NO. 1-0.6	140-160	0.1-0.6	0.01	5	abdgc	138-193										

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	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$	Mfr	Model	OUTPUT		REGULATION			Notes	Price \$
			Range Volts	Max Amps	Line %	Load %	Ripple mV					Range Volts	Max Amps	Line %	Load %	Ripple mV		
M 64	Dynage	H Series	156.1-252	0.13-0.4	±0.025	±0.025	1	abdgu	161-210	Fluke	423A	0-3000	0.01	0.001	0.001	5p-p	460	
	Dynage	D Series	228.5-252	0.025-0.05	±0.025	±0.025	5	abdgu	130-155	*Spell-man	MRM3P 1500	1.5-3k	0.0005	0.01	0.25	3000	ad req	385
	CEA	CEA6D Z500R	140-259	0.05	0.0001	0.0004	0.0003%	rs	275	Power Des	UPMD-530N	200-3k	0.01	0.0025	0.0025	10	dh	420
	CEA	CEA6C Z500R	140-259	0.05	0.0005	0.002	0.0005%	rs	205	Power Des	UPMD-530P	200-3k	0.01	0.0025	0.0025	10	dh	175-716
	CEA	CEA6BZ 500	140-259	0.05	0.002	0.008	0.001%	rs	155	Abbott	U Series	4.7-3650	13.83	±0.2	±0.5	0.2%	dghj	175-716
	CEA	CEA6AZ 500	140-259	0.05	0.01	0.04	0.01%	rs	145									
M 65	*ACDC	BX250N0.1-0.6	240-260	0.1-0.6	0.01	0.01	5	abdjk	158-249	Abbott	GBk 17D-3460A	3260-3650	0.049	±0.5	±2	1%	djh	716
	*TDI	STR	3-300	0.25-10	0.05	0.05	0.2	abdjj	75-215	*Spell-man	FRHM5P 10D	5000	0.002	0.01	0.01	1000	ad	235
	*Acopian	RF1 Series	85-300	0.025	±1-3	±1-2	2-18	j	39	Abbott	HN2D-4860A	4580-5140	0.004	±0.5	2	2%	djh	495
	*TDI	TDM	1-306	2.8-60	0.01	0.01	0.2	abdjj	109-475	*Spell-man	MRM6P 1500	3-6k	0.0002	0.01	0.25	6000	ad req	765
	*ERA	MS Series	0-310	0.05-8	±0.01	0.05	0.8	abdeg	220-595	Abbott	GN4D-7000A	6600-7400	0.004	±0.5	2	2%	djh	765
	*ERA	SR Series	0-310	0.05-40	±0.01	0.05	0.8	abdeg	115-685									
M 66	*ERA	TR Series	5-310	0.5-8	0.05	0.05	2	abdww	90-360	*Spell-man	FRHM 10P 10D	10000	0.001	0.01	0.01	2000	ad	260
	*ACDC	BX300N0.1-0.6	290-310	0.1-0.6	0.01	0.01	5	abdjk	186-282	Abbott	T Series	47-10,400	19.44	±0.2	±0.5	0.2%	dghj	140-885
	Assoc Spec	2	200-325	0.1	1	1	10		64.50	Abbott	V Series	4.7-10,400	19.44	±0.2	±0.2	0.2%	dghj	145-885
	*Sorensen	QSA265-.15	200-330	0.17	±0.01	±0.01	0.3	abdegj	175	Abbott	GN4D-9900A	9300-10,400	0.004	±0.5	±2	2%	dhj	885
*Techni	PM95 Series	192-340	0.05-3	±0.5	±0.5	5	su	210-900	*Spell-man	MRM12P 1000	6-12k	0.0001	0.01	0.25	12000	ad req		
M 67	*Techni	F115 Series	210-340	0.05-1.5	±0.05	±0.05	1	su	355-2401	*Spell-man	FRHM15P 10D	15000	0.0006	0.01	0.01	3000	ad	435
	*Techni	P80 Series	210-340	0.05-3	±0.5	±0.5	5	su	165-670	*Spell-man	MRM18P 1800	9-18k	0.0001	0.01	0.25	18000	ad req	
	*ACDC	BX350N0.1-0.6	340-360	0.1-0.6	0.01	0.01	5	abdjk	186-282	*Spell-man	FRHM20P 10D	20000	0.0005	0.01	0.01	4000	ad	435
	*Techni	HF80 Series	225-375	0.03-1	±0.05	±0.1	0.2%	su	130-455	*Spell-man	FRHM30P 10D	30000	0.0003	0.01	0.01	6000	ad	480
	*ACDC	BX400N0.1-0.6	390-410	0.1-0.6	0.01	0.01	5	abdjk	186-282	Del	TRHV Series	1-30kV	0.005	0.25	0.25	0.5%	dg	245-615
M 68	CEA	CEA6D Z102R	260-500	1	0.0001	0.0004	0.0003%	rs	690	Uni-Volt	BPER	1-30k	5nA	0.1	0.1	0.1-0.25	g	250-1000
	CEA	CEA6C Z102R	260-500	1	0.0005	0.002	0.0005%	rs	620	Del	HRM Series	0.6-50kV	0.005	0.03	0.03	0.03%	adg	315-1080
	CEA	CEA6BZ 102	260-500	1	0.002	0.008	0.001%	rs	570									
	CEA	CEA6AZ 102	260-500	1	0.01	0.04	0.01%	rs	560									
	*Techni	HF80 Series	300-500	0.025-0.5	±0.05	±0.1	0.2%	su	140-460									
*Techni	HF80 Series	600-1000	0.012-0.375	±0.05	±0.1	0.2%	su	175-475										
M 69	*ERA	SV Series	75-900	0.005-0.02	±1.5	1.5	0.1	abdm	80-165									
	*Techni	HF80 Series	450-750	0.025-0.75	±0.05	±0.1	0.2%	su	160-470									
	Arnold	PHU-1500	1150-1500	0.015	0.1	1	0.1%	d	350									
	Arnold	PHU-2000	1500-2000	0.01	0.1	1	0.1%	d	350									
Abbott	Hak12D-1970A	1860-2080	0.061	±0.5	±2	1%	djh	425										

- a. Remote programming
- b. Remote sensing
- c. Price includes meters
- d. Solid state
- e. Automatic crossover from constant current to constant voltage.
- f. Dual output
- g. This model designation covers a series of modular supplies. These supplies are listed in the tables according to their output voltage.
- j. Reversible polarity.
- k. Specify BC series for 0.5% line & load regulation at reduced cost.
- m. Triple output.

- q. Model 506/16 power rack adapter will house 10 or 12 units of the type in a standard relay rack.
- r. Select any voltage by inserting the desired voltage after CEA6 plus letter series. Output voltages fixed or adjustable 5%, 10%, 20%, 30%, 40% or 50%. Constant current models available, specify.
- s. Dual output available
- u. Select any voltage by selecting the desired voltage and current after letter series. Constant current models available.
- v. IC Power Supply
- w. Slot type

Reader service numbers for literature and application notes, see page D6.

Companies advertising in the power supply section are marked by an asterisk.

## Know the Difference?



HW 10-8



HW 200-1

Right. One HW power supply is a 10-volt, 8-amp model; the other a 200-volt, 1-amp model. They are two of twenty constant-voltage, constant-current power supplies ideally suited for lab or system. .01% load and .005% line regulation are standard — as are remote programming and sensing, series/

parallel operation, 500 $\mu$  volt ripple, and separate voltmeter and ammeter. Many other standard and optional features and prices for this and other series power supplies are fully detailed in our color catalog. **Send for yours now.** Oh, yes. Another difference is that one costs \$205 and the other \$355.



**Mid-Eastern Industries** A Division of Eanco, Inc.  
660 Jerusalem Rd. / Scotch Plains, N.J. 07076 / (201) 233-5900

INFORMATION RETRIEVAL NUMBER 628



## Precise automatic battery charging

. . . For microwave, communication, telemetering, standby power, starting emergency generators, any unattended battery powered equipment. Use-proven by public utilities.

### Ratelco Quality Features

**Fully Automatic:** Constant voltage . . . output current *automatically* regulated to meet battery demands . . . can't overload!

**Unaffected by Line Voltage variations:** Compensates automatically — output varies less than 1% with line voltage variations of 10%. Exceeds government and utilities requirements.

**Simple, reliable:** Solid state circuits—no relays or moving parts.

**Easy to install:** Takes little space, easy mounting, full access to terminals, not damaged if connected with polarity reversed.

**May be paralleled:** Without special accessories.

**Capacities:** Up to 20KW available.

Write for more information or phone (206) 624-7770.

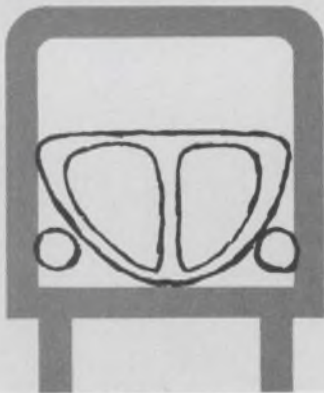
**Ratelco** INC.

ELECTRONICS MANUFACTURERS

612 Pontius Avenue North, Seattle, Washington 98109

INFORMATION RETRIEVAL NUMBER 629

## "the Voltswagon"



### INTRODUCING

The VW Series \* . . . Power supplies providing Economy, Reliability and Performance by NUCOR . . .

\*Available in 65°C + 95°C Base Temp. Ratings



Nuclear Corporation of America  
2 Richwood Place  
Denville, New Jersey 07834  
(201) 627-4200 (TWX) 710-9878487

INFORMATION RETRIEVAL NUMBER 630

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*When it comes to high voltage dc power supplies, come to the*

# INNOVATORS

**from Hipotronics.** *Here we are, one of the world's largest suppliers of HV Test Equipment and some people don't know we make HV DC Power Supplies. And we're getting bigger and better all the time: We just expanded our facilities by 150 percent, allowing us to more fully supply the needs of present — and future — customers.*

## **CAPABILITIES:**

- EHV DC Power Supplies; i.e., 1 million volts (a 20 ma, with reversible polarity)
- HV "Brute Force" Supplies; i.e., 500 KV (a 100 ma)
- HV High Energy Supplies; i.e., 200 KV (a 1 amp or 100 KV (a 2 amps, with reversible polarity)
- 100 kw Constant Current Monocyclic Capacitor Charging Supplies
- Power Packs, epoxy and oil filled
- Standard HV Power Supplies; i.e., 100 watts to 200 kw, 1000 volts to 1 million volts

## **FACILITIES:**

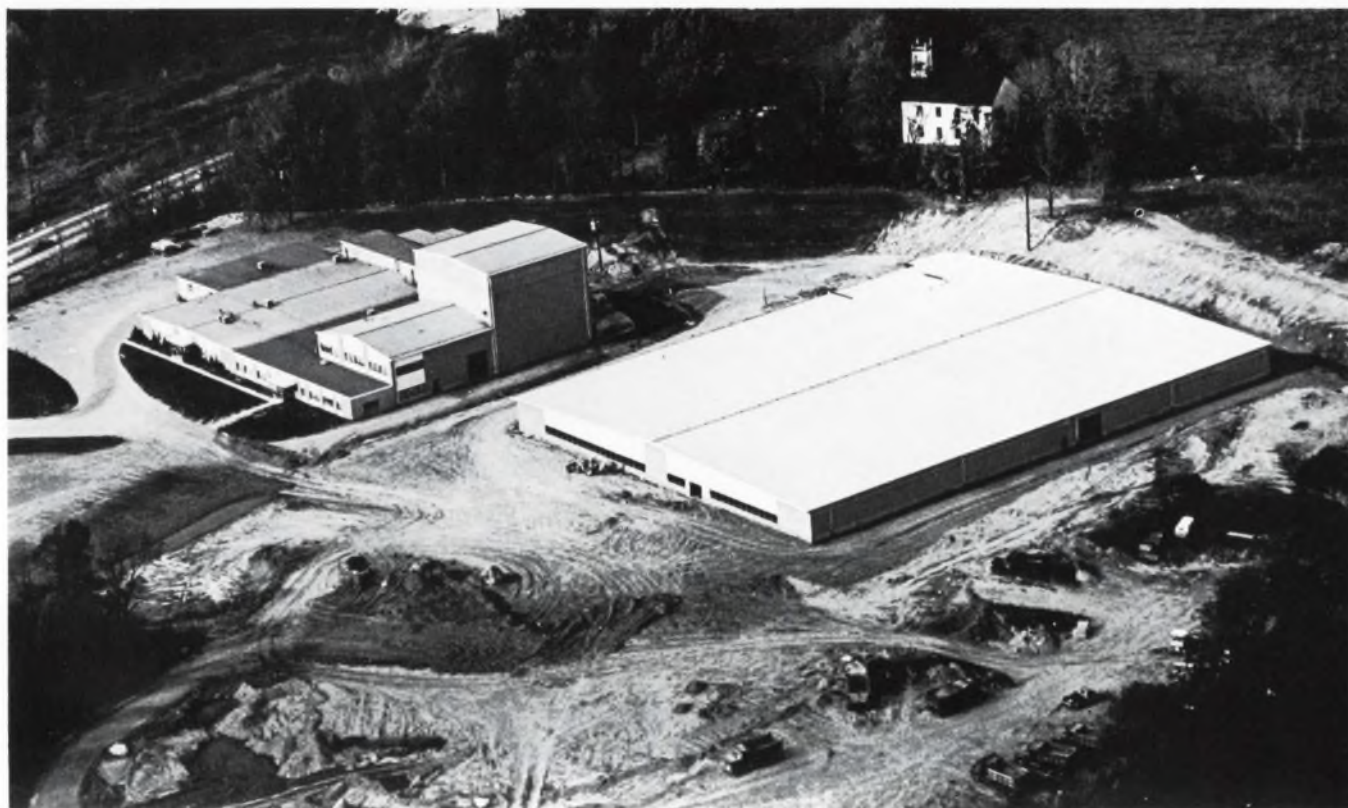
- Capacitor manufacturing facility (Corson Electric Division of Hipotronics)
- Transformer manufacturing facility
- Vacuum, varnishing and impregnating system, for coils up to 7 foot diameter
- Advanced vacuum oil processing system
- Indoor high bay assembly and test area for operating units into the megavolt range
- Lift facilities in excess of 25 tons
- AND . . .
- 85,000 square feet of modern air-conditioned plant facilities.

**Call or send your specific requirements to  
Mr. David Spiegelman, Chief Engineer, Power Supplies**



*High Potential Electronics*

BREWSTER, NEW YORK 10509 / (914) BR 9-8091



INFORMATION RETRIEVAL NUMBER 631

# smooth

RCA WP-700A, 702A, 703A and 704A constant voltage dc power supplies are all solid-state. A negative feedback circuit maintains constant output voltage with low ripple — regardless of varying line. In fact, at rated load, these supplies are so smooth that "they hardly cause a ripple."

They are versatile bench-type units—ideally suited for use in circuit design, servicing, industrial, and educational applications.

Output voltage of the WP-700A and WP-702A is continuously adjustable from 0 to 20 volts at current levels up to 200 mA.

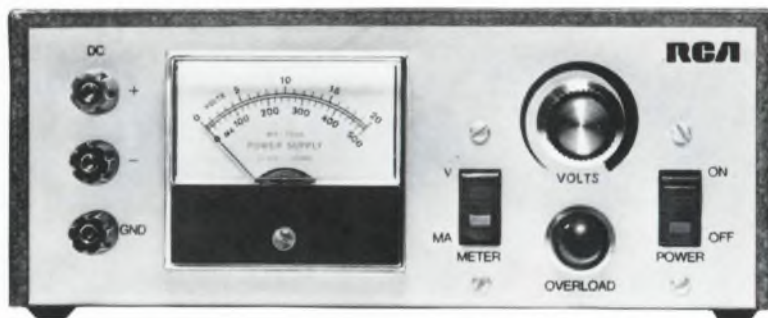
Output voltage of the WP-703A is continuously adjustable from 0 to 20 volts at current levels up to 500 mA.

Output voltage of the WP-704A is continuously adjustable from 0 to 40 volts at current levels up to 250 mA.

All four power supplies have built-in electronic short-circuit protection—and a front panel overload-indicator that signals approach to maximum rated current level.



WP-700A: \$40.00\* (five or more) \$48.00\* (less than five)



WP-703A: \$49.00\* (five or more) \$58.00\* (less than five)

WP-704A: \$49.00\* (five or more) \$58.00\* (less than five)



\*Optional Distributor Resale Price.

WP-702A: Siamese Twins of WP-700A, but electrically isolated \$73.00\* (five or more) \$87.00\* (less than five)

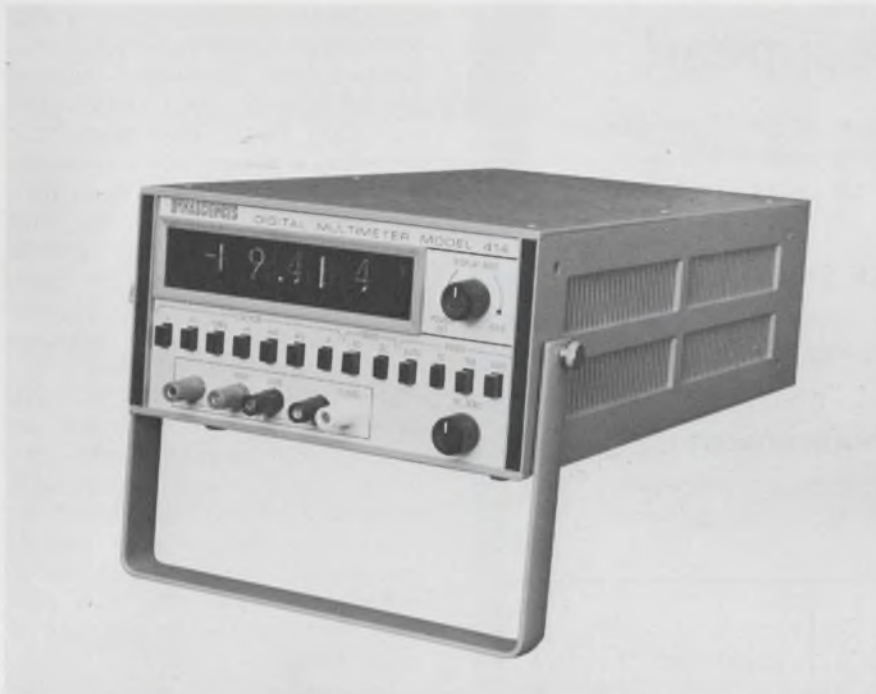
For further information write: RCA Electronic Components, Commercial Engineering, Department 2-15-W97, Harrison, N. J. 07029

Look to RCA for instruments to test/measure/view/monitor/generate

INFORMATION RETRIEVAL NUMBER 632

# New Products

## Four-digit low-cost multimeter checks 5 functions in 30 ranges



*Dynasciences Corp., Instrument Systems Div., 9601 Canoga Ave., Chatsworth, Calif. Phone: (213) 341-0800. P&A: \$795; 90 days.*

Intended for use as a highly versatile bench instrument, a new four-digit multimeter with 100% overranging features a low cost of only \$795 in an instrument that is capable of measuring five functions in 30 ranges.

With 13 pushbuttons and a 100-ms response time, the model DM414 Maxi-Ranger digital multimeter is capable of measuring ac and dc voltages, ac and dc currents, and resistances, all in very wide ranges.

It can measure dc voltages from 1  $\mu$ V/digit to 1000 V full scale in six ranges, with a standard accuracy of 0.05% +1 digit. Resolution is from 1  $\mu$ V to 100 mV, and

input impedance covers 10 to 10,000 M $\Omega$ .

Ac voltages can be measured from 10  $\mu$ V/digit to 1000 V full scale in five ranges, with a standard accuracy of 1% +0.05% of full scale. Resolution is 10  $\mu$ V to 100 mV, and input impedance is 10 M $\Omega$ .

It can measure dc currents from 1 nA/digit to 1 A full scale in six ranges, with a standard accuracy of 0.05% +1 digit. Resolution is 1 nA to 100  $\mu$ A, and input impedance extends over 0.1  $\Omega$  to 10 k $\Omega$ .

Ac currents can be measured from 1 nA/digit to 1 A full scale in six ranges, with a standard accuracy of 1% +0.05% of full scale. Resolution is 1 nA to 100  $\mu$ A, and input impedance ranges from 0.1  $\Omega$  to 10 k $\Omega$ .

Resistances are measured from 1 m $\Omega$ /digit to 10 M $\Omega$  full scale in seven ranges, with a standard accuracy of 0.05% +1 digit to 0.5% +0.05% of full scale. Resolution is 1 m $\Omega$  to 1 k $\Omega$ , at a sampling current of 0.5  $\mu$ A to 10 mA.

The multimeter's frequency response ranges from 47 Hz to 10 kHz, and it is input protected to accept up to 1200 V ac or dc (top two ranges), or 300 V on ac and dc current and resistance inputs.

CIRCLE NO. 250

### Also in this section:

**Computing counter for \$750** logs frequencies from 1.0000 Hz to 1.0000 MHz. p. 98.

**Low-noise S-band MIC flatpack amplifiers** can be directly soldered together. p. 108.

**Multi-layer ceramic wiring structure** fits four complex ICs in standard DIP. p. 116.

**Modular read/write memory cards** feature 10-ns cycle time and 15-ns access time. p. 123.

**Evaluation Samples**, p. 150..... **Design Aids**, p. 152.

**Application Notes**, p. 154..... **New Literature**, p. 156.



## filter magic? watch envelope-delay problems disappear!

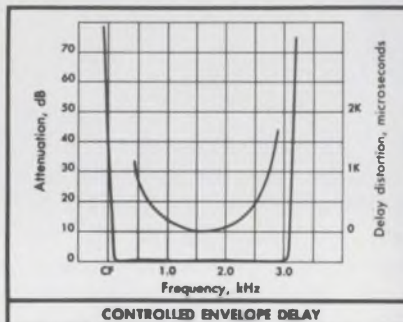
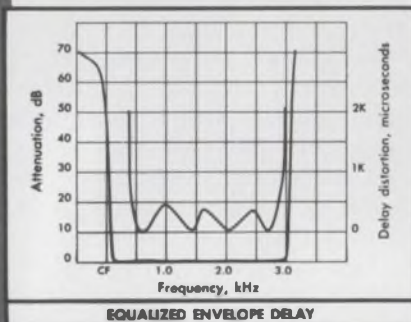
High-speed data transmission demands Reeves-Hoffman Hi-Fidelity crystal filters with advanced control of envelope delay combined with optimum selectivity!

### Available at most IF frequencies

Our Hi-Fidelity crystal filters minimize envelope-delay distortion, and eliminate the need for discrete equalizers.

### Describe your requirement

Reeves-Hoffman designs to your specifications. Call, TWX, or write today for delivery and price.



#### One of 4 channels

1750.000 kHz	Carrier frequency	1750.000 kHz
55dB	Carrier suppression	55dB
1749.745 kHz	1dB point, min.	1749.745 kHz
1746.965 kHz	1dB point, max.	1746.965 kHz
1750.250 kHz	70dB point, min.	1750.100 kHz
1746.750 kHz	70dB point, max.	1746.700 kHz
1.0dB	Passband ripple, 25°C	0.5dB
0dB ± 0.5dB	Insertion loss, 25°C	3.0dB
50 ohms	In and out impedance	200 ohms
+10° to +64°C	Operating temp. range	+5° to +65°C

#### One of 4 channels

craft-masters in crystal controls

# REEVES-HOFFMAN

DIVISION, DYNAMICS CORPORATION OF AMERICA

400 WEST NORTH ST., CARLISLE, PENNSYLVANIA 17013 • 717/243-5929 • TWX: 510-650-3510

INFORMATION RETRIEVAL NUMBER 49

## Computing \$750 counter measures 1 Hz to 1 MHz

Time Systems Corp., 265 Whisman Rd., Mountain View, Calif. Phone: (415) 961-9321. P&A: \$750; 30 days.

Truly a fully automatic instrument—free of control knobs and mid-operation adjustments—a new computing frequency meter can measure any frequency between 1.0000 Hz and 1.0000 MHz to five significant digits. This means that you can now accurately pinpoint very low frequencies without paying for a broadband counter that gives you high-frequency capabilities you do not necessarily need. With its \$750 price tag, the new computing counter drops measurement costs to \$150 per digit.

Model 270 displays the first five significant digits of the input frequency, automatically locates the decimal point, and annunciates Hertz or kiloHertz. Because of its autoranging and automatic operation, the unit is ideal for skilled or unskilled personnel. The only controls are a power switch and a reset button.

The new counter measures the period of the input signal. A computing circuit then takes the reciprocal of the period so that the final display is always directly in frequency.

Gate times, which are automatically selected according to the frequency of the input signal, range from 0.1 to 1 seconds. The unit's accuracy is plus-and-minus one count, plus-and-minus the time-base error, plus-and-minus the trigger error. Its sample rate is one second.



Front and rear panels of 1-MHz computing counter do away with control knobs for fully automatic operation.

CIRCLE NO. 251

**CTS  
HYBRID  
MICRO-  
CIRCUITS  
PICK'EM  
OFF-THE-  
SHELF  
TRY US!**

**850/851 Relay Drivers**

A single 700ma or dual 350ma driver in a compact TO-8 package can be driven directly or with TTL or DTL inputs. Prices: 1 to 9—\$15.00 ea; 100—\$11.50 ea.



**873 ±15 V Voltage Regulator**

Independent +15V and -15V regulators in a TO-8 package. Offers better than .03% line regulation and .05% load regulation. Externally adjustable from 8V to 36V. Price: 1 to 9—\$32.00 ea.; 100—\$20.85 ea.



**870 5 Volt Regulator**

Offers .05% line and load regulation and built in short circuit protection. TO-3 package provides safe and rugged high power operation. Prices: 1 to 9—\$27.25 ea; 100—\$17.70 ea.



**861 Log I.F. Amplifier**

Used in cascade, the 861 Series provides a log video output. It features internal supply decoupling, built in video detector and allows direct rf coupling between stages. Prices: 1 to 9—\$36.00 ea; 100—\$26.50 ea.



**878/879 Voltage Regulator**

A 2 ampere regulator in a TO-3 package which is externally adjustable from 8V to 57V. Prices: 1 to 9—\$20.00 ea; 100—\$13.00 ea.



**862 Operational Amplifier**

Operates from ±6V to ±28V supply and will drive 50 ohm load. TO-5 package. Prices: 1 to 9—\$22.80 ea; 100—\$14.80 ea.



Pick your standard CTS microcircuits off-the-shelf. All available for fast, 48-hour delivery from stock and all produced under the same stringent processes as CTS custom hybrid circuits. These precision packages are hermetically sealed and operate over -55°C to +125°C full military temperature range.

Try CTS total hybrid circuits capability for all your requirements. Complete in-house facilities assure you get the package you need to meet your exact requirements. Ask for our Hybrid Microcircuits Brochure. CTS Microelectronics, Inc., West Lafayette, Indiana 47906. Phone: (317) 463-2565.

**CTS CORPORATION**  
Elkhart, Indiana



# AT LAST a reliable and inexpensive cryogenic refrigerator.



We made the Displex™ to meet growing demands for a small system that "runs and runs." Its displacer expander provides cold from 30°K to 300°K and produces 17 watts at 77°K. No refilling and consumables—it's a closed-cycle system, so you get long-term operation with high reliability. Gas cushioned displacer action in the expander results in low vibration and low noise.

Wherever you need a portable or installed unit for cryogenic operations, the Displex Model CS-102 will give months of round-the-clock service. May we help you with cryogenic application engineering for your need? Air Products and Chemicals Inc., Advanced Products Dept., Allentown, Pa. 18105. Tel. 215/395-8446.



INFORMATION RETRIEVAL NUMBER 51

## INSTRUMENTATION

### Low-cost digital clock has two time modes



*Pulse Monitors, Inc., 351 New Albany Rd., Moorestown, N.J. Phone: (609) 234-0556. P&A: \$69; 2 wks.*

By touching the probe tip of a new hand-held logic probe to a circuit under test, one can determine logic levels of DTL, TTL and RTL circuits. The model 1280C Digi-Probe detects pulse trains, improper levels, open circuits, a single pulse as fast as 25 ns and relative duty cycles. Its readout is displayed by two (HI and LO) indicator lamps.

CIRCLE NO. 253

### Compact oscilloscopes widen response to 7 MHz



*Analogic Corp., Audobon, Rd., Wakefield, Mass. Phone: (617) 246-0300. P&A: \$144; stock to 2 wks.*

The new AN500 series of panel-mounting counter/displays are compact units with up to five full decades of digital display or counting functions. They are DTL/TTL compatible and can count at rates up to 10 MHz. Optional features include a polarity symbol, an over-range "one", buffer storage registers and decade counters.

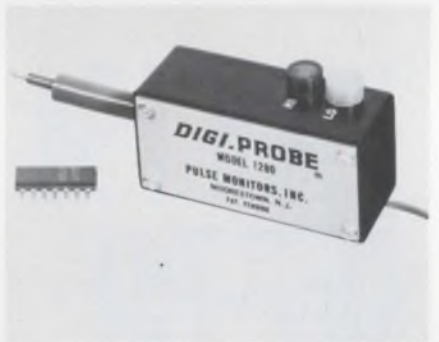
CIRCLE NO. 255

*Datatron, Inc., 1562 Reynolds Ave., Santa Ana, Calif. Phone: (714) 540-9330. Price: \$1200.*

For only \$1200, including options, a new IC digital clock accumulates time from the line frequency or an external one-pulse-per-second source in real or elapsed-time modes. The model 3350 uses standard Nixie tubes to display time in days, hours, minutes and seconds. Options include days accumulated and displayed, internal oscillator and parallel BCD output.

CIRCLE NO. 252

### Hand-held logic probe detects most levels



*Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 326-7000. P&A: \$950, \$1175; stock.*

Additions to the 1200-series oscilloscopes are two new oscilloscopes with a frequency range of dc to 7 MHz each. Models 1215A and 1217A are single and dual-channel instruments, respectively. Both have deflection factors from 5 mV/division to 20 V/division and 21 sweep times from 1  $\mu$ s/division to 5 s/division.

CIRCLE NO. 254

### Compact panel meters indicate to five digits



INFORMATION RETRIEVAL NUMBER 52 ►



# Xtal Filters.

## Damon shapes up fast!



Whether your signal shaping need is a sharp rejection notch, a band-pass or a single side-band filter – call Damon. Choose from dozens of computer-assisted standard designs including Butterworth, Chebyshev, Gaussian or Bessel. Or let Damon create a custom filter to your specs. Either way, you're sure of the exact crystal filter you need. A production run or a prototype, Damon meets your schedule. Try us. Damon/ Electronics Division, 115 Fourth Ave., Needham, Mass. 02194. Phone: (617) 449-0800.

### Band-Pass Filters

PARAMETER	RANGE
Center Frequency .....	10 Khz-75 Mhz
Bandwidth .....	.01%-3% of C.F.
Phase Linearity .....	<±5%
Transient Overshoot .....	>40 db
Shape Factor .....	<1.25:1
Differential Phase Shift .....	<±2°
Group Delay Uniformity .....	<±5%

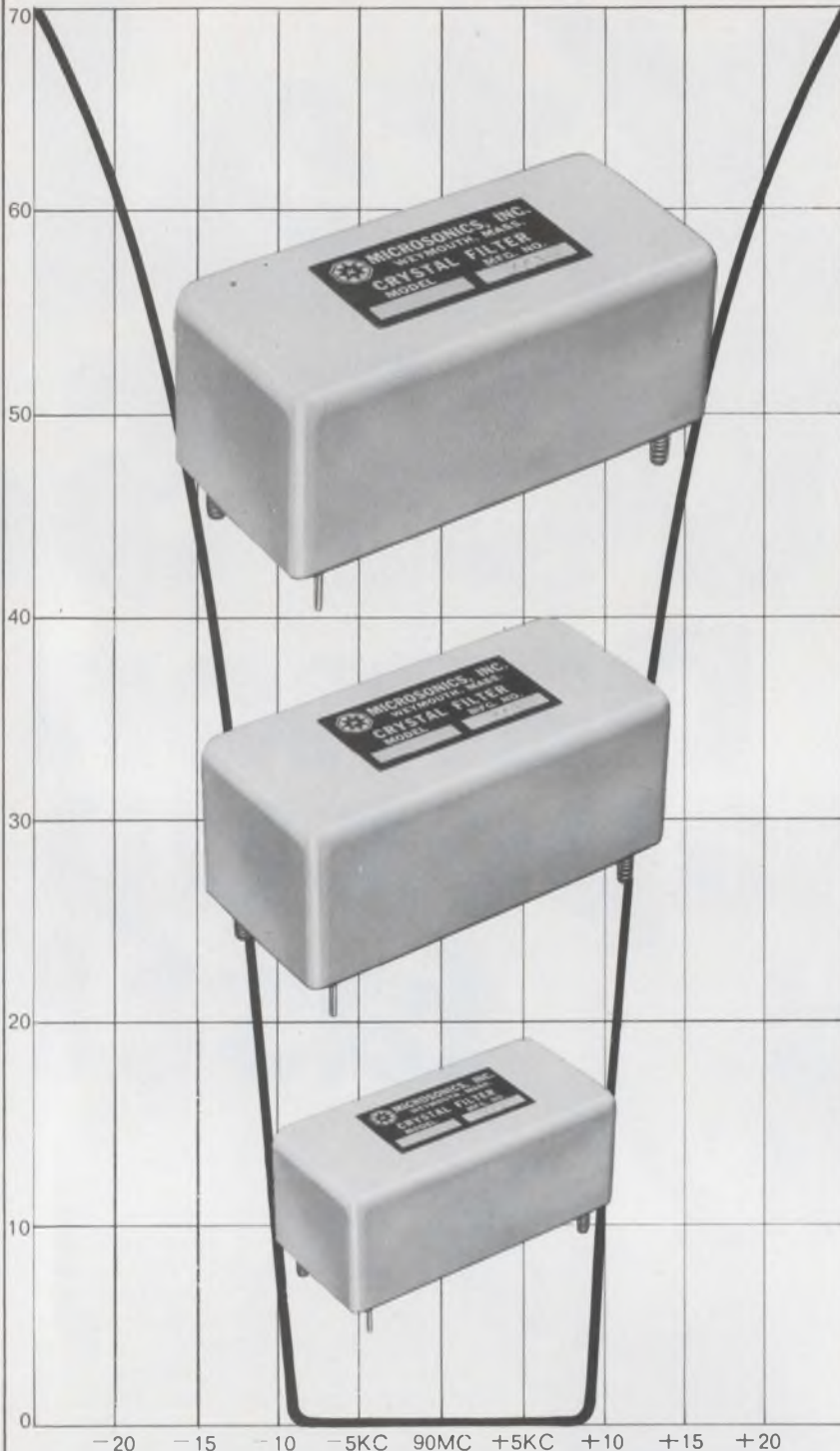
### Band-Reject Filters

PARAMETER	RANGE
Center Frequency .....	10 Khz-35 Mhz
Reject Bandwidth .....	.01% to .5% of C.F.
Pass Bandwidth .....	Up to 100% of C.F.
Shape Factor .....	<1.8:1
Notch Rejection .....	>80 db
Insertion Loss .....	<0.5 db
Ripple .....	<0.25 db

### Single Side-Band Filters

PARAMETER	RANGE
Center Frequency .....	10 Khz-35 Mhz
Pass Bandwidth .....	.01% to 2% of C.F.
Carrier Rejection .....	>40 db
Shape Factor Carrier Side .....	<1.15:1
Shape Factor Side-Band Side .....	<1.25:1
Insertion Loss .....	<3 db
Ripple .....	<1 db

**DAMON**



**MICROSONICS**  
*for proven design, reliability &  
 performance in*  
**CRYSTAL FILTERS**



Write for Bulletins today  
**MICROSONICS**  
 60 Winter Street, Weymouth, Mass. 02188  
 Tel: 617 337-4200  
 A division of the Sangamo Electric Company

INFORMATION RETRIEVAL NUMBER 53

INSTRUMENTATION

**DPM with 3-1/2 digits  
 adjusts its own zero**



*Digilin, Inc., 6533 San Fernando Rd., Glendale, Calif. Phone: (213) 246-8161. P&A: \$169; stock to 3 wks.*

Featuring 3-1/2 digits and low cost, a new digital panel meter eliminates the need for zero adjustment. The model 330 automatically zero-adjusts itself by grounding its input amplifier, comparing its output to ground, and using the difference signal to generate a zero-correction signal. Its input amplifier features a technique that eliminates circuit loading.

CIRCLE NO. 256

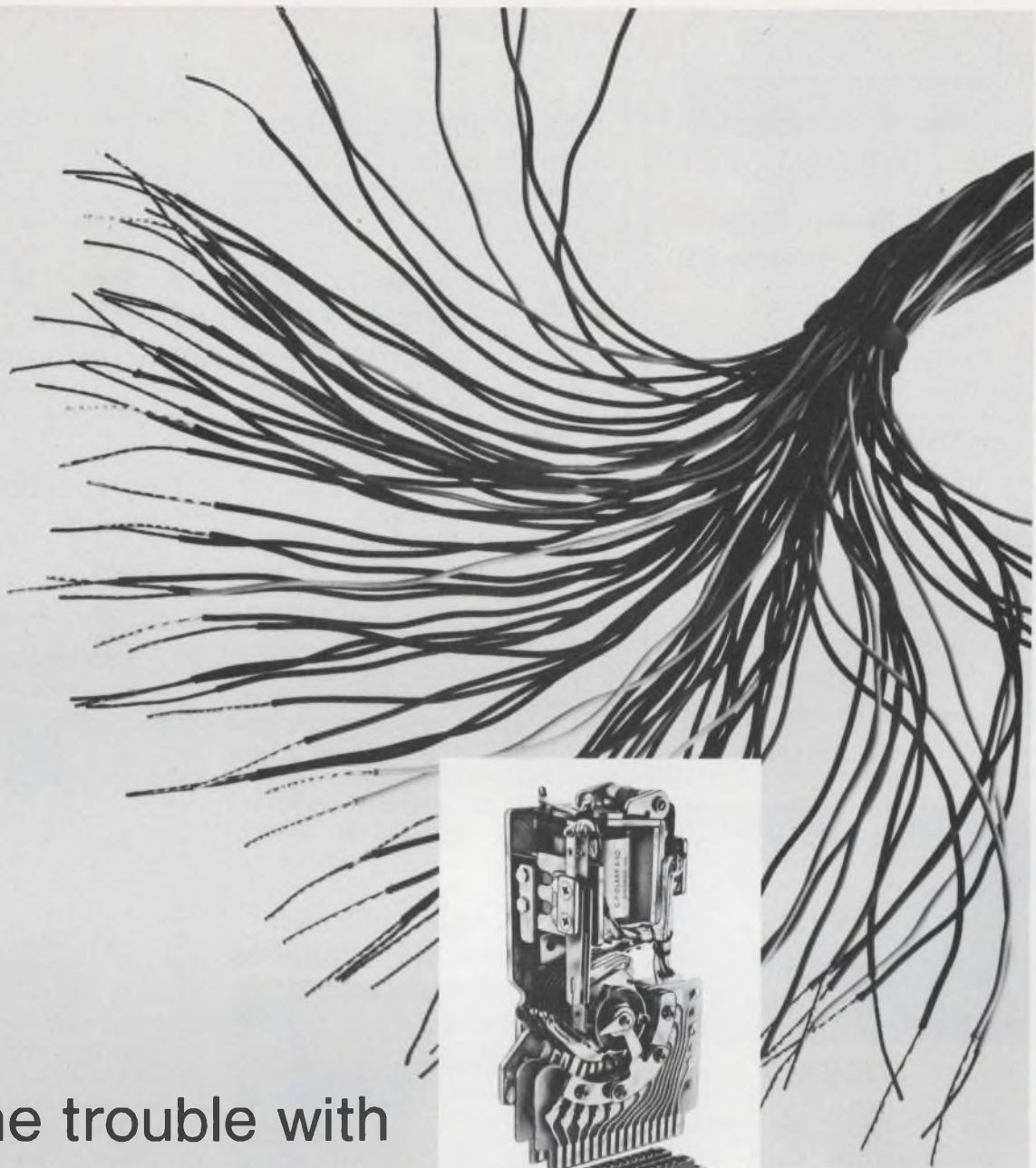
**Wideband variable filter  
 attenuates in 4 slopes**



*Kron-Hite Corp., 580 Massachusetts Ave., Cambridge, Mass. Phone: (617) 491-3211. P&A: \$850; stock.*

Spanning the range of 0.02 Hz to 20 kHz, a new variable filter offers four selectable attenuation slopes. The model 3750 is a low-pass, high-pass, band-reject and bandpass filter with attenuation slopes of 6, 12, 18 or 24 dB/octave. Its passband gain is unity (0 dB) or ten (20 dB) and it attenuates more than 80 dB for the 24-dB/octave position.

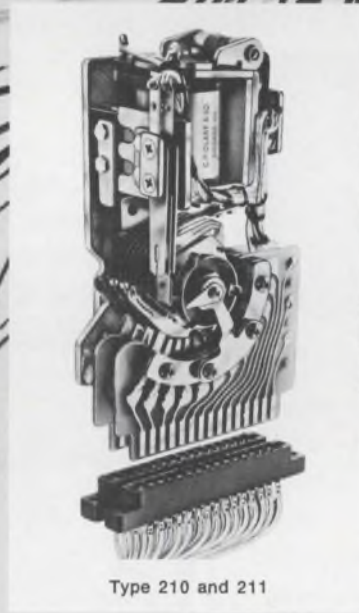
CIRCLE NO. 257



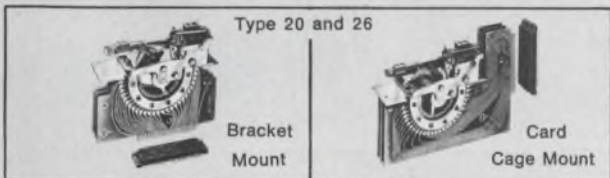
## the trouble with stepping switches isn't anymore

You no longer have to fight a fist-full of spaghetti when you service a stepping switch. Exclusive Clare Quick-Mount lets you pull out the old switch and plug in the replacement—in less downtime than it takes to install the simplest device.

Clare Quick-Mount is available on all spring-driven stepping switches, using 15, 22 or 28-pair connectors. You can get up to 416 switching points in less space than most other hard-contact devices.



Type 210 and 211



Clare offers a complete line of standard and special-purpose stepping switches to meet every application requirement—spring-driven and direct drive—operating voltages from 6 to 110vdc, speeds to 60 steps/second.

For complete information, circle Reader Service Number, or write for Manuals 601, 602, and Data Sheet Series 651. C. P. Clare & Co., Chicago, Illinois 60645... and worldwide.

LOOK  
TO



**CLARE** FOR  
STEPPING SWITCHES

a GENERAL INSTRUMENT company

# C-COR AMPLIFIERS

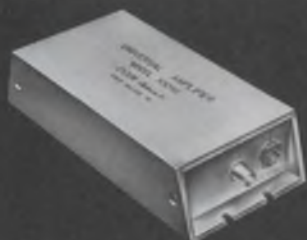
## — UNIVERSAL —

### Wide Dynamic Range Super Video - Wideband R.F.

Bandwidth: 5 Hz-425 MHz  
Gain: 20-60 dB  
Output: +10 to +28 dBm  
Price: \$85-\$850

### — FAMILY FEATURES —

- High Output
- Wide Dynamic Range  
—greater than 80 dB
- Spin-offs from Critical Military/  
Aerospace Projects
- Meet Many MILSPEC Applications  
without Modification
- Exceptional Reliability
- 20/40/60 dB Gain Versions  
Available



### EXAMPLES

Model	Freq Hz	Gain	Output
3364*	1K-200MHz	40dB	+20dBm
3388-E*	5Hz-130MHz	60dB	+25dBm
3010-A	.6MHz-425MHz	23dB	+28dBm
3007-L	2K-230MHz	20dB	+28dBm
3528	100Hz-100MHz	20dB	+12dBm

\*20/40/60 dB Gain Versions Available

Select from 29 models off-the-shelf.  
See EEM '69-'70 Edition Section  
1100, Page 517.

"C-COR Amplifiers . . . Rated First  
Where Performance is Rated First."



## C-COR

ELECTRONICS, INC.

60 Decibel Road  
State College, Pennsylvania 16801  
814 238-2461

## INSTRUMENTATION

### Tri-function generator outputs within $\pm 0.05$ dB



Clarke-Hess Communications Re-  
search Corp., 43 W. 16th St., New  
York, N.Y. Phone: (212) 255-2940.  
P&A: \$365; stock to 2 wks.

Clarke-Hess Communications Re-  
search Corp., 43 W. 16th St., New  
York, N.Y. Phone: (212) 255-2940.  
P&A: \$365; stock to 2 wks.

Providing outputs from 0.001  
Hz to 2 MHz, a new generator can  
be voltage or fm-swept with out-  
put amplitude variations of less  
than  $\pm 0.05$  dB. Model 743 has  
sine, square and triangular-wave  
outputs and includes tone-burst  
and synchronization capabilities.

CIRCLE NO. 258

Varitron Corp., Box 2594, St.  
Louis, Mo.

Developed for requirements of  
continuously variable waveforms in  
the audio and ultra-sonic frequen-  
cy ranges, a tiny new wideband  
generator simultaneously supplies  
square, triangular and sinusoidal-  
waveform outputs. It has a front-  
panel control for adjusting the  
square wave to variable-width neg-  
ative or positive pulses, and for  
adjusting the triangular waveform  
to right or left-sawtooth outputs.

CIRCLE NO. 259

### Tiny function generator supplies 3 waveforms



### Phase-angle voltmeter measures six quantities



North Atlantic Industries, Inc.,  
Terminal Dr., Plainview, N.Y.  
Phone: (516) 681-8600. P&A:  
\$490; 4 wks.

Using plug-in ICs and PC cards,  
a new phase-angle voltmeter mea-  
sures total ac voltage and five  
other quantities of the total vol-  
tage. The model 210 can measure  
in-phase, quadrature and funda-  
mental components of the total  
voltage, plus the phase angle and  
a reference signal. It accepts 3 mV  
to 300 V full scale from 20 Hz to  
40 kHz.

CIRCLE NO. 260

Pulse Monitors Inc., 351 New Al-  
bany Rd., Moorestown, N. J. Phone:  
(609) 234-0556. Price: \$1290.

Eliminating the need for periph-  
eral instrumentation is a new ana-  
lyzer that tests ICs and modules.  
Model 2080 has a built-in genera-  
tor with 3 clock frequencies and 4  
synchronous waveforms. A monitor  
indicates logic levels and detects  
square waves, pulse trains and open  
circuits. A supply provides 3 to 7  
V for energizing chips and mod-  
ules.

CIRCLE NO. 261

### IC and module analyzer eliminates peripherals



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**RESOLON® CONDUCTIVE PLASTIC ELEMENTS UP TO 36" LONG..... UP TO 3" DIAMETERS**

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Single-turn/servo-mounted, rotary pots are available in ⅞" to 3" diameters. Either linear or non-linear functions may be provided by these potentiometers.

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- Low output smoothness: maximum of 0.1% of total applied voltage.
- Low temperature coefficient: -300 ppm/°C max.
- Wide temperature range: -65°C to +125°C.
- Conformance to all applicable MIL specs. Including MIL-R-39023
- Linearity and conformity tolerances to ±.05%. Closer tolerances available.



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PHONE: (714) 545-8261 □ TWX 910-595-1128



INFORMATION RETRIEVAL NUMBER 56

## X-band transistor yields 1 mW at 8 GHz

*Texas Instruments Inc., Components Group, P.O. Box 5012, Dallas, Texas. Phone: (214) 238-2011. P&A: \$300; first quarter, 1970.*

Providing fundamental oscillator power at low X-band frequencies, a new microwave transistor delivers 20 mW at 6 GHz and 1 mW at 8 GHz when used as a class C oscillator. Typically, model MS0146 generates 0.6 W saturated output power at 4 GHz and 0.4 W at 5 GHz. A second transistor, model MS0147, is also available for low-noise applications to 6 GHz.

CIRCLE NO. 262

## Hot-carrier diodes slash prices to 32¢

*Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 326-7000. P&A: 32¢; stock.*

Prices on a line of hybrid hot-carrier diodes have been cut as much as 25% on quantity orders. Unit price of type 5082-2800 is now 32¢ in quantities of 100,000, versus the previous price of 43¢. The price for larger quantities can be expected to drop to less than 20¢ each in quantities of 1,000,000. Lower prices make it feasible to use these diodes where price has been a deterrent.

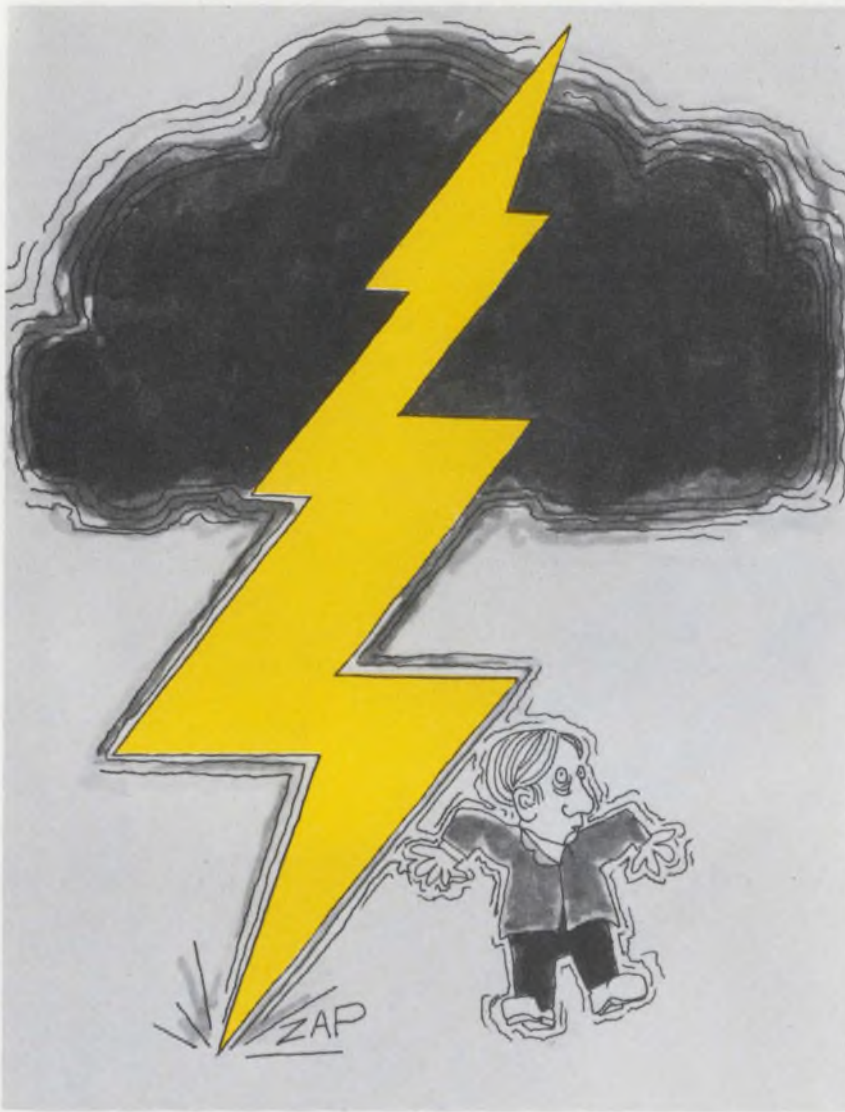
CIRCLE NO. 263

## Gunn-effect devices give 75 mW at 9.5 GHz

*Mullard, Torrington Pl., London, W. C. 1, England.*

Two new Gunn-effect devices for use from 8 to 12 GHz give outputs of 50 or 75 mW operating in a coaxial cavity at 9.5 GHz. Types 820CXY/A (50 mW), and 820CXY/B (75 mW) operate with a supply voltage of 9 V dc and are contained within hermetically sealed pill encapsulations. They are particularly suitable for doppler and wide tuning-range oscillator transmitters, as well as local oscillators of microwave radar equipment.

CIRCLE NO. 264



## There's more to rubber parts than electrical resistance.

In these days of guarantees, zero-defects and fail-safe performance, Stalwart custom compounds elastomers to meet customers' critical performance requirements. Important requirements like resistance to heat aging, radiation, flame, and compression set—to mention only a few. What's more, Stalwart offers design assistance to make sure molded, extruded, and calendered rubber parts conform to precise tolerances. Ask your Stalwart representative for an objective analysis of your design problems. Or, send today for your copy of the 18-page "Stalwart Rubber Selector."

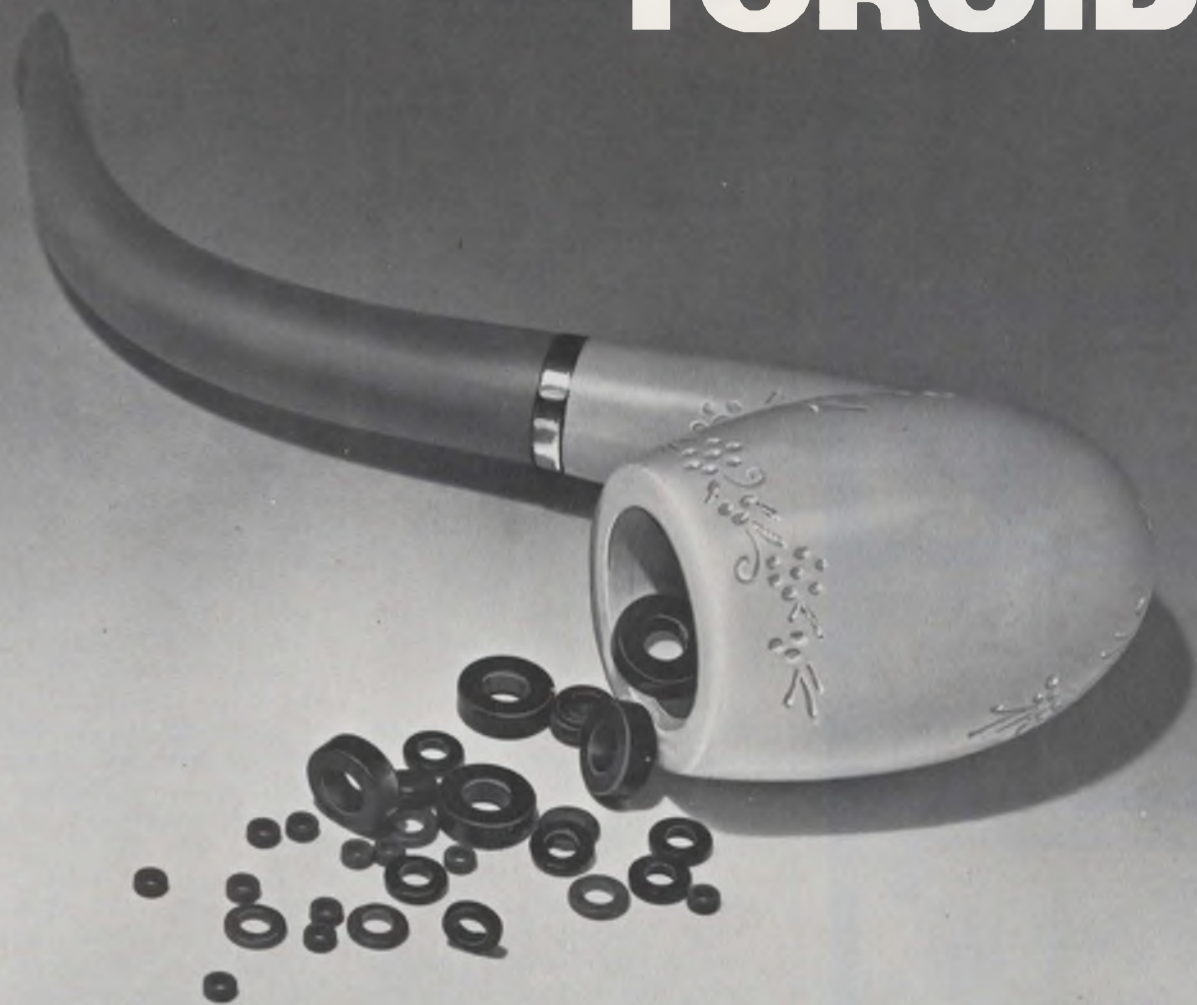
# SR

**Stalwart Rubber Company**

Bedford, Ohio 44146 Subsidiary of Blasius Industries, Inc.

INFORMATION RETRIEVAL NUMBER 57

# THE 5000 PERM TOROID



## NO LONGER A PIPE DREAM

That's right. 5000 initial permeability. And we mean it!

Perhaps your designs for pulse transformers have gone up in smoke for want of a powerful enough material. Well, now you've got it. And then some. Stackpole Ceramag® 24H ferrite material.

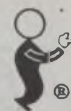
Ceramag® 24H is a precision engineered product. Exact processing, density checks, rigid kiln controls and precise

sintering. You get more out of it simply because we put more into it.

Here are a few more conservative characteristics. Maximum permeability, 6900. Typical. Saturation flux density, 4100 gauss and residual magnetism of 850 gauss. If curie point is significant to your operation, how about one of 175° C. Then there's temperature coefficient. Ceramag® 24H goes + 0.700% / ° C at -25°

C to 25° C and -0.450% / ° C at 25° C to 75° C. And all of this with a disaccommodation factor of  $1.4 \times 10^{-6}$ .

Ceramag® 24H is ready. Are you? Drop us a line and we'll send you some even more interesting facts about this fantastic new material. And the charts to prove it. Stackpole Carbon Company, Electronic Components Division, St. Marys, Pa. 15857. Ph: 814-834-1521



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INFORMATION RETRIEVAL NUMBER 58

# front panel ideas

\*Prices shown are single lot.  
Inquire about quantities.



## Keyboard Switch

A reliable reed switch is actuated by a permanent magnet. Stringent close tolerance maintained in operation pressure and operating points are standard. **RSM-41** with plain key cap. **2.70\***

CIRCLE NO. 151

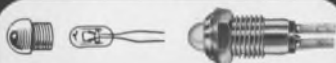
## Replaceable Readout!

7-Segment incandescent numeric, 3-5V @ 40-60 ma. Wide angle, built-in filter. With socket. **MS-4000BR.**



**6.93\***

CIRCLE NO. 152



## Replace-a-Lamp Pilot

Miniature lamp assembly utilizes unbased T-1 lamps replaceable from front. Equipped with #680 lamp rated 5V @ 60 ma. Screw lens colors optional. **BFK-5.** **1.29\***

CIRCLE NO. 153

## Knurled Aluminum Knobs

Machined aluminum anodized to satin finish. Slight conical top and hairline. Natural finish. **KD Series:** 1/2", 55¢; 1", 70¢.

**55¢\***



**70¢\***

CIRCLE NO. 154

## Ceramic Terminal Strips

Enhance equipment with high quality ceramic. Simplifies component replacement, provides test points. Long life. Trial Kit, 2 ea. 7 sizes. Snap mounting. **(MEP-NB).**

**10.00 Kit**

CIRCLE NO. 155

## Remote Control Relay

Plugs into 117 VAC outlet and provides "safe" low-voltage remote control. **FRE-103.**



**4.95\***

CIRCLE NO. 156

Immediate Deliveries on Above Items!

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ELECTRONIC PRODUCTS, INC.

Lawrence, Massachusetts 01843

# S-band IC flatpack amplifiers can be soldered together

*Avantek Inc., 2981 Copper Rd., Santa Clara, Calif. Phone: (408) 739-6170. P&A: from \$350; 60 days, or stock to 30 days.*

Supplied in ceramic IC flatpacks about the size of a razor blade, a new line of thin-film widerange S-band amplifiers allow the output leads of one stage to be soldered directly to the input leads of the next stage. Besides interconnection convenience, series UAT-2000 units hold noise figure to 6.5 or 7.5 dB maximum over their full frequency range of 100 to 2000 MHz.

The direct-soldering feature is made possible through copper tabs that are attached to the extremities of the package. These tabs can also be soldered to power supply leads, as well as the tabs of other amplifier stages.

These ceramic flatpacks, according to the company, offer increased reliability because there are no connectors. At rf frequencies, the performance characteristics of connectors can be ambiguous—for instance, a connector could act like a filter if properly installed.

Besides the ceramic flatpack housing, the new amplifiers also can be supplied in shielded stainless-steel cases complete with SMA connectors. These units are designated as series AMT-2000. They also offer a maximum noise figure

of 6.5 or 7.5 dB over the frequency range of 100 to 2000 MHz.

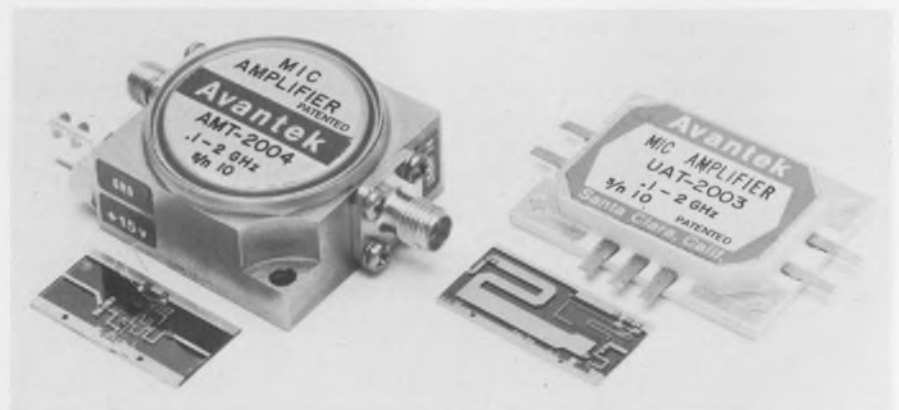
The new thin-film amplifiers consist of sapphire substrates, on which gold leads and tantalum resistors are evaporated via sputtering. Chip transistors and capacitors are then die-attached to the substrate and gold-ball bonded to the circuit leads.

Series UAT-2000 devices consist of four models: types 2001, 2002, 2003 and 2004. Minimum gain is 9 dB for the 2001 and the 2002, 18 dB for the 2003, and 26 dB for the 2004. Gain flatness is either  $\pm 0.5$  or  $\pm 1$  dB.

There are seven models in the series AMT-2000 family: types 2001 to 2007, inclusive. Minimum gain is 9 dB for the 2001 and 2002, 18 dB for the 2003, 26 dB for the 2004, 35 dB for the 2005, 42 dB for the 2006, and 50 dB for the 2007. Gain flatness varies from  $\pm 0.5$  to  $\pm 3$  dB, depending on the model.

Power output for a 1-dB gain compression is +4 dB at most for both series. Input and output VSWR is 2:1 maximum for each of the amplifier families.

The UAT flatpacks measure 1.15 × 1.5 × 0.225 in. Their metal-case sisters come in two package sizes—1.3 × 1.3 × 0.6 in. or 2.3 × 1.3 × 0.6 in.



Thin-film S-band amplifiers come in IC ceramic flatpacks that can be soldered together, or in conventional metal cases with standard SMA connectors. Noise figures are as low as 6.5 dB from 100 to 2000 MHz.

CIRCLE NO. 265



# When You Choose An AC Meter Best Isn't Always Most Expensive

So you're going to buy an AC meter. You want the best meter for your job—at the best price. Right? You have a problem! Let's talk about it.

We have AC meters, lots of AC meters. We have AC meters that sell for more than \$4500—and for their job, they can't be beat.

But how about the engineer who doesn't have a big production problem or need 5-digit resolution? How about the engineer who is making only two or three measurements a day... or week? We have a series of meters for him, too.

A series that has built a solid reputation for accurate performance and reliability—most of you have used them in the past. About three years ago, Hewlett-Packard updated with three redesigned, solid-state instruments—the 400 E/EL for broad frequency, 10 Hz and 10 MHz; the 400 F/FL for high sensitivity, 100  $\mu$ V to 1000 V; and the 400 GL for broad dB range, -100 to +60 dB, 100  $\mu$ V to 1000 V sensitivity.

These instruments are packed with convenience features. Two of these meters have a built-in 100 kHz low-pass filter to take out unwanted high frequencies for low-level audio mea-



surements. You get fast response—a reading in less than 2 seconds after turn-on, and <2 seconds overload recovery. These instruments have an internal wideband ac amplifier, with an 80 dB gain—so we put an output on the back. With all these you can have the log scale uppermost for greater resolution in dB measurements.

Each HP-made taut-band suspen-

sion friction-free meter movement is individually calibrated to its scale for accurate readings over the entire range. Elimination of friction gives these meters excellent repeatability.

These, and more, are the features that assure reliable, day-in, day-out performance that gets the job done on time. If your problem is in sonar, acoustics, audio response, communications, calibration, ac to dc conversion and amplification—or any other application where precision ac voltage measurements are a must—then consider the HP 400 series carefully. They will fit your measurement requirements, leave your wallet fatter, and make your job easier and faster.

Check your HP catalog, starting on page 201, and choose the meter that best meets your measurement needs. Order today by calling the nearest HP order desk. For data sheets, write to Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland. Price: \$300 to \$390.

059/18 A



ANALOG VOLTMETERS



INFORMATION RETRIEVAL NUMBER 60

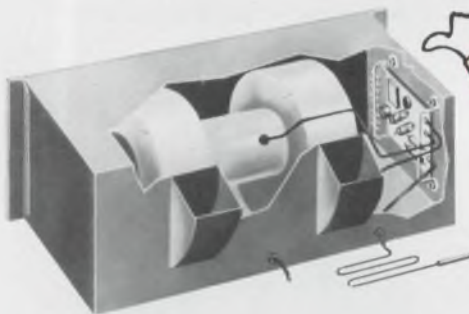
**McLEAN'S NEW SOLID STATE CONTROLLER SOLVES THE PROBLEM OF NOISY COOLING**

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**FURTHERMORE THE SLOWER BLOWER SPEED RESULTS IN LONGER LIFE FOR COMPONENTS AND BLOWERS! — THAT'S REAL ECONOMY!**

**I GUESS YOU CALL IT A SCOTCH COOLER**



Yes, a transistorized control and modulating thermostatic probe sense the temperature of your components, or outlet air temperature. The preset system regulates airflow between 80°F and 90°F. For instance, if it senses outlet air temperature at 90°F it operates at full volume and, as it cools the equipment, it gradually decreases output. The slower blower speed results in more peace and quiet plus big savings in blower and component life.



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**MICROWAVES & LASERS**

**Directional coupler lowers cost to \$49**

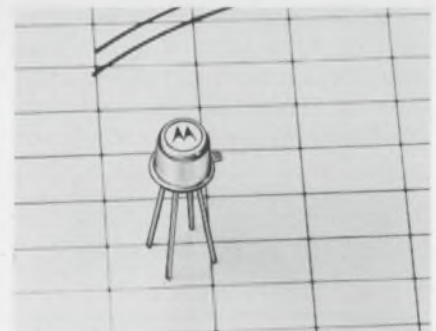


Solitron/Microwaves, ESCA Div., Cove Rd., Port Salerno, Fla. Phone: (305) 287-5000. P&A: \$49; stock.

Claimed to be the lowest priced and highest quality coupler of its type available to the industry is a new miniature coaxial directional coupler. The series 9071 coupler provides flat-coupling response and broad-frequency coverage of 500 MHz to 8 GHz. It has coupling of 10 or 20 ±0.5 dB, sensitivity of ±1 dB, directivity of 20 dB and a maximum VSWR of 1.2.

CIRCLE NO. 266

**Pnp switching transistor reaches out to 4 GHz**

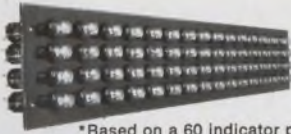


Motorola Semiconductor Products Inc., Box 20924, Phoenix, Ariz. Phone: (602) 273-6900. P&A: \$8.75; stock.

Featuring a typical base capacitance of 0.8 pf, a new pnp silicon switching transistor has a high switching speed with a minimum  $f_T$  [unity-gain (0-dB) frequency] of 4 GHz. Type MM4049 has leakage current of 10 nA at 10 V, and a dc current gain of 20 to 80 at 25 mA and 2 V. It is packaged in a TO-72 case and features annular construction.

CIRCLE NO. 267

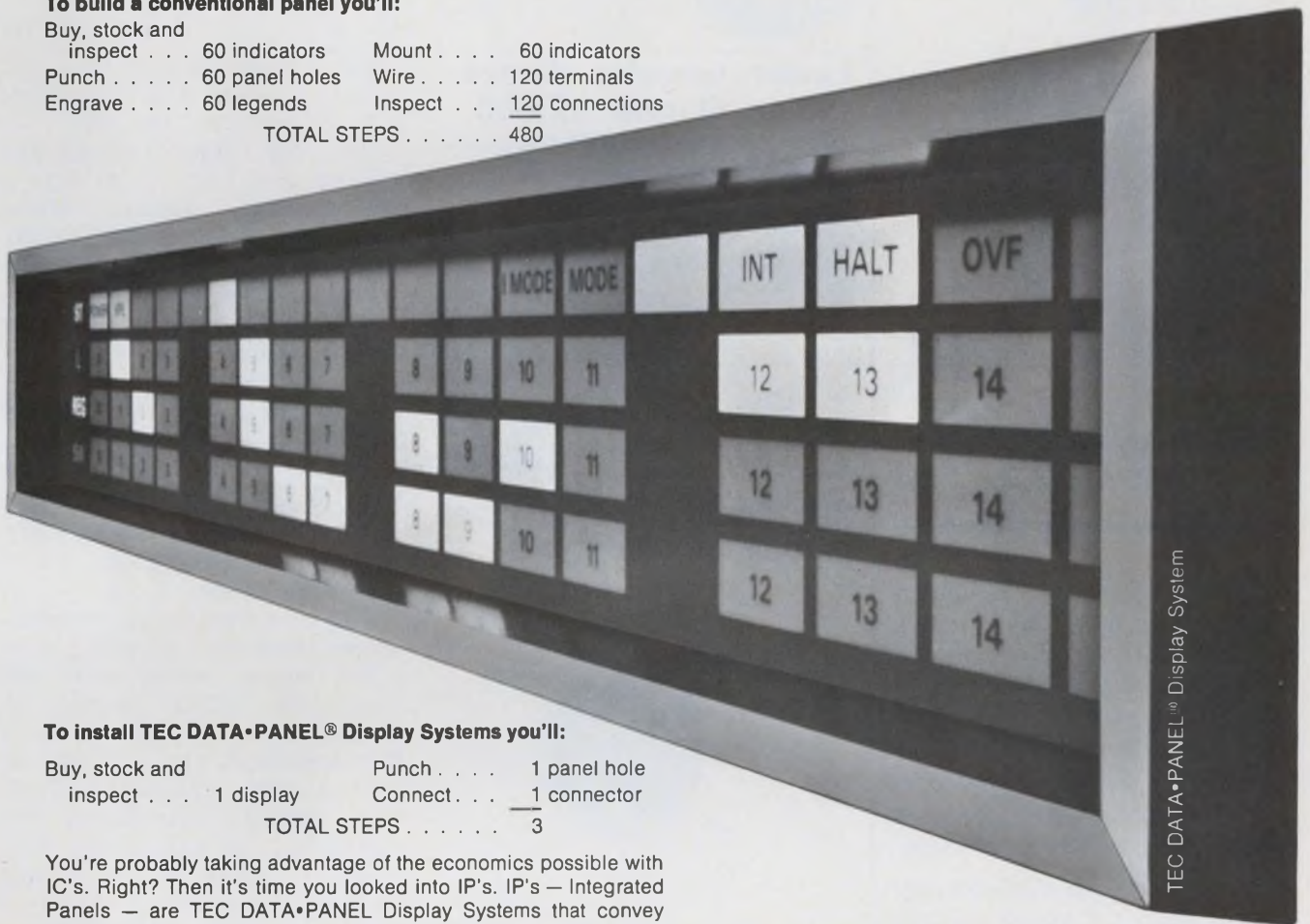
# TEC Can Save You 477\* Steps on Your next Display Panel



\*Based on a 60 indicator panel.

## To build a conventional panel you'll:

Buy, stock and inspect . . . . .	60 indicators	Mount . . . . .	60 indicators
Punch . . . . .	60 panel holes	Wire . . . . .	120 terminals
Engrave . . . . .	60 legends	Inspect . . . . .	120 connections
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TEC DATA•PANEL<sup>TM</sup> Display System

## To install TEC DATA•PANEL® Display Systems you'll:

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You're probably taking advantage of the economics possible with IC's. Right? Then it's time you looked into IP's. IP's — Integrated Panels — are TEC DATA•PANEL Display Systems that convey messages and symbols brilliantly and colorfully in a single viewing plane. Better display, yet costing less per point than individual indicators. And they cut installation work by 50% or more.

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Fullerton, California 92634

INFORMATION RETRIEVAL NUMBER 63

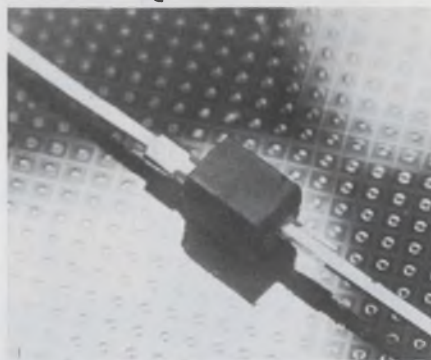
## MICROWAVES & LASERS

### Impatt oscillators span 8 to 18 GHz



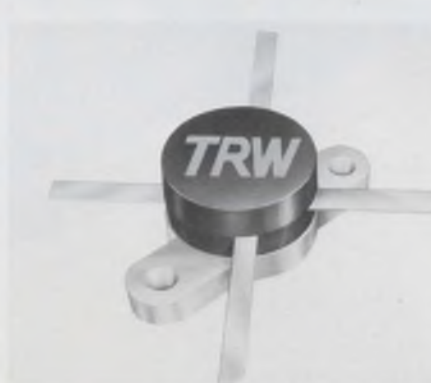
CIRCLE NO. 268

### Linear varactor diodes extend Q over 12,000



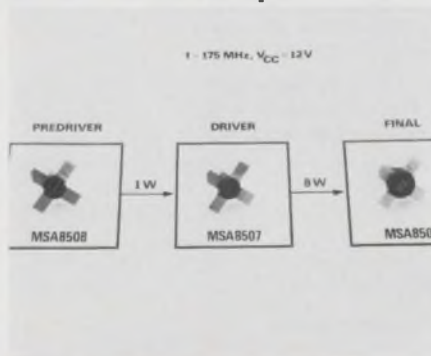
CIRCLE NO. 269

### Broadband transistors handle 80-W outputs



CIRCLE NO. 270

### Three vhf transistors form a 25-W power kit



CIRCLE NO. 271

Varian, Solid State Div., Salem Rd., Beverly, Mass.

Four series of high-Q impatt oscillators with low a-m and fm-noise characteristics and in tunable and fixed-frequency versions operate from 8 to 18 GHz with outputs of 25 to 200-mW. Units in the VSX-9500 series span 8 to 10 GHz; the VSX-9501-series units span 10 to 12.4 GHz; the VSU-9502-series units span 12.4 to 15 GHz and units in the VSU-9503 series span 14 to 18 GHz.

Standard Kollsman Industries Inc., 111 New York Ave., Westbury, N.Y. Phone: (516) 997-8300.

Featuring a linear response and a spread of 5:1 at 3 to 30 volts, a new series of varactor diodes shows a Q of more than 12,000. Model SK-210, SK-420 and SK-525 devices provide linear capacitance-versus-voltage characteristics for simpler designs and lower costs. They are completely passivated units and are encased in plastic housings.

TRW Semiconductor Div., 14520 Aviation Blvd., Lawndale, Calif. Phone: (213) 679-4561. P&A: \$140, \$160; stock.

Two new broadband communications transistors, operating from a 28-V source, provide 80-W outputs. Type PT5666 operates at frequencies to 150 MHz with a 15% bandwidth. It has a gain of 6 dB and its efficiency is 70%. Type PT5666A operates at frequencies to 125 MHz with a 50% bandwidth. Its gain is 6 dB and its efficiency is 65%.

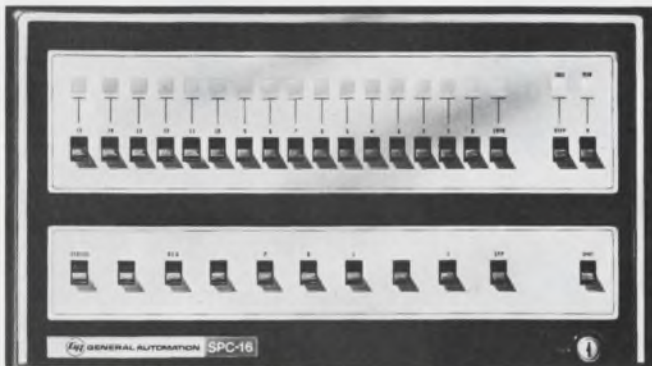
Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. Phone: (415) 962-3563. P&A: \$58 per kit.

A kit of three compatible npn power transistors form a vhf amplifier system with 25-W outputs from a 12-V supply. It consists of the MSA8506, MSA8507 and MSA8508 transistors. Connected serially, they provide a power gain of 24 dB over the range of 150 to 175 MHz. Full outputs are achieved with inputs of 125 to 500 mW.

INFORMATION RETRIEVAL NUMBER 64 ►

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SPC-16 is a powerful new 16-bit machine...960 nanoseconds fast...expandable 4K memory.

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King of Prussia, (215) 265-6525

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Silver Spring, (301) 593-6010

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Esher, Surrey, Esher 65764

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Goleta, California 93017  
Tel. (805) 968-3551

## MICROWAVES & LASERS

### Tiny spdt coaxial relay takes 50 W at 1.2 GHz

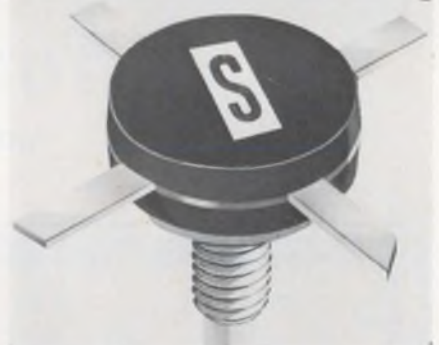


*Dow-Key Co., Box 348, Broomfield, Colo. Phone: (303) 466-7303.*

Measuring approximately  $2 \times 2 \times 3/4$  in., a new single-pole double-throw magnetic-latching coaxial relay handles 50 watts of cw power at frequencies up to 1200 MHz. The #181-2307 relay has a maximum VSWR (voltage standing-wave ratio) of 1.3:1 at 1200 MHz and requires a coil-voltage of 26 V dc for operation. It is fitted with type TM coaxial connectors and consumes very little power.

CIRCLE NO. 272

### Rf power transistor gives 60 W at 150 MHz



*Solitron Devices, Inc., 1177 Blue Heron Blvd., Riviera Beach, Fla. Phone: (305) 848-4311. P&A: \$66; 3 to 4 wks.*

Operating at a collector-to-emitter voltage of 28 V, a new rf power transistor delivers 60 W at 150 MHz with a minimum gain of 6 dB. Known as the SRD54117, it also can deliver 50 W at 175 MHz with a minimum gain of 6 dB. The device has a VSWR (voltage standing-wave ratio) of 3:1 and is packaged in a TO-128 power tower.

CIRCLE NO. 273

 <p><b>MODEM 2200/24</b></p> <p>1200 bps 2400 bps</p>	 <p><b>MODEM 3300/36</b></p> <p>3600 bps</p>
 <p><b>MODEM 4433/20H</b></p> <p>2000 bps</p>	 <p><b>MODEM 4400/48</b></p> <p>4800 bps</p>
 <p><b>MODEM 4433/20L</b></p> <p>2000 bps</p>	 <p><b>MODEM 5500/96</b></p> <p>9600 bps</p>
 <p><b>MODEM 4400/24PB</b></p> <p>2400 bps</p>	 <p><b>MODEM 1100</b></p> <p>4800 bps to 1,000,000 bps</p>

## 8 WAYS TO STAMP OUT DATA COMMUNICATION PROBLEMS

We build 8 different data sets for dependable high-speed data communications. They work. Even with line conditions that lick other modems.

ICC data sets transmit at speeds from 1200 bps to 1,000,000 bps. They're built to deliver maximum throughput at the speed specified. Without problems.

Send for new descriptive literature.

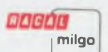


**International Communications Corporation**

7620 N.W. 36th Avenue, Miami, Florida 33147  
Telephone 305 + 691-1220 TWX 810-848-6588

a milgo company

In Europe —



Reading, Berks, England

INFORMATION RETRIEVAL NUMBER 66

## NEW PRODUCTS FROM EDC

ELECTRONIC DEVELOPMENT CORP.  
BOSTON, MASSACHUSETTS



**TWIDDLE BOX HAS DC OUTPUTS DOWN TO 10 NANOVOLTS.** The Model MV-106 has three (3) output ranges with resolution of 1 ppm. Operator may select output voltages from 10 nanovolts to 11 volts bipolar. Accuracy is  $\pm 0.005\%$ , based on the Limit of Error concept. There is up to 50 mA of current available in the volt ranges. The warm-up and stabilization time is 30 seconds from turn-on. Stability of the dialed voltages is better than  $\pm 0.0005\%$  for 8 hours on any range. Versatile in applications, this instrument may be used as a Source, Reference, Calibrator, Simulator, and Standard. Among the many applications are general calibration, thermocouple and transducer calibration, simulation and measurements, recorder calibration and linearity. A very useful instrument for bridge excitation for transducers; and it is an extremely valuable instrument for checking the gain of low-level amplifiers. *Option:* Rack mountable models. From stock. \$950.00 F.O.B. Boston.

INFORMATION RETRIEVAL NUMBER 67



**DIGITALLY PROGRAMMABLE DC STANDARDS** are programmed from BCD 8421 logic signals (other codes available). True digital programming (not resistive or voltage programming). Many models and options available to meet engineering requirements. Programmable voltage ranges from 100 mV (f.s.) to 100 Vdc (f.s.), plus 10% over-range. *Option:* 10 ppm or 100 ppm resolution. *Options:* Current output 10 mA to 100 mA, remote sensing, unipolar or bipolar output. *Logic level input swing:* from (min.) 2V swing to (max.) 28V swing. *Output accuracies (Limit of Error Concept):*  $\pm 0.02\%$  to  $\pm 0.1\%$  of setting. Output electrically isolated from digital control circuit and chassis. Operator may program for either serial (by decimal digit) entry or full parallel entry. Programming speed 5 ms. Prices range from \$1019.00 to \$1650.00 F.O.B. Boston. Delivery: Stock to 30 days.

INFORMATION RETRIEVAL NUMBER 68

Instruments available for no-charge engineering evaluation.



**Electronic Development Corporation**  
11 Hamlin Street • Boston, Mass. 02127  
(617) 268-9696

# Multi-layer IC wiring structure packs 4 chips in standard DIP

*E. I. DuPont de Nemours & Co., Inc., Electronic Products, Wilmington, Del. Phone: (302) 774-1000. P&A: \$10 to \$150; 90 days.*

Multilox ceramic wiring structures are a new development in IC packaging technology that satisfy the current design need for speed and complexity on a single substrate. The new structures consist of high-alumina ceramic parts containing one or more layers of buried high-conductivity hermetic wiring.

Hermetic risers connect the buried wiring to the top and bottom of the assembled structure. The various layers are then assembled, stacked on top of each other,

and fired together as a single unit.

The short interconnections made with the buried lines permit high chip density on the same substrate. This, in turn, provides minimum signal delays in high-speed circuits, and very low line resistance (typically one ohm per inch for buried runs and 0.5 ohms per inch for surface conductors).

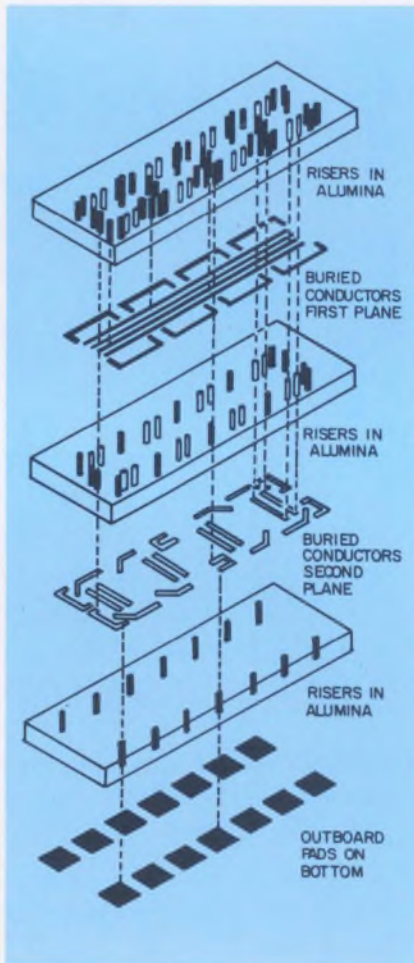
Another advantage of the Multilox structures is their ability to be processed in high-temperature oxidizing or reducing environments. This means that any one of the three metal technologies—thick film, thin film or active metal—may be employed on the top and bottom surfaces for package sealing and lead attachments.

The structure shown is an example of how a standard buried-wiring configuration can be used to form more than 50 different logic functions from four IC chips by discretionary top-surface wiring. It also demonstrates how four IC chips can be packaged in the space normally required for one.

This general-purpose multi-layer configuration is the size of a standard dual-in-line package. The large metallized areas are for back-bonding of the dice. The 5 and 10-mil-wide lines accept ultrasonic or thermocompression-bonded wires from the ICs and make connections to the proper risers. A slight modification of the top surface layout would allow use of flip-chips or beam-lead devices.

Buried interconnections are the real key to the new structure's versatility. The upper buried level carries conductors running the length of the package. These wires are used for service functions like ground, voltage, clock and reset signals.

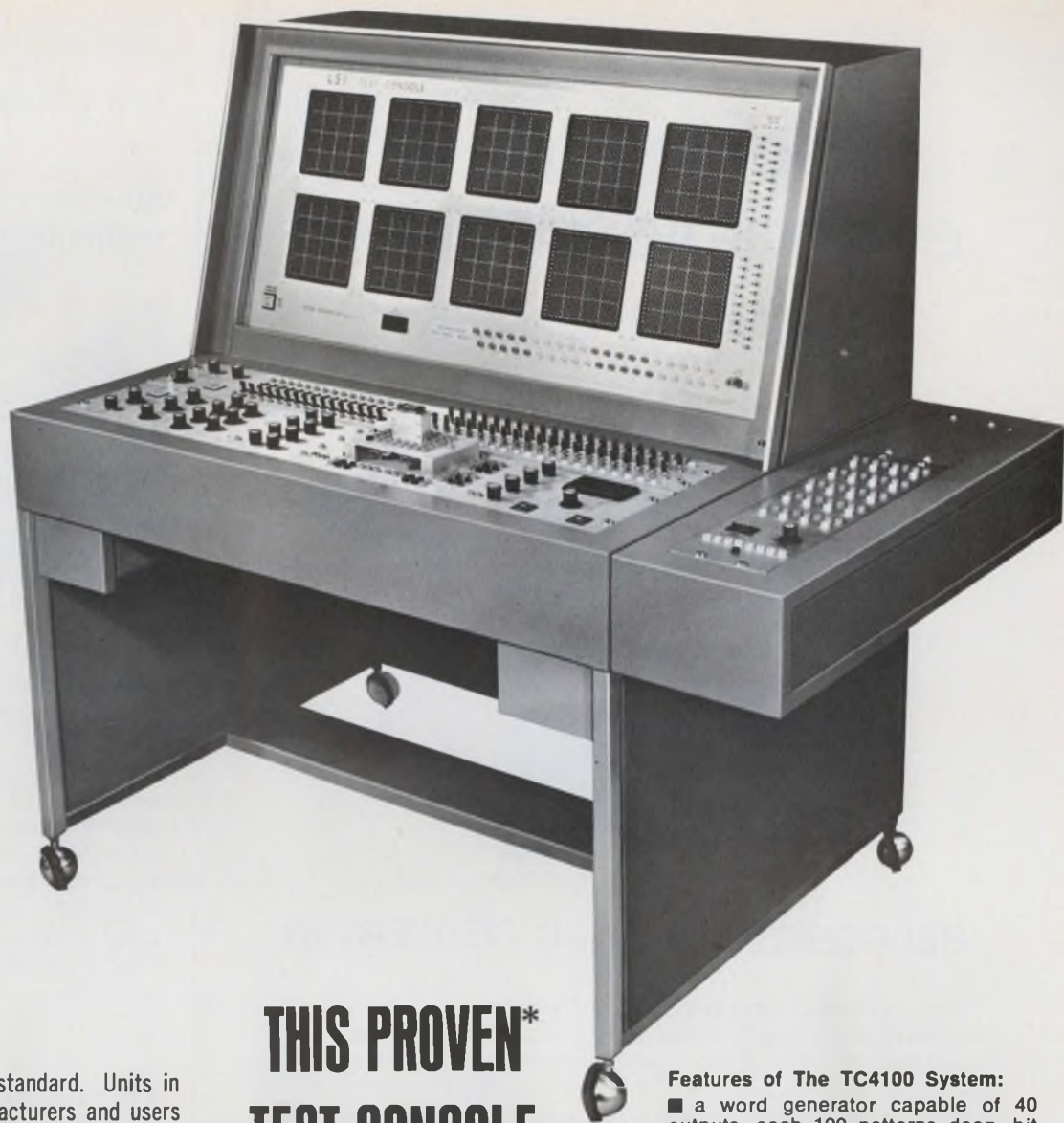
The lower buried level provides two crosslinks under each IC position. Connections are also made to risers from the outboard connection pads on the bottom of the substrate. The risers from the outboard pads are terminated at this level and weave through the buried wiring.



Multi-layer ceramic wiring structure accommodates four complex integrated circuits in the space normally occupied by a single chip. Only the size of a standard DIP, it adds interconnection versatility to packaging designs.

CIRCLE NO. 274






**\*PROVEN**—The industry standard. Units in use by the largest manufacturers and users (names on request);

**ECONOMICAL**—Costs far less than any other testing method, including black boxes;

**DELIVERABLE**—Normal shipment in 45 days;

**VERSATILE**—Can be programmed in less than 15 minutes for almost any type array (LSI-MSI-MOS), IC, digital PC board, or functional chassis . . . without punched cards, paper tape or magnetic tape.

For complete information, write or phone:

 **North American Electronic Systems**  
 DIVISION OF EDUCATIONAL COMPUTER CORPORATION  
 Sicklerville, N. J. 08081 Tel. 609-629-4141

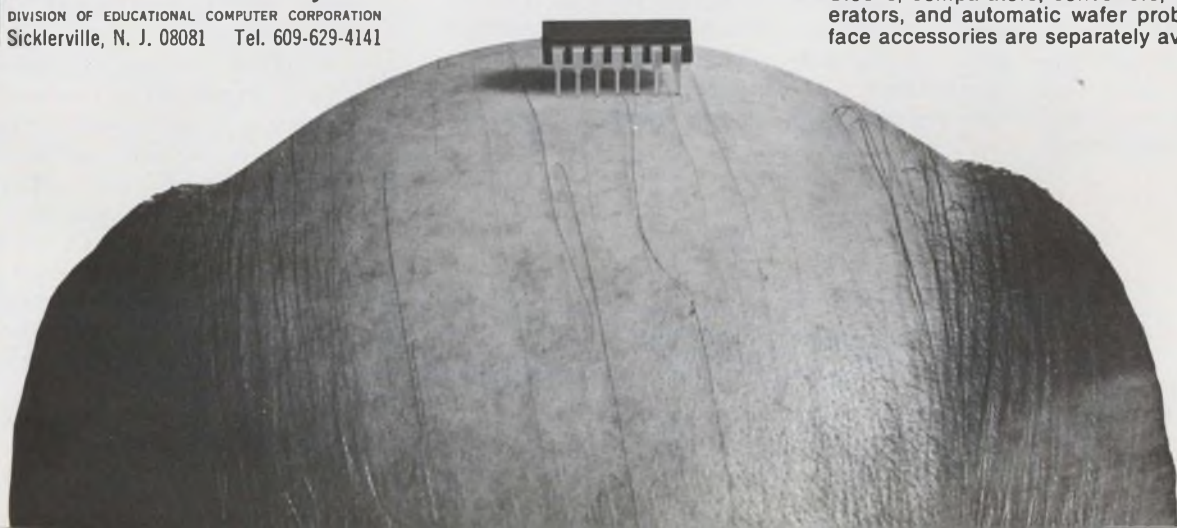
**THIS PROVEN\***  
**TEST CONSOLE**  
takes problems  
of LSI testing  
off your mind!

**Features of The TC4100 System:**

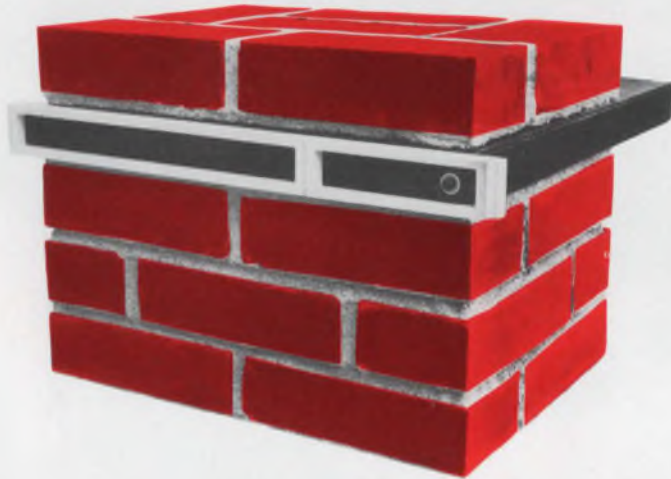
- a word generator capable of 40 outputs, each 100 patterns deep, bit rates from DC to 2.5 MHz. (options: adjustable depth, split-phase advancement);
- a four channel clock generator with adjustable frequency, sequencing, positioning, inhibiting, and leveling of clock pulses;
- a 16 channel comparator with adjustable strobe width and position, 1 and 0 level windows, don't care inhibits, and error overrides;
- a 40 channel converter with every word adjustable for 1 and 0 levels;
- a work area with quick connect fasteners for different array socket carriers;
- word toggling capability for words up to 800 bits.

**Functional Components:**

Clocks, comparators, converters, word generators, and automatic wafer probing interface accessories are separately available.



# Looking for an economical system building block?



## REDCOR 720 MUX/A-D CONVERTER

REDCOR's Model 720 Multiplexer/A-D Converter is an economical and versatile system-building block that accepts up to 32 channels of analog data. Time-shared multiplexing and successive approximation analog-to-digital conversion are utilized to process the analog input data into a format suitable for inputting directly into a computer. The basic 720 contains modular multiplexers, high-input impedance buffers, a sample and hold, an ADC, power supplies, and a voltage reference.

The 720 Multiplexer/A-D Converter offers distinct cost-performance advantages for a wide variety of data-acquisition problems where high resolution and attendant accuracy must be compared to system cost and throughput rates. The 720 is available in 8 to 12 bits binary, with system throughput rates ranging from 40 KHz to 20 KHz. Either single-ended or differential inputs are provided, with full-scale input ranges from 5v to 20v in bipolar or unipolar configurations.

The 720 is completely self-contained in a forced-air-cooled 19-inch chassis that requires only 1¾ inches of panel space. Modular concepts are employed throughout the instrument, with all circuitry contained on plug-in circuit modules that are removable from the master interconnect mother PC board. All test points required for system test calibration and maintenance are available from the swing-out front panel. The modular structure of the 720 ensures ease of maintenance and simplifies field expandability of channels.

Simplified operation, low-cost, ease of interfacing, and guaranteed system performance specifications make the Model 720 Multiplexer/A-D Converter attractive for any computer-controlled data-acquisition or process-control application.

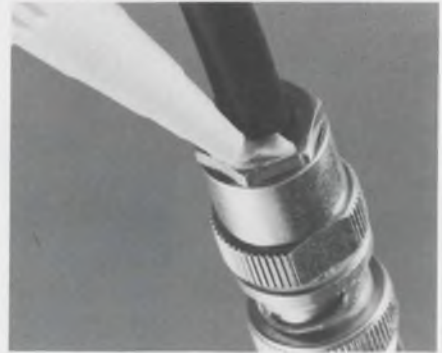
**R** **REDCOR**  
**C** CORPORATION

Complete Systems Capability / 7800 Deering Avenue, P.O. Box 1031,  
Canoga Park, California 91304—(213) 348-5892

INFORMATION RETRIEVAL NUMBER 70

## PACKAGING & MATERIALS

### Silicone rubber sealant eliminates corrosion

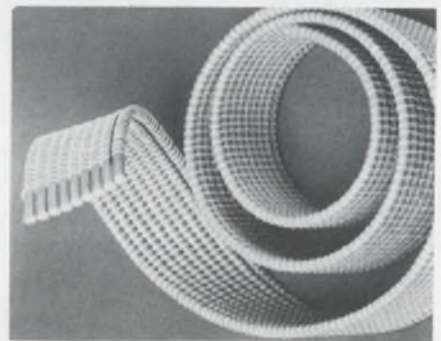


*Dow Corning Corp., Midland, Mich. Phone: (517) 636-8510.*

Long-term corrosion of coaxial cable connectors can be practically eliminated by the application of a new silicone rubber sealant to the made-up connection. By applying sealant #732 in a thin bead to the cable-connector joint and over the connector's external mating surface, the connection is rendered completely vapor and water-proof. Cable disconnection and reconnection is not affected and is still easy to achieve.

CIRCLE NO. 275

### Flat-ribbon coax cable handles fast signals

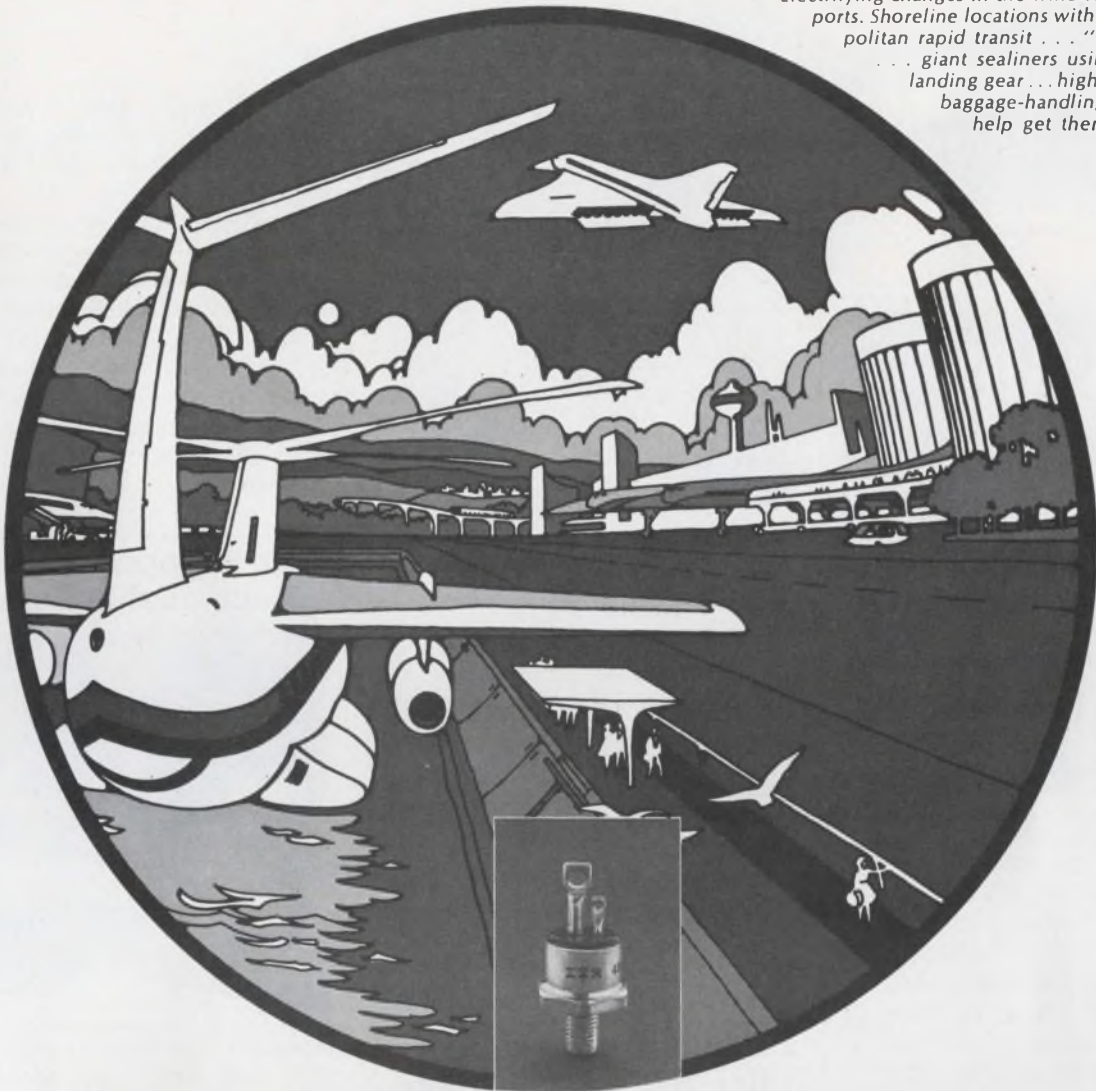


*Zippertubing Co., 13000 S. Broadway, Los Angeles, Calif. Phone: (213) 321-3901.*

Meeting the need for high-speed signal transmission in data processing and communications applications is a new sub-miniature coaxial cable in a flat-ribbon configuration. FRC-Fab-Ri-Cable's drain wire and center conductor have a silver-plated alloy for greater strength and higher conductivity. The drain wire is helically applied in a flexing situation for maximum life.

CIRCLE NO. 276

*Electrifying changes in the wind for tomorrow's airports. Shoreline locations with integrated metropolitan rapid transit . . . "floating" runways . . . giant sealiners using pressurized-air landing gear . . . high-speed automated baggage-handling systems. IR can help get them off the ground.*



**New 40 Amp high voltage SCRs from IR.  
Up to 80% less weight in 20% of the space.  
At half the fare.**

Those are the trade-ups you get for every bulky TO-94 or TO-83 you replace with one new IR 40RCS silicon controlled rectifier, rated from 700 to 1200 volts. Applications: precision dc motor drive controls. Industrial ovens. Light-dimming systems. And all applications requiring the highest surge and I<sup>2</sup>t ratings available in this size device. Including the avionics and hydraulic landing and control surface systems of tomorrow's electrifyingly changed aircraft.

Our six new high voltage 40RCS devices are metal-cased and glass-sealed for superior hermeticity and resistance to shock, vibration and moisture. They and our previously announced 50-600V. types are available from distributor stock to speed your electrifying change.

See how IR's 40RCS line matches up against competition—write for a full comparison table and watch the specs fly. Also up-to-date catalog, application data or engineering assistance.

Silicon Controlled Rectifiers  Power Logic-Triacs  Silicon Power Rectifiers  Selenium Rectifiers  
 Zener Diodes  Custom-engineered Sub-assemblies and Systems  Light Sensitive Devices

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INFORMATION RETRIEVAL NUMBER 71

**NPL**

# BINARY TO DECIMAL CONVERTER

The Northern Precision Laboratories' Binary To Decimal Converter converts Gray Code, V-Scan or True Binary Inputs into a decimal display thru the use of a fixed program computer. Upon receipt of an update pulse the computer samples the input information and processes it via shift registers and control logic. At the end of the conversion process, the resulting BCD number is stored in registers until the next update pulse is received. The BCD data is then used to drive a Nixie™ Display and/or is fed directly to output buffers. A complete conversion of 16 bit data is attained in approximately 50 microseconds; visual tracking of the input information is accomplished by utilizing an automatic internal update period of less than 5 milliseconds.

## APPLICATIONS . . .

Peripheral Equipment Interfacing  
Binary Format System Monitoring  
Digital Test Equipment

SEND FOR NEW CATALOG . . .

**NPL**

**NORTHERN PRECISION  
LABORATORIES INC.**

202 FAIRFIELD ROAD  
FAIRFIELD, NEW JERSEY 07006  
area code (201) 227-4800  
TWX 710-734-4301

INFORMATION RETRIEVAL NUMBER 72

## PACKAGING & MATERIALS

### PC transistor socket lowers its profile



*Interdyne, 2217 Purdue Ave., Los Angeles, Calif. Phone: (213) 477-6051. Availability: stock.*

Developed to meet the changing needs for larger devices that are capable of being wire-wrapped are two new 36 and 40-pin sockets for dual-in-line components. These sockets are the only receptacles that will accept any width center (0.5, 0.6, or 0.8 in.). They can be designed in any custom configuration and can be wire-wrapped for maximum versatility and performance.

CIRCLE NO. 278

### PC-board connectors offer 312 combinations



*Berk-Tek, Inc., Box 60, Reading, Pa. Phone: (215) 376-8071.*

Designed for situations where many signal lines of a specific characteristic impedance are required, with space at a premium, is a new 32-twisted-pair cable for interconnecting computer peripherals. It uses Vylex wire insulation, a Mylar laminate, and a flame-retardant overjacket of polyurethane. Conductors are AWG #28 and the insulation thickness over each conductor is typically 0.0033 in.

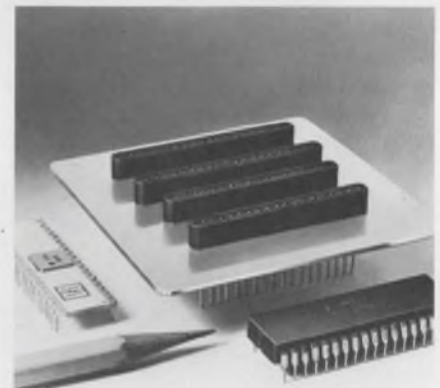
CIRCLE NO. 280

*Cinch Mfg. Co., Div. of TRW, Inc., 1501 Morse Ave., Elk Grove, Ill. Phone: (312) 439-8800. Availability: stock.*

Engineered for PC-board applications is a new low-profile three-lead socket for TO-5-cased transistors. Its overall height above the PC board is only 0.113 in. and it uses contacts of the closed-entry type. It can accept TO-18 case styles if full-length leads are used, or if leads are formed to TO-5 centers.

CIRCLE NO. 277

### Wire-wrapped sockets accept dual-in-lines



*Sylvania Electric Products Inc., 730 3rd Ave., New York, N.Y. Availability: 4 to 6 wks.*

Called the P101 series, a line of PC-board connectors permits the ordering of up to 312 connector combinations from available tooling. They have bifurcated contacts and metal or plastic polarizing keys. Four types are available: connectors with gold-plated bellows, or with a gold-dot contact, each with 0.1 or 0.125-in. contact centers.

CIRCLE NO. 279

### Cable for computers has 32 wire pairs



# Dynamic duo.



Dynamic variety in subminiature switches. Our SM and 1SX switches.

Take our SM series with a complete variety of integral or auxiliary actuators, bifurcated gold contacts for improved reliability and quick-connect

detent terminals. It's temperature resistant and meets Military Specification 8805.

And if our SM won't fit your needs, try our tiny 1SX. It's the smallest of the snap-action switches, and has low differential—.001 inch max. And it has all the features of the SM.

For more information on these dynamic subminiatures, contact your MICRO SWITCH Branch Office, Authorized Distributor or write for Catalog 50.

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HONEYWELL INTERNATIONAL: Sales and service offices in all principal cities of the world.

INFORMATION RETRIEVAL NUMBER 73

# LOGIC DESIGNERS WHO SPEND ALL NIGHT DRAWING "FROM-TO" WIRE LISTS AREN'T LOGIC DESIGNERS



## EECO'S LOGIC-WARE COMPUTER AUTOMATED SYSTEM WILL GET YOU HOME ON TIME.

In a typical logic design project, you can spend over 200 hours generating "from-to" wire lists, and other routine activities. That's work designers shouldn't have to do; and that's why EECO developed Logic-Ware, a computer automated system for design, hardware and production.

Logic-Ware takes the dirty, sticky, unrewarding monotony out of logic design, but it's more than just a design aid. It's software, hardware, production and final test. It's a total package available at any level of design or manufacturing. It can become "involved" in the initial circuit development, during hardware selection or the production phase. We've even worked from

schematics. You give us a pin list — that's all — we do the rest.

Our computer will simulate your logic and help goof-proof your design. It will compute optimum wire routing and produce machine wiring instructions. From there EECO will automatically wire wrap on two levels, leaving the third for any later design changes. And, provide operational hardware with a lifetime warranty in a standard drawer or on planes. 30 days after getting your pin list.

Write for our Logic-Ware do-it-yourself kit: The Emancipator. We'll get you home on time.



## ECCO'S LOGIC-WARE.

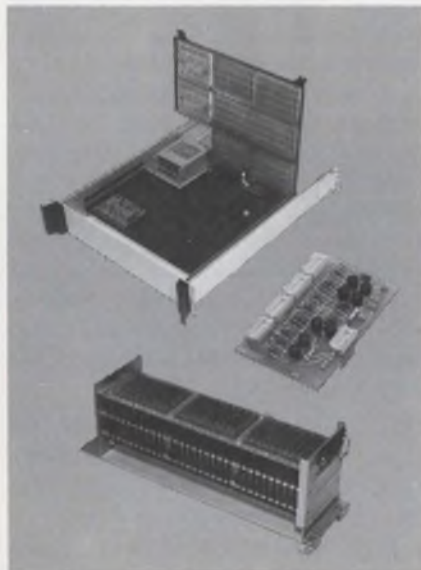
It's a full service system for the logic designer.



**Computer automated design aid** — logic simulation, error checking exception reports, string list and documentation.



**Computer automated production system** — wire routing, component placement and wire wrapping.



**Hardware** — boards, chassis, cards, connectors, power supplies, IC's, racks, frames, sockets, panels and drawers. Final assembly and checkout.

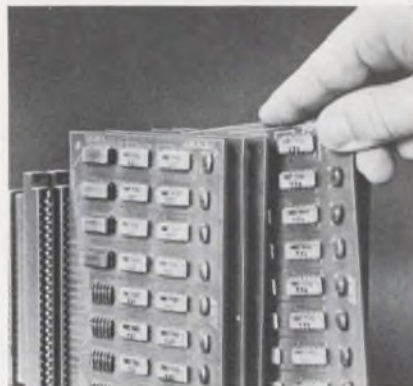
Electronic Products Division  
Electronic Engineering  
Company of California  
1441 East Chestnut Ave.  
Santa Ana, Calif. 92701  
Ph: (714) 547-5651



INFORMATION RETRIEVAL NUMBER 74  
ELECTRONIC DESIGN 4, February 15, 1970

## DATA PROCESSING

### Modular memory cards boast 10-ns cycle time



*Victor Comptometer Corp. Business Machine Group, 3900 N. Rockwell St., Chicago, Ill. Phone: (312) 539-8210. Price: \$795.*

Model 14-321 CRT electronic calculator for only \$795 features a visible accumulating memory to provide an automatic total of negative and positive extensions. Accumulations in the memory can be transferred to the working register for further calculations, thus eliminating manual re-entry. Each register has a 14-digit capacity.

CIRCLE NO. 282

### Parallel data modem takes 8-level inputs



*Info-Max, 470 San Antonio Rd., Palo Alto, Calif. Phone: (415) 327-4570. Price: \$8000.*

A new high-speed electrostatic computer graphics hard-copy printer, which is also effective for X-Y plotting, facsimile, line printing and automatic drafting, needs only 5 s to place  $10^6$  fine black dots in a 10-in. square. Each dot is accurately positioned by digital logic to form the desired patterns. It is a self-contained desk-top unit designed for direct computer interface.

CIRCLE NO. 284

*Advanced Memory Systems, Inc., 1276 Hammerwood Ave., Sunnyvale, Calif. Phone: (408) 734-4330. P&A: \$768 or \$845; one month.*

Two new high-speed, fully functional, modular PC-card read/write memories feature 15-ns access times and 10-ns cycle times. Models 0238 and 0239 are organized as 32 words by eight bits and 32 words by nine bits, respectively. They are available in either ECL or TTL-compatible versions. Terminating resistors and bypass capacitors are standard.

CIRCLE NO. 281

### Desktop CRT caculator shows memory contents

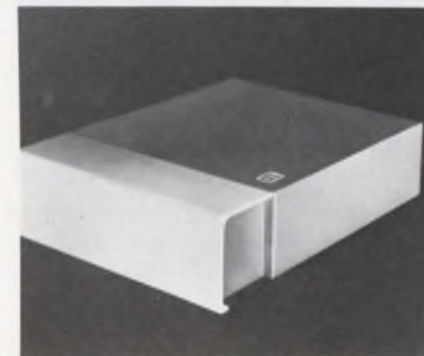


*General Data Comm Industries, 537 Newtown Ave., Norwalk, Conn. Phone: (203) 847-2445.*

Designated as the GDC-402C, a parallel-input simplex modem accepts 5, 6, or 8-level tape reader inputs (paper or magnetic) and converts the data to parallel tones for transmission over the public telephone network. The modem transmits nine tone channels in parallel, eight data channels, and one timing channel. Operating speed is 75 characters per second.

CIRCLE NO. 283

### Fast graphics plotter prints electrostatically



# HANSEN'S NEW 900 SERIES



gives you  
standard Synchron<sup>®</sup>  
reliability with up  
to 98 oz.-in. torque

Now, without sacrificing compact size, you can get high torque even at higher speeds—from 1 to 900 RPM. Synchron<sup>®</sup> 900 Series has thick, wide gears, specially designed to give the added gear strength that makes full use of its power increase. Highest quality instrument gear train for all speeds below 900 RPM.

The new self-starting hysteresis motor has positive direction of rotation—right or left hand. Plus extra heavy phenolic first gear for low noise level. It can be stalled continuously without electrical or mechanical damage.

Added strength in both the rotor and gear train enables 900 Series to handle your toughest timing and control jobs. Because of its compact dimensions, it is often interchangeable with motors of lower torque. To find out what 900 SERIES can do for you, write or phone today to have a representative contact you.



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Princeton, Indiana 47570

**HANSEN REPRESENTATIVES:** CAREY & ASSOCIATES, Houston and Dallas, Texas; R. S. HOPKINS CO., Sherman Oaks, Calif.; MELCHIOR ASSOCIATES, INC., San Carlos, Calif.; THE FROMM CO., Elmwood Park, Ill.; JOHN ORR ASSOCIATES, Grand Rapids, Mich.; H. C. JOHNSON AGENCY, INC., Rochester, N.Y.; WINSLOW ELECTRIC CO., Essex, Conn.; Villanova, Pa., and New York, N.Y.

**EXPORT DEPARTMENT:** 2200 Shames Drive, Westbury, N.Y. 11590

INFORMATION RETRIEVAL NUMBER 75

## DATA PROCESSING

### Cassette demagnetizer keeps heads in tune

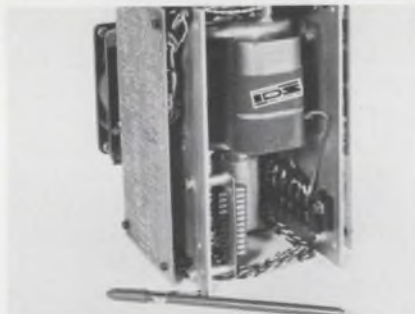


*Robins Industries Corp., 15-58 127th St., College Point, N.Y. Phone: (212) 445-7200. Price: \$8.30.*

Built into a compact cassette case, the model TD-10 demagnetizer removes excessive magnetic build-up from cassette-equipment heads to keep fidelity high and sound loss low. A flat mylar-copper laminate lead wire permits closing the cover of the player. Other features include a pilot light and operation on standard house current. Price is only \$8.30.

CIRCLE NO. 285

### Small disc memories store 145,000 bits



*Information Data Systems, Inc., 8260 E. Eight Mile Rd., Detroit, Mich. Phone: (313) 891-2400.*

Developed for the mini-computer market, new compact lightweight disc memory systems feature a storage capacity of 145k bits, fixed non-positioning (no head-to-disc contact), flying heads and read/write electronics. Series 8100 self-contained units measure only 9-in. wide by 9-in. deep by 10-1/2-in. high. They have eight data tracks.

CIRCLE NO. 286

### Cassette circulator stretches playback



*Norelco Div., North American Philips Corp., 100 E. 42nd St., New York, N.Y. Phone: (212) 697-3600. Price: \$19.95.*

A new cassette circulator is a snap-on device that gives continuous playback capacity to automatic cassette changers. Model CG6, which has no moving parts, makes possible 12 hours of non-stop no-repeat playback and then starts the cycle over again. It handles four to six cassettes, automatically flips each for second-side play, and then re-stacks them.

CIRCLE NO. 287

### Fast graphic terminal digitizes hard copy

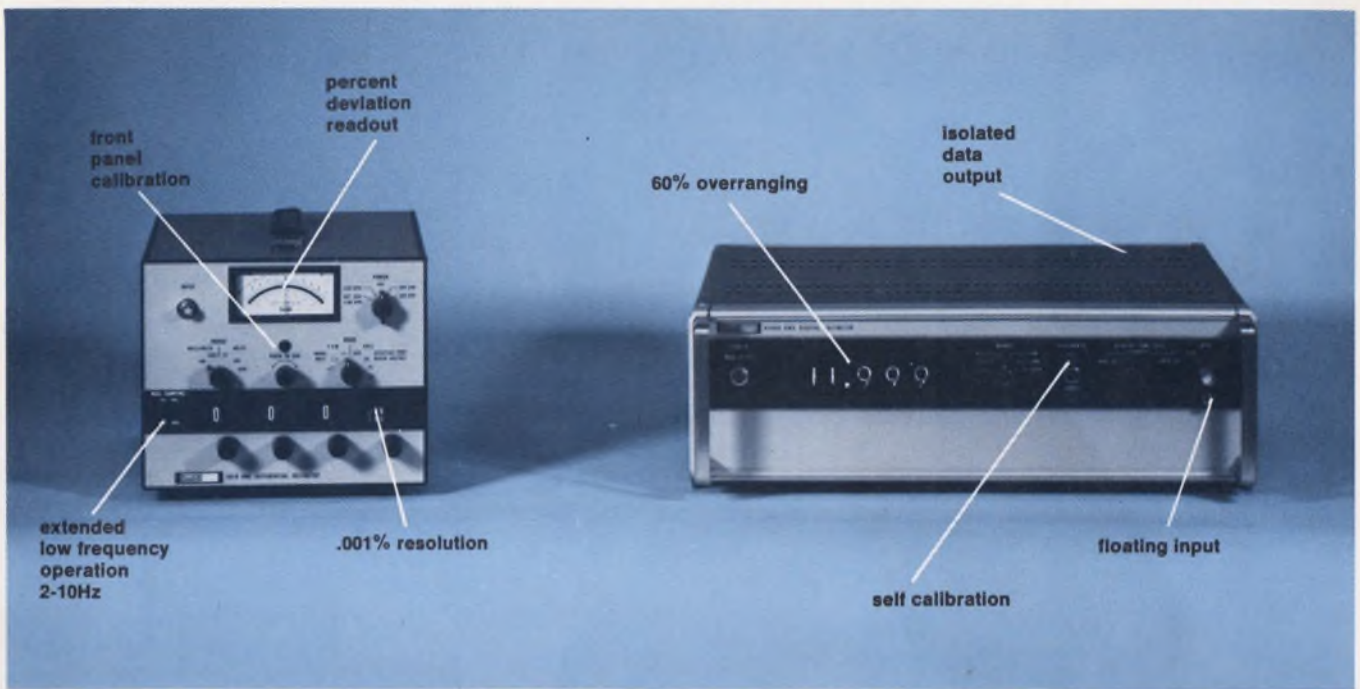


*Data Conversion Systems, P.O. Box 1008, State College, Pa. Phone: (814) 237-6521.*

Fully compatible with all popular tape recorders and large and small-scale computers, a new graphic conversion terminal can convert an 11 × 17-in. document into electrical signals in less than 60 seconds. The digitizing of graphic information by model GC-2 allows cross and auto-correlation, spectrum stripping, convolution and deconvolution, and digital filtering.

CIRCLE NO. 289





**Measure any complex waveform from random noise to pure sinusoidal for its true rms value from 2 Hz to 2 MHz over a 0 to 1100 volt range with an accuracy of 0.05% and a crest factor of 10.**

## 931B

Now you can measure complex waveforms at nearly all the useful frequencies over a wide voltage range. Two instruments are available from Fluke.

First, the new 931B True RMS Differential Voltmeter which features a 2 Hz to 2 MHz bandwidth and recorder output (ac to dc conversion). With this low frequency response, the 931B is extremely well suited to vibration, acoustic and seismic measurements as well as noise and power supply ripple measurements. It can also be used as a secondary ac measurement standard.

Basic price of the Model 931B is \$995. Options include line or rechargeable battery power (\$100).

## 9500B

The new Fluke 9500B, the only fully automatic 0.05% true rms ac digital voltmeter on the market, features 60%

overranging and isolated data output. Use it to measure noise, spurious signals, intermodulation distortion, losses in magnetic devices, microphonics, harmonic distortion, and power ripple.

Other features include frequency response essentially flat 20 Hz to 700 KHz, low capacitance, high resistance input, self calibration, and DTL logic compatibility. Floating inputs can be accepted. Up to 1100 V RMS can be applied to any range without damage.

Price is \$2485. Options include rear panel BNC input (\$50), and isolated 1-2-4-8 or 1-2-2-4 BCD outputs (\$445).

**For full details, see your Fluke sales engineer (listed in EBG) or contact us directly.**



Fluke, Box 7428, Seattle, Washington 98133. Phone: (206) 774-2211. TWX: 910-449-2850. In Europe, address Fluke Nederland (N.V.), P. O. Box 5053, Tilburg, Holland. Phone: (04250) 70130. Telex: 884-50237. In the U.K., address Fluke International Corp., Garnett Close, Watford, WD2 4TT. Phone: Watford, 27769. Telex: 934583.

**See us at IEEE.**

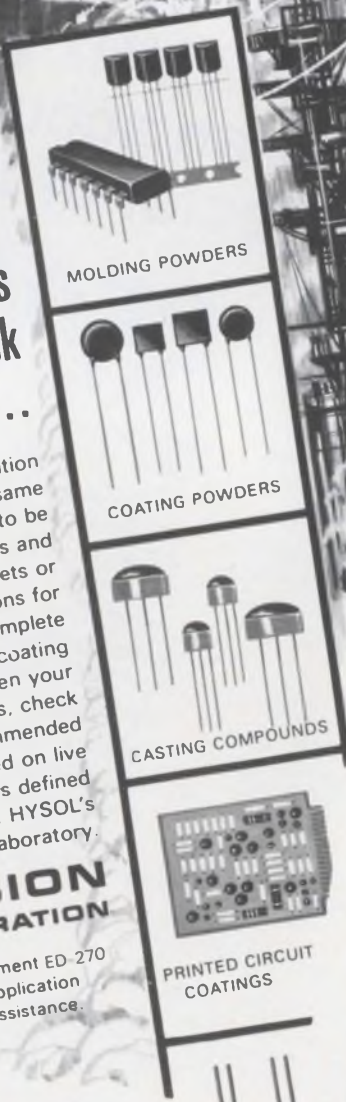
INFORMATION RETRIEVAL NUMBER 76

## Compatible ... Moisture Resistant ... Hysol Makes Epoxy and Urethane Compounds to Sink, Fly and Click Anywhere ...

Solve your electronic component insulation and protection problems now with the same HYSOL materials that have been found to be completely compatible in space, underseas and computer components. HYSOL meets or exceeds the most rigid specifications for electronic component protection with a complete line of molding powders and liquids, coating powders and printed circuit coatings. When your program calls for epoxies or urethanes, check HYSOL. Have assurance that HYSOL recommended materials have been thoroughly tested on live components under environmental conditions defined in MIL-STD 750 and MIL-STD 202 in HYSOL's Electronic Testing Laboratory.

**DEXTER HYSOL DIVISION**  
THE DEXTER CORPORATION

Write, wire or call HYSOL, Department ED 270  
Olean, N.Y. 14760 for application  
engineering assistance.



INFORMATION RETRIEVAL NUMBER 77

## DATA PROCESSING

### Teleprinter control allows communication

*Rydar, Inc., 76 Belvedere St., San Rafael, Calif. Phone: (415) 454-0943. Price: \$1440 to \$2489.*

In a single package, a teleprinter automatic control terminal provides all the functions required to convert an hf radio transceiver and teleprinter into an integrated attended or unattended communications terminal. The unit is designed for use with a model 32 Teletype or equivalent. Functions include automatic start/stop and polling.

CIRCLE NO. 290

### Read-only memory alters instructions

*Optical Memory Systems, Inc., 1520 S. Lyon St., Santa Ana, Calif. Phone: (215) 371-6567.*

Through the use of optics, a new read-only memory features on-site alternation of its instruction set. A change in machine structure, control logic, or even a single instruction word may be accomplished by either altering or replacing an optical mask. Model OM-1000 has a 70-ns access time with a total cycle time of 100 ns and word lengths from 16 to 256 bits.

CIRCLE NO. 291

### Acoustic data sets expand telephone use

*Electronic Voice Inc., 2059 E. 223 St., Long Beach, Calif. Phone: (213) 830-6161.*

Three new devices make up a set of acoustic data couplers for use in the switched telephone network. Model 101A is for two-way transmission between EIA-interface terminals; the 102A provides half- or full-duplex transmission in either direction. Both models have an error of less than 1 bit in  $2 \times 10^6$  bits. Model 102B is for operation through type 80 telephones.

CIRCLE NO. 292

# there is only one rapid-charger

**BREAKTHROUGH!** Now nickel-cadmium batteries can be safely recharged *in 15 minutes or less!* **RAPID-CHARGE**, the new energy source system from McCulloch Electronics brings fully discharged sealed nickel-cadmium batteries up to rated capacity in *15 minutes or less.* Conventional systems take 14 to 20 *hours!*

Design opportunities are limited only by imagination. The utility of existing battery-powered products can be increased many



times with **RAPID-CHARGE**. Entire *NEW* concepts are now possible for portable-power products for home, business and industry.

The **RAPID-CHARGE** system can be adapted to any nickel-cadmium power-pack configuration or capacity. And McCulloch engineers will assist in the development of **RAPID-CHARGE** applications to meet your design requirements.

Write today for additional information.

**McCULLOCH**  
*Rapid Charge*  
**McCULLOCH**   
ELECTRONICS DIVISION  
Dept. B/McCulloch Corporation  
6101 West Century Boulevard  
Los Angeles, California 90045  
LEADERSHIP THROUGH CREATIVE ENGINEERING

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 •  $f_1$  .1 Hz thru  $f_2$  25 MHz

## Ultra Low Noise?



**AMF SOLID STATE MODULAR PREAMPLIFIER**  
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... tailor an AMF Cybertran Preamplifier to fill your needs.

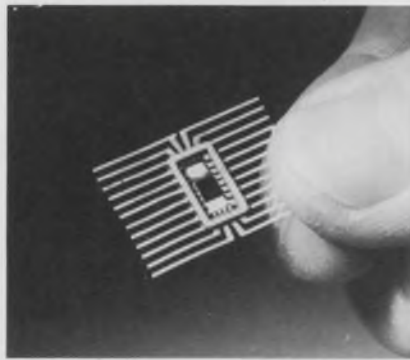
Cybertrans fulfill your needs whether they be ultra-low noise, subsonic requirements or extreme broadband video specifications. The flexibility of our "off-the-shelf" preamplifiers enables AMF to satisfy a wide range of special or standard needs... we call it Cybertran Technology. This new expertise makes it possible for you to specify your preamplifier requirements and have AMF ship it to you. Write or call Jim Campman, Applied Cybernetics Products, AMF Alexandria Division, 1025 North Royal Street, Alexandria, Virginia 22314 Phone (703) 548-7221. TWX 703-931-4209. Representatives in major cities of U.S.A.

**AMF ALEXANDRIA**

INFORMATION RETRIEVAL NUMBER 79

## ICs & SEMICONDUCTORS

### Twelve-bit ladder fits on single chip

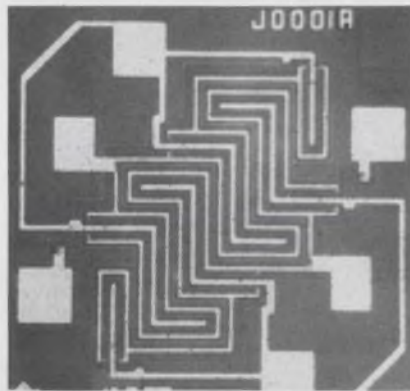


*Motorola Semiconductor Products Inc., P.O. Box 20924, Phoenix, Ariz. Phone: (602) 273-6900. P&A: \$2.75; stock.*

Requiring only the addition of a miniature bulb, a new monolithic tuning indicator circuit, which costs only \$2.75, indicates proper fine tuning of color TV and fm receivers. When the receiver is correctly tuned, the circuit's two input voltages are equal and the lamp is turned ON. Model MC1335 has a typical standby current of 5.5 mA.

CIRCLE NO. 294

### Dual matched FETs occupy same chip



*Solitron Devices, Inc., Transistor Div., 1177 Blue Heron Blvd., Riviera Beach, Fla. Phone: (305) 848-4311.*

Supplied in chip form for hybrid applications, a new line of silicon planar power transistors include 2, 5, 10 and 20-A devices in npn, pnp and npn high-voltage families. The npn and pnp chips are offered as complementary pairs with sustaining voltages up to 100 V; the npn high-voltage chips have sustaining voltages up to 300 V.

CIRCLE NO. 296

*Hy Comp, Inc., 146 Main St., P.O. Box 250, Maynard, Mass. Phone: (617) 897-4578. P&A: \$175; stock to 2 wks.*

Cramming 12 bits on a single chip for digital-to-analog conversions, a new thin-film resistor ladder network features an accuracy of one-half the last significant bit from -55 to +125°C. Model HC100 is supplied in a 24-lead flatpack (1/4 x 3/8 in.) or in a 24-lead DIP, either hermetically sealed or epoxy encapsulated.

CIRCLE NO. 293

### Monolithic \$3 circuit indicates fine tuning

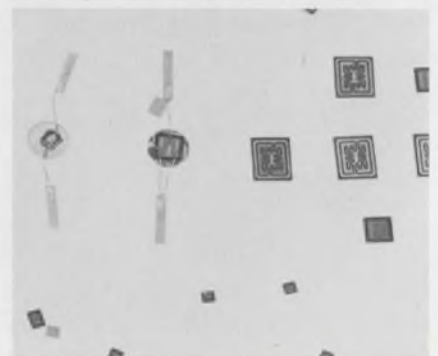


*National Semiconductor Corp., 2975 San Ysidro Way, Santa Clara, Calif. Phone: (408) 245-4320. P&A: \$2.40 to \$12.70; stock.*

Series FM3954 monolithic n-channel matched dual FETs eliminate the difficulties of matching and testing individual die by integrating both transistors on one chip. This makes possible very close tracking regardless of bias point, from 50 to 500  $\mu$ A, a low leakage of 100 pA and a high gain of 1000  $\mu$ mhos. Uses include balanced modulators.

CIRCLE NO. 295

### Power transistor chips carry 20 A at 300 V



INFORMATION RETRIEVAL NUMBER 80 ►

# How to catch a code in time

Feel a time code coming on? If you're tagging analog data for correlation and indexing, Datatron timing instrumentation can catch coding problems before they start.

Problems like the chronic congestion caused by enormous equipment. Or acute inaccessibility for maintenance. Or even progressive "inflexiblitis rigor mortis." And finally irritating costs.

Now there's fast, round-the-clock relief. Datatron timing instrumentation goes right to work with its proven 4-way action: Flexibility, ease of maintenance, size and cost.

To begin with, unparalleled versatility is afforded by Datatron's exclusive "main frame" construction. This approach features

identical logic, power supply and chassis for both the time code translator and generator.

What's more, Datatron generators handle up to five time codes simultaneously. And the translators change codes by the flick of a switch or by changing a printed circuit card.

Equipment maintenance is facilitated by a unique "pancake" design that permits simultaneous accessibility to all circuitry.

And when it comes to size, Datatron isn't a tough pill to swallow. Dosage is concentrated in only 3½" of vertical rack space.

Datatron's fast-acting ingredients? Dual in-line DTL and TTL integrated circuits. Wide dynamic range AGC Amplifier. And precision oven controlled crystal oscillator.

As for cost, just consider this one fact: Features that Datatron offers as standard are usually optional on more expensive competitive equipment.

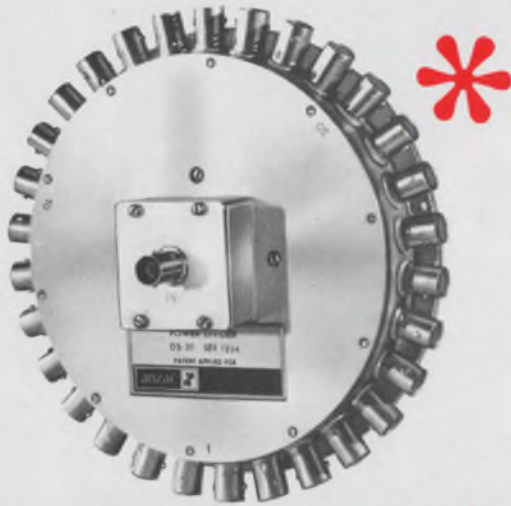
So at the first sign of timing aches and pains, take one Datatron 16-page brochure. It completely details the Datatron timing family, including Tape Search Units, DC Code/Failsafe units and Remote Display units.

Send for it today. It won't hurt a bit.

## **Datatron Inc.**

1562 Reynolds Avenue  
Santa Ana, California 92705  
(714) 540-9330





# 2-3-4-8-30-45 SPLIT

Or combine power any way, N-ways. There's an ANZAC answer in our complete family of power dividers/combiners. Precise outputs, broad bandwidths and high-power handling capability for telemetry, receiver and transmitter applications.

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Representative of over 80 ANZAC N-way power dividers/combiners are:

### MULTI-WAY

Model	Outputs	Freq.	Isol. (db)	Loss (db)	Unbalance Phase	Ampl. (db)
DS-30	30	10-500 MHz	30	4.0	3.0°	±0.2
DS-45	45	10-300 MHz	35	4.5	3.0°	±0.2

### BROADBAND (compact)†

3H-50	3	2-200 MHz	30	0.75	2.0°	0.2
4V-50	4	20-200 MHz	30	0.75	2.0°	0.2

† Also available in standard "plug-in" packages.

### ULTRA-BROADBAND — 10 OCTAVES

DS-4	4	2-2000 MHz	25	0.5	3.0°	0.5
DS-8	8	2-2000 MHz	25	0.75	3.0°	0.5

### HIGH-POWER (1,000 W & higher)

DS-134	4	50-200 MHz	30	0.5	5.0°	0.4
--------	---	------------	----	-----	------	-----

### PRECISE OUTPUT, LOW-LOSS (microstrip)

DS-160	2	1.25-1.75 GHz	20	0.1	0.5°	0.1
DS-161	3	1.25-1.75 GHz	20	0.1	1.0°	0.2

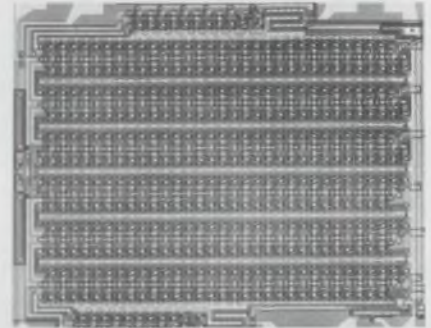
Typical specifications listed



ANZAC Electronics • 39 Green Street • Waltham • Massachusetts 02154 • Tel: (617) 899-1900

INFORMATION RETRIEVAL NUMBER 81

## Dual 100-bit registers are 2-MHz LSI chips

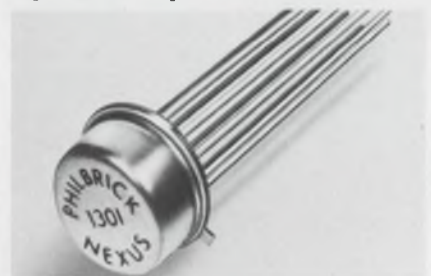


Intel Corp., 365 Middlefield Rd., Mountain View, Calif. Phone: (415) 969-1670. P&A: \$30 to \$60; stock.

Guaranteed to operate at clock rates up to 2 MHz, four dual 100-bit LSI shift registers provide a clock input capacitance of 35 pF, and use only 15 mA of power-supply current at 10 V. Models 1-406 and 1-407 operate from -55 to +125°C, while models 1-506 and 1-507 operate from -25 to +70°C. All units may be interfaced directly with standard DTL and TTL.

CIRCLE NO. 297

## IC op amp for \$3.50 upholds performance



Teledyne Philbrick Nexus, Allied Drive at Route 128, Dedham, Mass. Phone: (617) 329-1600. P&A: \$3.50; stock.

Costing only \$3.50 in quantities of 1 to 9, model 1301 general-purpose operational amplifier provides a common-mode voltage range of ±13.2 V, voltage offset of ±2 mV, and a voltage drift of ±5 μV/°C. The input circuitry is fully protected against damage from transient overloads and accidental connection of the input terminals to signals as large as the power supply voltages.

CIRCLE NO. 298

# Room for improvement

General Electric's TO-5<sup>2</sup> transistor-size sealed relays give you more room for increased power, improved performance

We didn't cut any corners on this high-reliability, transistor-size sealed relay. We left them on so there'd be more room for a more powerful magnet—2½ times more powerful.

This added power means this type 3SBS, 2PDT, 1 amp relay gives you higher contact forces, larger contact gaps, and greater overtravel to minimize mechanical shifts. Shifts which usually increase early-in-life failures.

Though there's more room inside to give you all these advantages, the outside dimensions—top-to-bottom (.275") and side-to-side (.370")—are the same as any transistor-size relay.

So don't cut corners on your next transistor-size relay application. Specify GE's square Type 3SBS. For full details, write General Electric, Section 792-45, Schenectady, New York 12305.



ACTUAL SIZE

**GENERAL**  **ELECTRIC**

INFORMATION RETRIEVAL NUMBER 82

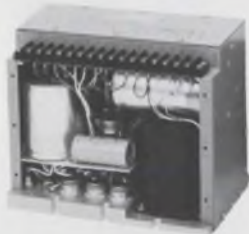
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## ICs & SEMICONDUCTORS

### Tuning diode for \$5.95 has ratio of 14 at 1 MHz



*Motorola Semiconductor Products Inc., P.O. Box 20924, Phoenix, Ariz. Phone: (602) 273-6900. P&A: \$5.95; stock.*

A new low-cost hyperabrupt-junction voltage-variable capacitance diode, type MV1401, features a minimum tuning ratio of 14 at 1 MHz, specified for a reverse-voltage range of 1 to 10 V. The device also has a high nominal capacitance of 550 pF at 1 V and 1 MHz, and a minimum figure of merit of 200 at 2 V and 1 MHz.

CIRCLE NO. 334

*Power Tech, Inc., 9 Baker Court, Clifton, N.J. Phone: (201) 478-6205. P&A: \$172 to \$325; stock.*

Eliminating clips or wire bonds, a new series of 300-W power transistors come in a TO-114 stud package that incorporates integral-lead construction. Series PT-700 units are 100% tested at rated power to assure maximum high reliability. They feature a maximum collector-emitter saturation voltage of less than 1 V at 100 A, and a guaranteed dc gain to 100 A.

CIRCLE NO. 335

### Power transistors take 300 W at 100 A

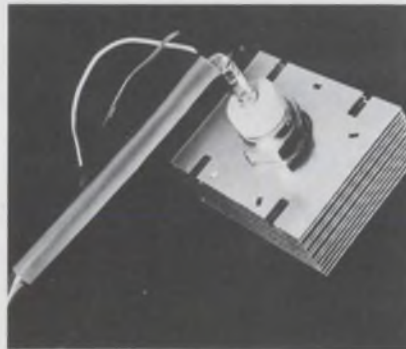


*Westinghouse Semiconductor Div., Youngwood, Pa. Phone: (412) 925-7272. P&A: \$300 or \$320; 2 to 3 wks.*

Said to be the highest-voltage commercially available thyristor, a new thyristor has a peak forward blocking voltage as high as 2000 V without trading-off other important characteristics. It can handle surge currents up to 6000 A. Type 286-Y30 contains an integral heat sink, while type 270-Y30 is a stud-mounted design.

CIRCLE NO. 336

### High-voltage thyristor handles up to 2000 V

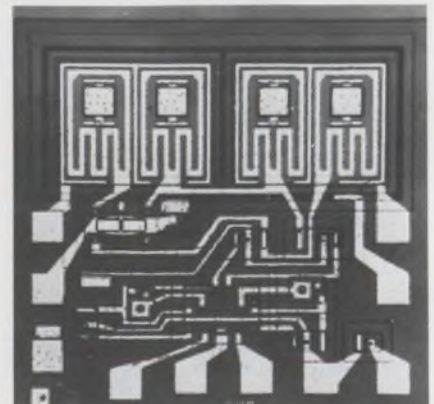


*Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. Phone: (408) 246-8000. P&A: \$18 or \$31; stock.*

Three new monolithic bipolar/MOS driver switches include the DG122 two-channel differential switch with driver, the SI3001 special-function driver switch and the SI3002 spdt switch with driver. All the devices can be used as multiplexers or d/a converters. They can handle analog signals up to 20 V pk-pk. Their inputs are compatible with 5-V DTL, TTL and RTL.

CIRCLE NO. 337

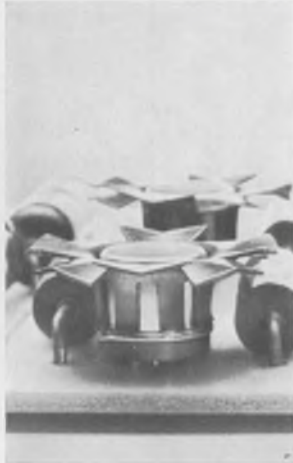
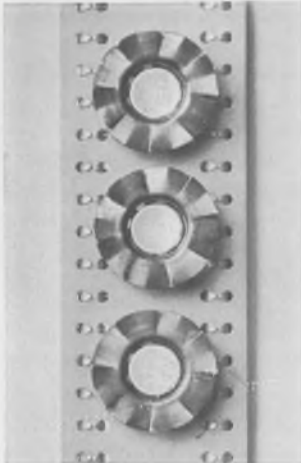
### Driver switches are bipolar/MOS ICs





# Tips on cooling off hot transistors

See how circuit designers use IERC heat dissipators to protect semiconductors...improve circuit performance and life.



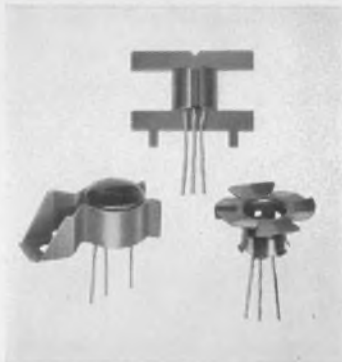
Fan-top dissipators for TO-5 and TO-18 cases drop temperatures dramatically; cost just pennies. T-shape adds almost nothing to board height; allows components to snuggle close to transistors. Spring fingers provide fast, press-on installation.

To cool off low-to-medium power transistors in TO-5 and TO-18 cases, use IERC's efficient LP's. Patented, staggered-finger design maximizes radiation and convection efficiency, radiates heat directly to ambient. Available in single or dual mounting for thermal mating of matched transistors.

IERC Therma-Link Retainers provide efficient thermal links between transistors and chassis or heat sinks. (Also, excellent dissipation when used on p-c boards.) Integral BeO washers reduce capacitance up to 2/3. Fast, no-snap installation; transistors are firmly held.

New! Dissipators and retainers for plastic and epoxy transistors. 3 new series for RO-97A, RO-97 and X-20's. Permit a jump of 10% to 33% in operating power.

Free 8-page short form catalog discusses IERC's complete line of dissipators, retainers and tube shields. Gives specifications, prices, how to order. Send for your copy today.



**Special insulating coating** — Insulube 448, a special non-hygroscopic finish developed by IERC, combines excellent dielectric properties, 50 K megs insulation resistance, and high heat emissivity. Also protects against salt spray, fungus, etc.

**Tough heat dissipating problem?** IERC engineers welcome your letter-head inquiry for specific information or assistance in selecting heat dissipators.

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HEAT DISSIPATORS



## Victoreen's rare specimen!

Our MOX-1125. A rare specimen made only by Victoreen. With rare qualities in the 1-10,000 Megohm range. Rated at 1.00W @70°C. 5,000 volts maximum. Yet it's just .130" in diameter by 1.175" long.

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**All Mastermox resistors are rare performers.** Excellent stability: As little as 1% drift under full load in 2000 hours — with more than 40 watts power dissipation per cubic inch.  $\pm 0.5\%$  tolerance. 10K ohms to 10,000 Megohms resistance range. Voltage and temperature cycling leaves no permanent effect. And Mastermox stays potent on the shelf — less than 0.1% drift per year.

Get Mastermox. Rare resistor performance.

Model	Resistance Range	Power Rating @ 70°C	*Max. Oper. Volts	Length Inches	Diameter Inches
MOX-400	1 - 2500 megs	.25W	1,000V	.420 ± .050	.130 ± .010
MOX-750	1 - 5000 megs	.50W	2,000V	.790 ± .050	.130 ± .010
MOX-1125	1 - 10000 megs	1.00W	5,000V	1.175 ± .060	.130 ± .010
MOX-1	10K - 500 megs	2.50W	7,500V	1.062 ± .060	.284 ± .010
MOX-2	20K - 1000 megs	5.00W	15,000V	2.062 ± .060	.284 ± .010
MOX-3	30K - 1500 megs	7.50W	22,500V	3.062 ± .060	.284 ± .010
MOX-4	40K - 2000 megs	10.00W	30,000V	4.062 ± .060	.284 ± .010
MOX-5	50K - 2500 megs	12.50W	37,500V	5.062 ± .060	.284 ± .010

\*Applicable above critical resistance. Maximum operating temperature, 220°C. Encapsulation: Si Can-formal. Additional technical data in folder form available upon request. Or telephone: (216) 795-8200.



DMA 532

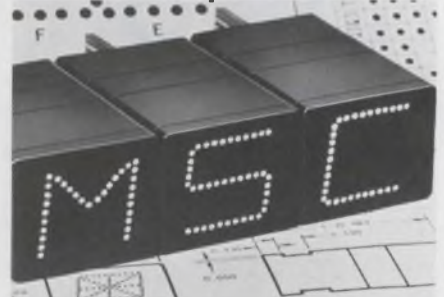
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 10101 WOODLAND AVENUE • CLEVELAND, OHIO 44104  
 EUROPE: ARNDALE HOUSE, THE PRECINCT, EGHAM, SURREY, ENGLAND • TEL: EGHAM 4887



INFORMATION RETRIEVAL NUMBER 85

## COMPONENTS

### Alphanumeric readouts use fiber optic bundles



Master Specialties Co., 1640 Monrovia, Costa Mesa, Calif. Phone: (714) 642-2427. PA: \$28; 3 to 4 wks.

With segments that are comprised of a series of dots, a new line of 16-segment plug-in alphanumeric readouts utilize fiber optics to provide 99.5% light transmission efficiency from the lamp to the readout face. Character height is 0.42 in. on the readout face, which measures 0.625-in. high by 0.75 in. wide. Series 902 units come in six illuminated face colors.

CIRCLE NO. 338

### Colorful indicators are one-piece units

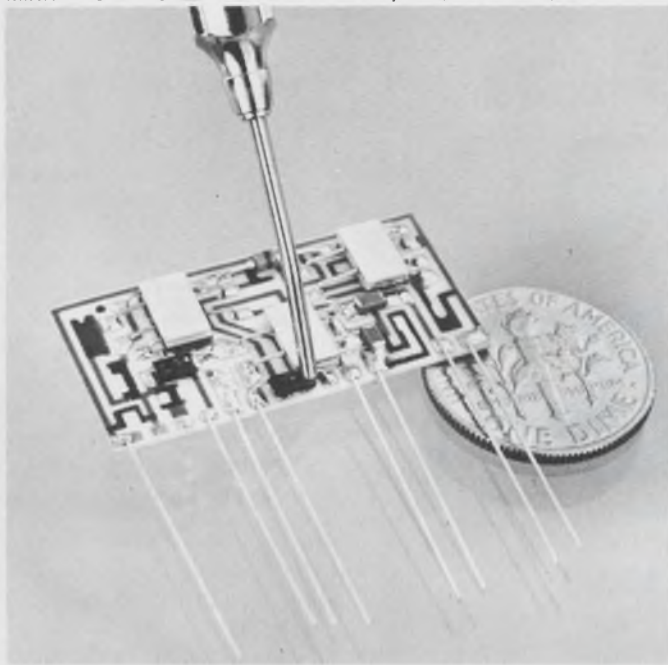


Industrial Devices, Inc., Edgewater, N.J. Phone: (201) 943-4084.

Able to be easily mounted in 5/16-in. diameter holes with push-on mounting nuts, Glo-Dot indicator lights are one-piece lens/body units with ratings of 6 or 12 V. This new series is available in five different lens colors: red, white, green, blue, and yellow. The units have built-in incandescent lamps, and 4-1/2-in. long AWG #24 insulated leads, which are pre-stripped 1/2 in. for rapid connection.

CIRCLE NO. 339

MINITAN is the first choice in size and reliability for Spacetic heart pacer modules.



# NOW ...more microfarads per millimeter with MINITAN!®

MINITAN . . . the world's smallest, proven microminiature solid electrolyte capacitor gives you the capacitance-to-volume ratios you've been searching for.

**75% Smaller than equivalent CS13 Sizes!** With Minitan you solve high density hybrid or thick film packaging problems without sacrificing performance. Polar and non-polar types from .001 to 220 ufd . . . working voltages to 35 volts . . . yet packaged in a case about the size of a pin-head — as small as .100 X .050 X .040.

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**Proven Reliability!** 1,679,000 Life Test Hours @ 85°C with only one failure. 130% surge voltage rating. Operating temp. range from  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . DC leakage typically less than .01 uA per ufd — volt.

Specified for manned space flights — where reliability and performance count!  
Specified for micropackaged commercial computers, portable communications, thick film hybrids — where reliability and performance count.

Specify Minitan to solve your space problems. Write today—we'll rush data sheets, samples and documented proof of Minitan reliability. See EEM file system 1500.

**COMPONENTS**   
INCORPORATED

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W 111	1A	.95
100V		
VE 18	1A	1.00
VS 148	2A	1.00
VH 148	6A	1.93
200V		
VE 27	1A	1.20
VE 28	1A	1.10
VS 247	2A	1.20
VS 248	2A	1.10
VH 247	6A	2.25
VH 248	6A	2.15
IN 4436	10A	4.15
VT 200	25A	5.35
400V		
VE 47	1A	1.30
VE 48	1A	1.20
VS 447	2A	1.30
VS 448	2A	1.20
VH 447	6A	2.59
VH 448	6A	2.49
IN 4437	10A	5.45
VT 400	25A	7.00
600V		
VE 67	1A	1.59
VE 68	1A	1.49
VS 647	2A	1.60
VS 648	2A	1.50
VH 647	6A	2.98
VH 648	6A	2.88
IN 4438	10A	7.45
VT 600	25A	9.85

\*Available with fast recovery characteristic

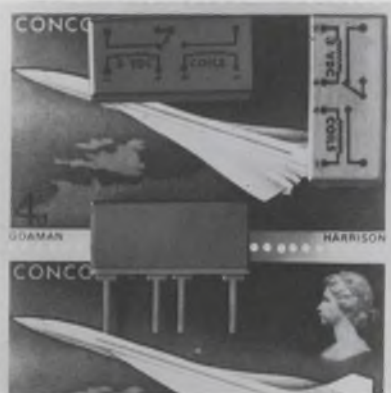


SEMICONDUCTOR DIVISION, 1000 N. SHILOH  
ROAD, GARLAND, TEXAS 75040 (214) 272-4551

INFORMATION RETRIEVAL NUMBER 87

## COMPONENTS

### Mercury-film relay undersizes TO-5 can

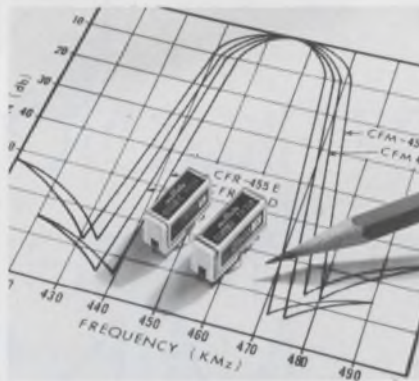


FR Electronics Div., Flight Re-fuelling Ltd., Wimborne, Dorset, England.

Less than two-thirds the size of a TO-5 can relay, the Logcell 8210-1A spst relay uses mercury-film contacts to give bounce-free operation and stable contact resistance. It is suitable for switching at very-low to medium-power levels, and can operate at radio frequencies up to 50 MHz. When it is mounted in proper coaxial packaging, the frequency range can be extended to the 2-GHz level.

CIRCLE NO. 340

### Ladder filter sells for \$5.50

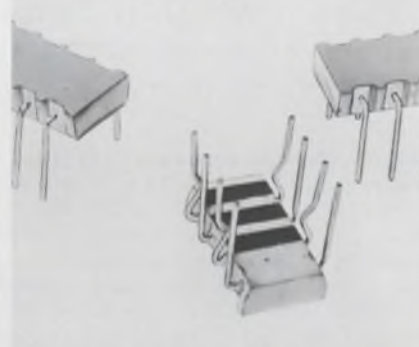


Murata Corp. of America, 2 Westchester Plaza, Elmsford, N.Y. Phone: (914) 592-9180. P&A: \$5.50; stock.

Designed for communications and general-purpose applications, the model CFR-4550 455-kHz ceramic ladder filter, which sells for \$5.50, has a 3-dB bandwidth of  $\pm 7$  kHz and a 60-dB bandwidth of  $\pm 20$  kHz. Maximum insertion loss is 5 dB, and both input and output impedances are 1.5 k $\Omega$ . The unit operates over the full temperature range of  $-20$  to  $+60^\circ\text{C}$ .

CIRCLE NO. 341

### Resistor modules are 8-lead DIPS

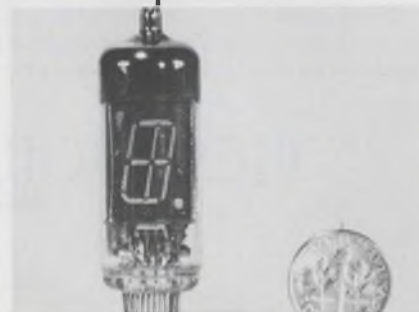


CTS of Berne, Inc., Berne, Ind. Phone: (219) 589-3111. Price: 74¢.

Compatible with standard monolithic DIPs, new eight-lead cermet dual-in-line resistor modules are now available for applications requiring seven or fewer resistors. Series 760 modules can be supplied with capacitor chips and/or active devices. Resistance tolerances are  $\pm 2\frac{1}{2}\%$ ; temperature coefficient is  $\pm 250$  ppm/ $^\circ\text{C}$ ; and resistances range from 50  $\Omega$  to 1 M $\Omega$ . Lead spacing is 0.1 in.

CIRCLE NO. 342

### Eight-segment readout is a low-power device



Legitron, 3118 W. Jefferson Blvd., Los Angeles, Calif. Phone: (213) 733-9105. P&A: \$5.50; stock.

The DG-19 series eight-segment digital indicator provides a low-voltage and low-power planar-readout device. Digits, symbols and letters are composed of phosphor-coated segments with clarity between digits at distances up to 40 feet. Different-color outputs and gridded design are available.

CIRCLE NO. 343

# Instant Changes.

## Revisions are easier with KODAGRAPH Wash-Off Films.

Here's a real bonus for draftsmen.

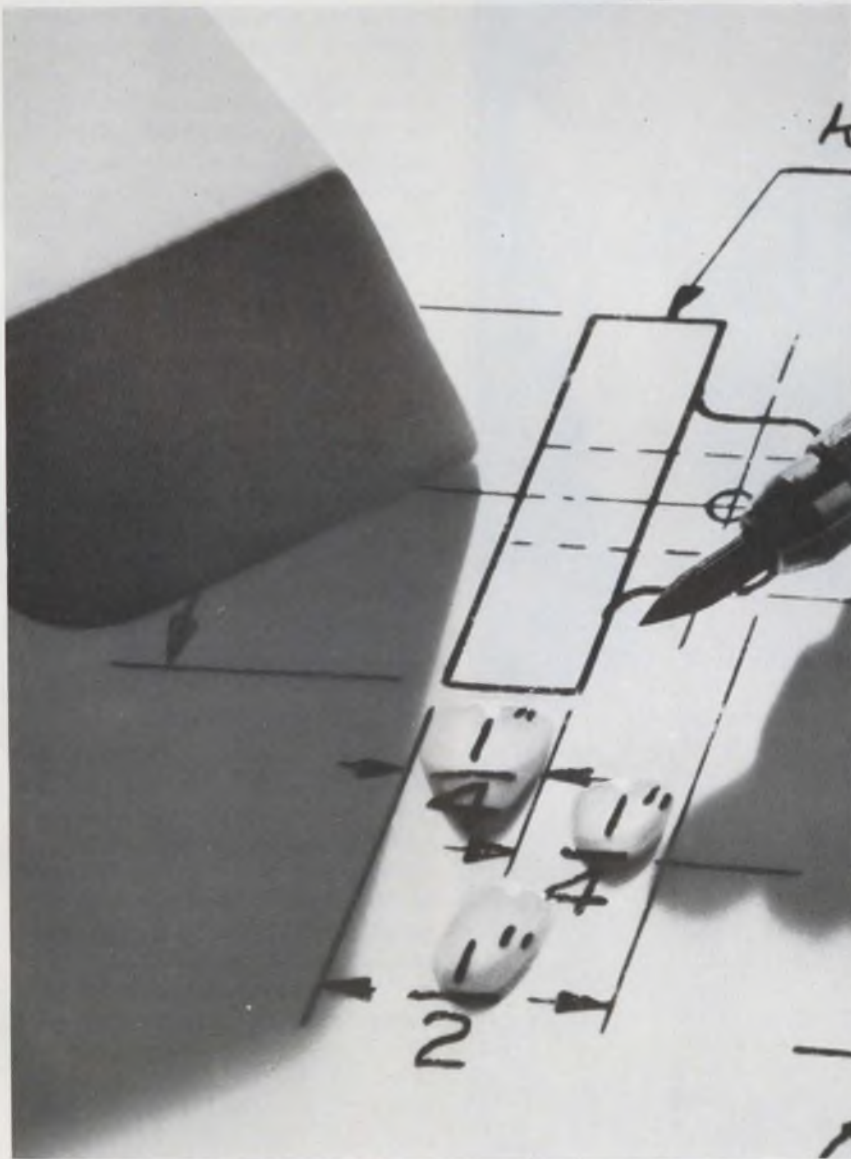
You don't need to retrace an entire drawing that needs only revision. A beautiful reproduction on KODAGRAPH Wash-Off Film can be made that includes only the unchanged areas. You merely draw the new details.

The improved drafting surface on these ESTAR Base Films takes pencil or pen nicely—holds up under repeated erasures. Photographic lines are wet erasable. Resulting diazo prints will be sharp and clean.

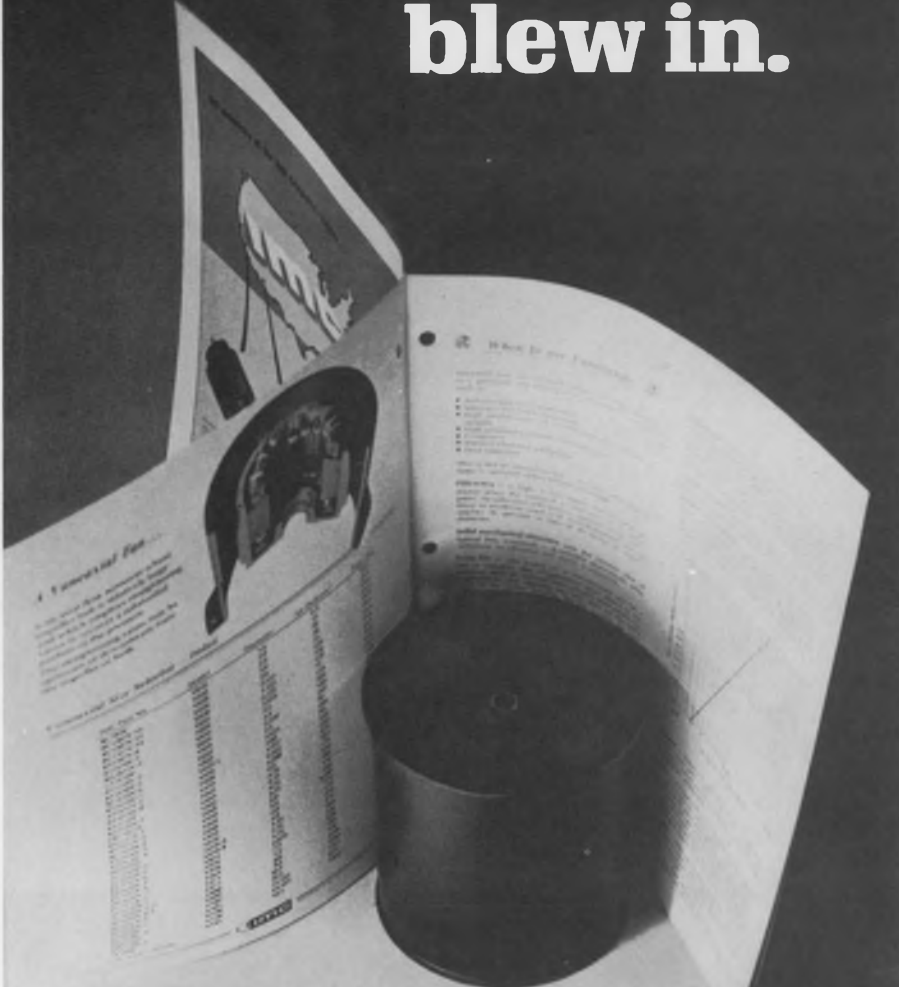
Ask your local Kodak Technical Service Representative to show you all the drafting shortcuts possible with Kodak Photo Drawing Systems. Or write Eastman Kodak Company, Business Systems Markets Division, Rochester, New York 14650.

**DRAWING REPRODUCTION SYSTEMS BY KODAK**

Kodak



# Look what just blew in.



## IMC's newest vaneaxial catalog

Prepared especially for designers who need information on vaneaxials, the most efficient and sophisticated of all airmovers. Versatile in application—for cooling electronic enclosures, ECM, klystrons, high-power tubes, and also for inflating shelters, dispensing chaff, refrigeration equipment, dust precipitators, and many others.

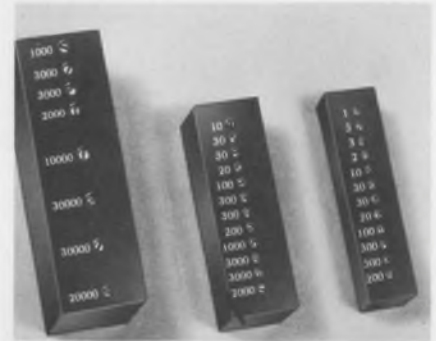
The 32-page catalog presents 40 different vaneaxial airmovers ranging in size from one to 15 inches in diameter, from 6.5 to 3450 cfm in output. Ample technical notes precede the detailed presentation of performance parameters, dimensions, and other specifications.

**IMC** IMC Magnetics Corp., Eastern Division, 570 Main St., Westbury, N.Y. 11591, (516) 334-7070, TWX 510-222-4469.

INFORMATION RETRIEVAL NUMBER 89

## COMPONENTS

### Capacitance trimmers adjust incrementally

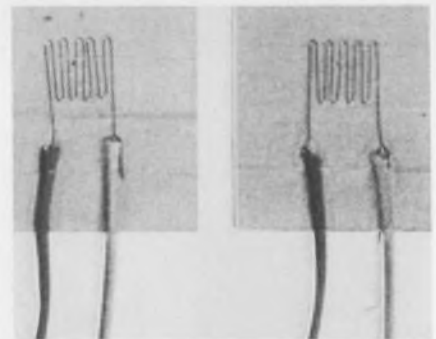


*Consolidated Resistance Instruments, Inc., 44-46 Prospect St., Yonkers, N.Y. Phone: (914) 963-5900. P&A: \$7.50 to \$23; stock.*

Offering the performance of a decade in the size of a trimmer, three new incrementally adjustable precision capacitance trimmers cover the range of 1 to 100,000 pF in 1-pF steps. Models CT1, CT2 and CT3 consist of several shunt-connected silver mica capacitors, each in series with a microminature screw-adjustable switch.

CIRCLE NO. 344

### Patch thermocouples zig and zag along



*Hy-Cal Engineering, 12105 Los Nietos Rd., Sante Fe Springs, Calif. Phone: (213) 698-7785.*

Designed for making accurate surface temperature measurements, series TC 2345 patch-type thermocouples feature an unusual zig-zag configuration to compensate for normal temperature losses through lead wires. They are supplied encased in H-Film for protection, and with a special pressure-sensitive silicon adhesive backing for quick and easy mounting.

CIRCLE NO. 345

# 15 nano-second memory...



**there's a lot behind it**

For one year we have been quietly mobilizing the industry's most capable semiconductor memory team. Personnel from all disciplines to design, assemble, test and volume produce the fastest, most reliable memory systems.

Here are the results:

**1.** Our memories are the world's fastest —15 nsec. access and 10 nsec. cycle times.

**2.** Our designs are pre-evaluated and optimized by computer simulation.

**3.** Our chips are individually packaged in proven, low-cost, ceramic Dual-In-Line packages and mounted on standard P/C cards.

**4.** Our cards are fully functional and incorporate our own logic support circuits to enhance system performance and minimize overhead circuit requirements.

**5.** Our quality is verified every step of the way by computerized testing that performs up to 5000 tests/sec. on the chip, the packaged devices, and the modular assemblies.

**6.** We are now in production.

We design our memories to be modularly expandable and we supply them in ECL and TTL compatible configurations. Our products reflect total capability...The kind of capability that puts a lot behind us, including the competition.

Our first series of modular cards is now available. To order:

	Price: (1 to 9)	ECL Compatible	TTL Compatible*
32 x 8	\$768.00	AMS 0328E	AMS 0328T
32 x 9	\$845.00	AMS 0329E	AMS 0329T

\*Delivery on TTL—one month.

## AMS

ADVANCED MEMORY SYSTEMS, INC., 1276 HAMMERWOOD AVENUE, SUNNYVALE, CALIFORNIA 94086, TEL. (408) 734-4330

INFORMATION RETRIEVAL NUMBER 90



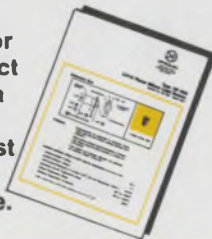
## SOLVING electro-optical problems is OPTRON'S ONLY business.... SO, WE HAVE TO BE GOOD!

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For example, through continuous process monitoring made possible by the use of diffusion lot traceability, Optron maintains the highest possible reliability. Still other special Optron manufacturing techniques make possible optimum device performance in variable light and temperature conditions. You get sensors with a lens/device relationship previously thought impossible.

Versatile OP 600 Series NPN planar silicon light sensors eliminate cross-talk and are ideally suited for high density arrays. In addition, these small, rugged devices will satisfy virtually any application requirement in optical character recognition. But, if your application isn't standard, you'll especially like Optron's fast reaction to your custom programs, too.

Write today for  
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**OPTRON, INC.**

1201 Tappan Circle  
Carrollton, Texas 75006  
214/242-6571

INFORMATION RETRIEVAL NUMBER 91

### MODULES & SUBASSEMBLIES

#### Analog multiplier can modulate too



Hybrid Systems Corp., 95 Terrace Hall Ave., Burlington, Mass. Phone: (617) 272-1522. P&A: \$55; stock to 2 wks.

Without using external trimming or components, the model 107 transconductance analog multiplier can multiply, divide or find square roots with a 1% accuracy. With the addition of a single potentiometer, the null of the unit can be reduced to 0.1%, allowing it to be used as a modulator. Bandwidth is 400 kHz and full-power response is 100 kHz.

CIRCLE NO. 346

#### Chopper op amps hold 0.5 pA/°C



Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. Phone: (602) 294-1431. P&A: \$49 to \$89; stock.

Three new chopper-stabilized operational amplifiers offer temperature-drift performance as low as 0.1  $\mu\text{V}/^\circ\text{C}$  for voltage and 0.5  $\text{pA}/^\circ\text{C}$  for current. In addition, noise is low (2  $\mu\text{V}$  pk-pk from 0.01 to 10 Hz) to ensure a minimum of input uncertainty for dc and low-frequency signals. The three models are types 3291/14, 3292/14 and 3293/14.

CIRCLE NO. 347

#### Wideband amplifier slews at 1000 V/ $\mu\text{s}$



Intronics, 57 Chapel St., Newton, Mass. Phone: (617) 332-7350. P&A: \$122.50; stock.

Designed for high-frequency inverting applications, a new operational amplifier will drive loads of  $\pm 50$  mA to  $\pm 10$  V while slewing at 1000 V/ $\mu\text{s}$ . Model A501 offers a wide bandwidth of 100 MHz and operates over a temperature range of  $-25$  to  $+85^\circ\text{C}$ . Minimum open-loop gain is 500,000, and output short-circuit protection is standard. The unit occupies 0.87 cubic inches.

CIRCLE NO. 348

#### High-voltage op amps slew at 50-V/ $\mu\text{s}$ rate

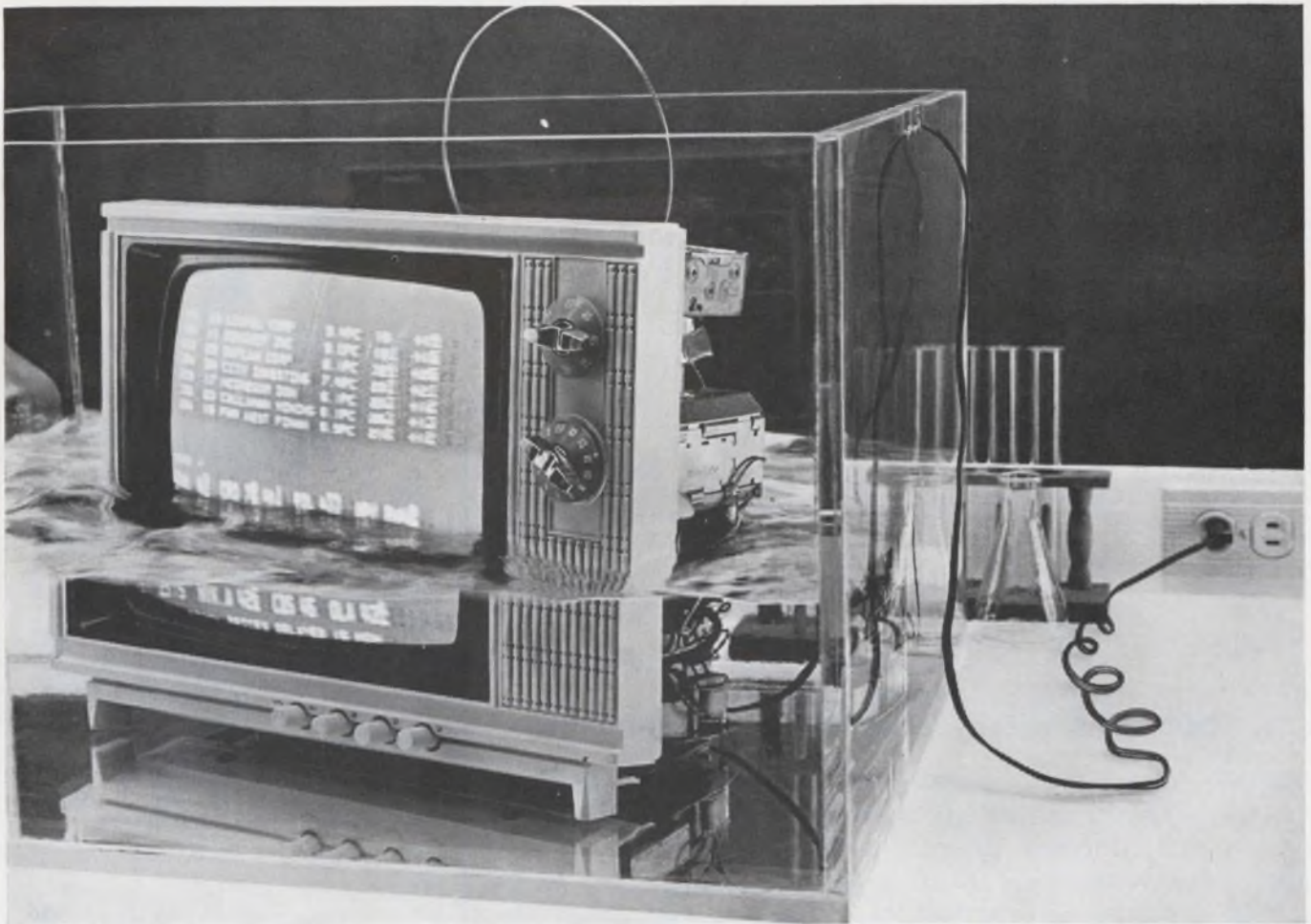


Analogic Corp., Audubon Rd., Wakefield, Mass. Phone: (617) 246-0300. P&A: \$90 or \$99.50; 2 to 3 wks.

With a slewing rate of 50 V/ $\mu\text{s}$ , the AN290 operational amplifier settles to 0.01% in 25  $\mu\text{s}$  for a 200-V step input, while the AN291 op amp settles to a 0.01% in 50  $\mu\text{s}$  for a 300-V step input. The first unit is a 100-V inverting amplifier, and the second is a 150-V follower amplifier. Both devices are short-circuit proof to ground and operate from 0 to 60°C.

CIRCLE NO. 349





## Our new dry test bath is getting a great reception

This should give you a pretty clear picture of what Fluorinert® Brand Electronic Liquids are all about.

They give you a dry test bath for temperature and gross leak testing of electronic and microelectronic units and integrated circuits. They detect flaws and leaks with great accuracy . . . and are efficient over a wide range of temperatures.

Fluorinert Liquids have high dielectric strength . . . which means you can safely test on-circuit. They do not react with the most sensitive of materials . . . which means you can test about anything.

Fluorinert Liquids drain clean, dry fast and leave no messy residue. You can use and ship units directly out of the test bath, without cleaning.

In fact, Fluorinert Electronic Liquids are now approved for the MIL-Standard 883 and the MIL-Standard 750A gross leak tests for microcircuits.

We have lots more information about this remarkable new test bath. The coupon will bring it all or call your local 3M representative.

### Fluorinert® Electronic Liquids 3M BRAND

3M Company, Chemical Division, 3M Center  
St. Paul, Minn. 55101

Dept. KAP2-70

Send me all the details about Fluorinert Brand Electronic Liquids.

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Company \_\_\_\_\_ Title \_\_\_\_\_

Address \_\_\_\_\_

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

INFORMATION RETRIEVAL NUMBER 92

# Small wonder!



## New air variable capacitors only 0.310" in diameter for vertical or horizontal tuning.

Johnson introduces these new Type "T" subminiature air dielectric capacitors for trimming applications that call for small size (0.310" diameter), high Q (greater than 1500 at 1 mHz), low TC, and low cost. Mounting dimensions of vertical mount "T" are identical to common 3/8" diameter PC mount ceramic disc trimmers.

Nominal capacities available range from 1.3 pF minimum to 15.7 pF maximum. Minimum voltage breakdown is 250 VDC. End frame is 95% alumina, grade L624 or

better, DC200 treated. Metal parts are silver plated and Iridited to inhibit discoloration.

Plates are precision machined from brass extrusions and offer exceptional uniformity, stability, and absolute freedom from moisture entrapment. Temperature coefficient is plus  $30 \pm 15$  ppm/ $^{\circ}$ C. Retrace characteristics are excellent. Outstanding stability during vibration from 10 to 2000 Hz. These new capacitors meet or exceed EIA-RS 204 and MIL Standard 202C Methods 204A and 201A.

- Please rush a sample of your new Type "T" capacitors, detailed specs and prices.  
 Include Catalog 701 covering the entire E. F. Johnson component line.

NAME \_\_\_\_\_ TITLE \_\_\_\_\_  
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## E. F. JOHNSON COMPANY

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Providing nearly a half-century of communications leadership

INFORMATION RETRIEVAL NUMBER 93

## Miniature supply powers 10 op amps



Datel Corp., 943 Turnpike St., Canton, Mass. Phone: (617) 828-1890. P&A: \$59; 2 wks.

Designed for powering linear integrated circuits, a new miniature dual dc power supply can drive up to 10 operational amplifiers with its  $\pm 15$ -V 50-mA output. Model UPM 15-50 is completely self contained and includes an input isolation transformer. It can mount directly on printed circuit boards with 0.5-in. centers. Output noise is 1 mV rms.

CIRCLE NO. 350

## Regulated supplies cost just \$19.95



Semiconductor Circuits, Inc., 163 Merrimac St., Woburn, Mass. Phone: (617) 935-5200. Price: \$19.95.

Selling for only \$19.95 in single-unit quantities, series LCD dual-output power supplies provide  $\pm 6$ ,  $\pm 12$  or  $\pm 15$  V at 25 mA. Models P2.6.25, P2.12.25 and P2.15.25 have a maximum line regulation of 0.05%, and a maximum load regulation of 0.2% from 0 to 100%. Their ripple and noise are less than 2 mV pk-pk; temperature coefficient is 0.02%/ $^{\circ}$ C maximum from  $-25$  to  $+71^{\circ}$ C.

CIRCLE NO. 419

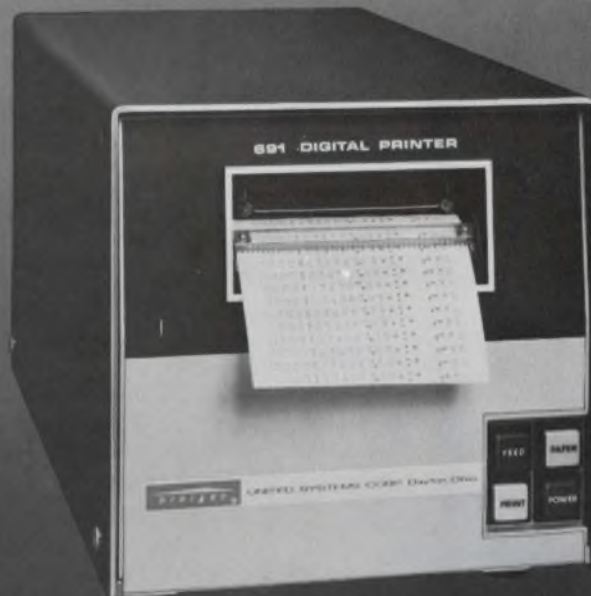
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per second

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21 Column  
Printer

- 3 lines per second
- Expandable from 4 to 21 columns
- 38 parameter symbols
- Floating decimal
- Starting at

**\$770**

Request new catalog D69B



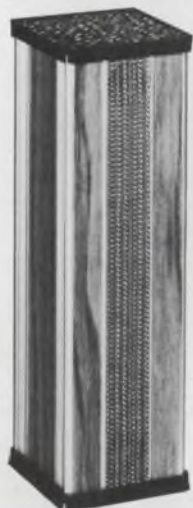
DIGI ▲ EC®

by UNITED SYSTEMS CORPORATION

918 Woodley Rd., Dayton, Ohio 45403 Phone (513) 254-6251

INFORMATION RETRIEVAL NUMBER 94

## TWO NEW BELL RINGERS FROM DELTA



**DELTALERT**...Your night watchman for pennies a month!

Delta introduces its all new ultrasonic silent sentry, the total motion detection, intrusion and monitoring alert system. The system plugs into any wall outlet. It also features variable sensitivity control and adjustable timing which provides the most advanced sentry system on the market.

**SPECIFICATIONS:**

Ultrasonic Frequency: 35 KHZ △  
Area Coverage: 15-30 feet (depending on shape of area) △ Controls: On-Off Switch; Built In Timer; Variable Sensitivity Control △ Output:

110-130V at 1 Amp. △ Power Requirements: 110-130V, 60 HzAC △ Dimensions: 10½" W x 3¼" H x 3¼" D △ Complete with 110-130V Drop Cord △ Walnut designer finish.

For Complete Unit, Ready to Use ..... ONLY **\$59<sup>95</sup>** ppd



**DELTA PRODUCTS, INC.**

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PHONE: (303) 242-9000



## HIGH VOLT ANALYST

Tune your car like a pro.

Delta's new concept in automotive tune-up, The High Volt Analyst, is a unique and complete auto analyzer which provides all the primary advantages of a scope and is completely portable.

**SPECIFICATIONS:**

Accuracy - Tachometer ±2% of full scale (all ranges) • Dwell Meter ±1% (both ranges) • OHMS Scale ±5% • Low Voltage ±2% of full scale • High Voltage ±5% of full scale △  
General - Fully protected meter circuit\* • Size: 6½" W x 8" H x 3½" D • Weight: 3½ lbs. △ Ranges - DC Volts 0-15V, 15KV and 45KV • OHMS: 0-1

Meg. (10K center scale) • Dwell: 4, 6 and 8 cylinders • Tachometer: 0-1500 RPM, 6000 RPM

\*Batteries (8 Type AA cells) included. Comes complete with standard lead set, a special probe, and high tension lead.

**\$79<sup>95</sup>** ppd / **\$59<sup>95</sup>** ppd  
Assembled Kit Form

**DELTA:** Please send me literature immediately.

I am enclosing \$\_\_\_\_\_ for items checked.

- DELTALERT
- High Volt Analyst, Assembled
- High Volt Analyst, Kit form

Please ship immediately.

Name \_\_\_\_\_

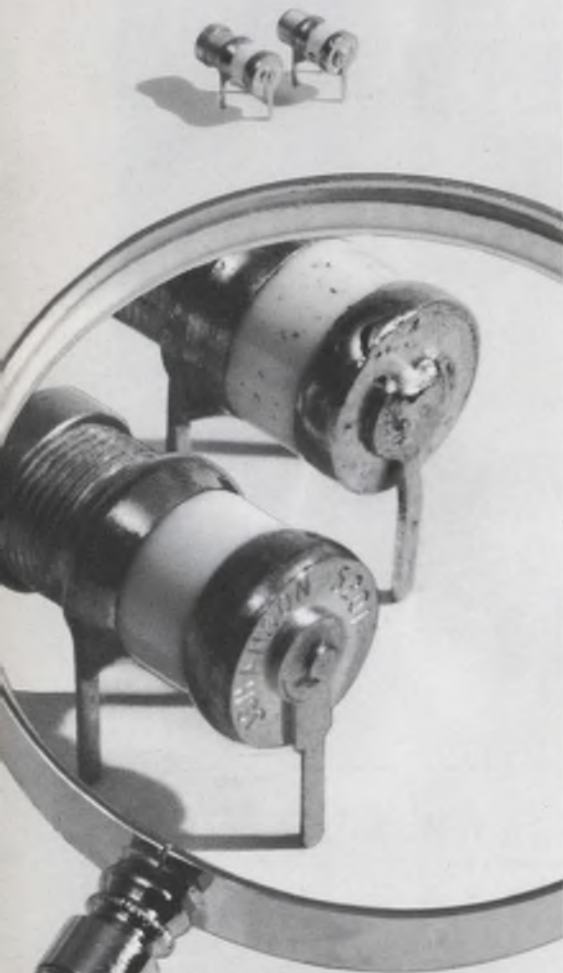
Address \_\_\_\_\_

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

ED 9-11

INFORMATION RETRIEVAL NUMBER 95

# COMPARE CLOSE-UPS

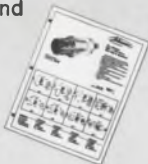


## and you'll specify Johanson.

Look at the obvious . . . Johanson craftsmanship — 24 Kt. gold plating, watchmaker's precision machined parts and handcrafted assembly and soldering just not available in other trimmers.

This built-in quality means you get superior performance characteristics . . . 16 pF in a 10 pF package, Q greater than 5000 at 100 Mz, a temperature coefficient of  $0 \pm 15$  PPM $^{\circ}$ /C, with tuning stability and long life.

Why settle for ordinary trimmers when the best is available — send today for our new catalog sheet on our 5200 series . . . and start comparing.



**Johanson**

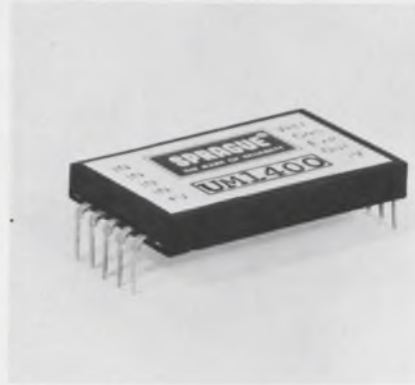
MANUFACTURING CORPORATION

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(201) 334-2676

Electronic Accuracy Through Mechanical Precision

## MODULES & SUBASSEMBLIES

### D/a converters are plastic DIPs



Hewlett-Packard, 150 Page Mill Rd., Palo Alto, Calif. Phone: (415) 326-7000. Price: \$640.

Costing as little as \$365 per channel, a new data amplifier provides switchable gains (1 to 1000 in decade steps) and switchable bandwidths (10 or 100 Hz, and 1, 10, and 50 kHz). Model 2471A has a gain accuracy of  $\pm 0.01\%$  of output, a common-mode rejection of more than 120 dB from dc to 60 Hz, a drift of  $1 \mu\text{V}/^{\circ}\text{C}$ , and noise of  $5 \mu\text{V}$  rms at full bandwidth.

CIRCLE NO. 421

### Digital counting unit can be seen for 150 $^{\circ}$



Datel Corp., 943 Turnpike St., Canton, Mass. Phone: (617) 828-1890. P&A: \$59; 2 wks.

Powering up to 40 DTL dual quad gates, a new miniature dc power supply measures only  $1 \times 2 \times 0.4$  in. The BPM 5-300 has an output of 5 V at 300 mA and regulates to  $\pm 0.05\%$ . It mounts on PC boards having 0.5-in. centers and is short-circuit and overvoltage protected. It operates on 115 V ac and has low noise of 1 mV rms.

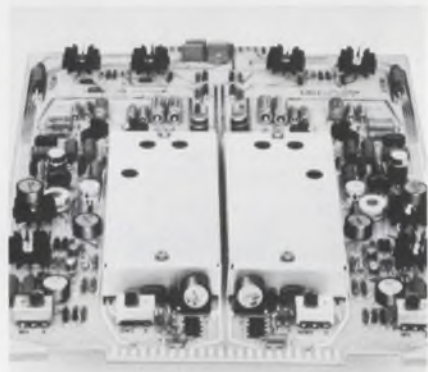
CIRCLE NO. 423

Sprague Electric Co., Semiconductor Div., 347 Marshall St., North Adams, Mass. Phone: (413) 664-4411.

Series UM-1400 Moduline digital-to-analog converters are packaged in a modified plastic dual-in-line case. The basic UM-1400 module is a four-bit d/a converter that contains a buffer amplifier, ladder network and a ladder switch. The UM-1450 is a set of three Moduline assemblies which gives an over-all accuracy of one-half the least significant bit at 12 bits.

CIRCLE NO. 420

### Accurate data amplifier selects gain and band



Varitron Corp., P.O. Box 2594, St. Louis, Mo.

A new digital counting unit, which can be incorporated into any digital system, uses a readout tube that displays the accumulated count as a green high-visibility numeral, which can be read at angles up to  $150^{\circ}$ . Multiple units can be mounted in combination and wired in cascade to allow counts as high as desired. The new counter is available as a one-piece subassembly or as a plug-in card for a 15-pin card socket.

CIRCLE NO. 422

### Modular power supply measures only 0.8 in.<sup>3</sup>



# So what if Grant Slides save hours of down time?

Is there a quicker, more efficient way to get to a fault location than by immediate and smooth extension of the unit for simple, fast check-out?

Would you guess the savings from being able to keep equipment connected (and in operation) while maintenance takes place?

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Virtually every product can use the ready access provided by Grant Slides. There are thousands of types, styles and sizes available. Slides that tilt, lock, extend and lock and perform dozens of other functions. Undoubtedly, there's a Grant Slide that can help make your product better too.

Write for complete data.

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**EASTERN DIVISION:** 21 HIGH STREET, WEST NYACK, NEW YORK 10994  
**WESTERN DIVISION:** 944 LONG BEACH AVE., LOS ANGELES, CALIF. 90021

INFORMATION RETRIEVAL NUMBER 96

# THE GIANT KILLERS

## SMALLER TOUGHER



## FOR LE\$\$!

### REGULATED and UNREGULATED DC POWER SUPPLY ENCAPSULATED MODULES

Here's a sampling:

#### REGULATED

3.6 VDC @ 250 MA to 180 VDC @ 10 MA

PM 529B 5V @ 250 MA — \$33.95\*

PM 551 ±15V @ 65 MA — \$34.95\*

PM 555 ±15V @ 100 MA — \$43.95\*

Single and dual output

Typical line/load reg. ±0.04%

Typical temp. coeff. ±0.02%/°C

#### UNREGULATED

5 VDC to 45 VDC up to 440 MA output current

PM 810 5V @ 400 MA — \$13.40\*

PM 830 16V @ 165 MA — \$12.40\*

PM 836 25V @ 100 MA — \$12.40\*

\* 10-29 Quantity Prices

Computer Products, Inc., P.O. Box 23849, Ft. Lauderdale, Fla. 33307

Phone: 305/565-9565



**COMPUTER  
PRODUCTS™**

FORT LAUDERDALE

### TOOLS & ENGINEERING AIDS

#### Precision drafting unit is completely portable



Hunter Associates, 182 Clairmont Terrace, Orange, N.J. Phone: (201) 672-0423. P&A: \$22.25; stock.

The model 403 is a precision portable drawing and drafting machine for desk, travel, or home-use. Drafting paper is secured to the board with 3 sliding clamps allowing the use of various-sized papers. The machine has a plexi-glass right angle that is graduated in inches, and a self-adjusting protractor that is graduated in degrees with a zero adjustment at the angle.

CIRCLE NO. 424

#### Tiltable drafting board is a reference desk too



Stacor Corp., 285 Emmet St., Newark, N.J. Phone: (201) 242-6600.

A new drafting station combines in one unit a foot-pedal operated drafting board and a reference desk. On one side, the Stacor-Matic has a drawing board that can be tilted by foot pedal from horizontal to vertical, and adjusted by another pedal from heights of 35-3/4 to 44-3/4 in. The other side is a 30 × 49-3/4-in. reference desk which can be pulled out to a length of 11-1/2 in.

CIRCLE NO. 425

# SWITCH/INDICATORS

## Alternate Action — 1,000,000-cycle reliability!

Push-on, push-off! Two circuit dri-reed switch for controlling separate circuits. When button-lens is depressed, one circuit is closed, the other opened. Button stays down until pressed again.

Has front-replaceable midget flanged base incandescent lamp. Match-mated with other TEC-LITE indicators for panel design harmony. Available in 14 lens colors. Rear Mounts in  $\frac{3}{8}$ " hole on centers as close as  $\frac{1}{2}$ ". Contact rating: 12 volt amp. As low as \$4.90 in quantities of 100 - 499.

For more information on ABL-ABS switch/indicators — or any part of our complete line of display/control products and systems — write: TEC, Incorporated, 6700 So. Washington Avenue, Eden Prairie, Minnesota 55343. (612) 941-1100.



INFORMATION RETRIEVAL NUMBER 98

## GRC *Big Specialists in* **SMALL GEARS**



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● One-Piece Combinations ● Precise

● Uniform ● High Quality ● Low Cost

GRC one-piece gear and pinion combinations make possible new designs, product improvements and production short cuts for higher value. Gear clusters, gears with shafts, spacers, hubs, cams . . . practically any shape combined with basic gear forms . . . spur, bevel, crown, miter, rack, worm, helical and spiral. Die-cast in zinc alloy or molded in engineering thermo plastics (nylon, Delrin, etc.) Gries special automatic limited cavity methods offer gears in quantity to satisfy your most intricate gearing designs. Also available—gears and pinions from stock or stock dies at little or no tool cost.

NO MINIMUM SIZE

Zinc Alloy-Max.: P. D.  $1\frac{1}{2}$ "; face width  $1/16$ ". Plastic-Max.: P. D. 1"; face width  $1/16$ ".

(\*wider faces for smaller P.D.'s)

Write for sample, literature and gear designer's aids.



SEND PRINTS FOR PROMPT QUOTATION.

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INFORMATION RETRIEVAL NUMBER 99

INFORMATION RETRIEVAL NUMBER 100

ELFIN  
2.99\*

# think digital



MS-4000  
3.85\*

Think ELFIN — the new single plane, segmented neon readout indicator that provides brighter displays and wider viewing. Only 0.41" dia. ELFIN display 0-9, + and —, some alpha symbols and decimal.

The MS-4000 Series has new readouts added to include numeric and symbol indications. Each model is a miniature encased readout with the flat single-plane viewing, and uses 100,000 hr. #683 T-1 subminiature lamps. Plug-in feature expedites replacement. Photograph above shows five MS-4000 readouts used with a module mounting and bezel kit.



MS-250  
4.97\*

ALCO's RK numeric and symbol readouts have a unique in-line design to provide clear displays without focusing problems. The precision machined 1-piece aluminum case also serves as a heat sink.



MS  
4.97\*

The MS Mosaic numeric segmented indicators are available in 2 sizes and use either 6 14 or 24V lamps for flexibility in design.



MSM-5A  
4.97\*

SEND FOR  
ALCO - NUMERIC  
CATALOG

\* 1000 Lot Price:

# ALCO

ELECTRONIC PRODUCTS, INC.

Lawrence, Massachusetts 01843

## TOOLS & ENGINEERING AIDS

### Solder/desolder tool accepts up to 85 tips



Technical Devices, 1402 Norman Firestone Rd., Goleta, Calif. Phone: (805) 684-2413. Price: \$44.

Designers, engineers, scientists, model makers, artists, architects, sign makers and craftsmen will find a number of uses for the new Model Machine plastic foam-cutting device. It cuts plastic foam, such as Styrofoam up to 6 in. thick, with ease and accuracy. The cutting wire does not vibrate, saw or move, since it works by melting a fine cut through the material.

CIRCLE NO. 427

W.T.O./Aquatemp Co., Box 352, Fort Lee, N.J.

Featuring quick-changing slide-in tips, a new soldering tool accepts up to 85 different soldering tips. Model M-64 accepts such tips as chisels, conical points and special bevels with no screws or set pins. With the tip removed, it can be used as a single-shaft desoldering tool, shrinking tubing with puffs of heat. It is available up to 500°C-versions with some models weighing as little as 1 oz.

CIRCLE NO. 426

### Foam cutting machine multiplies its uses



### Two connector tool kits insert/remove contacts



Technical Specialties International, Inc., 420 First Ave. West, Seattle, Wash.

A complete quality-control inspection set has a range of probes, each with a medical-type lamp powered by two 1.5-V batteries in a handle. It consists of straight, angled, rigid and flexible probes, each producing a patch of light to be used in conjunction with a slip-on magnifier and mirrors for close inspections. A hook and magnet for parts retrieval are also provided.

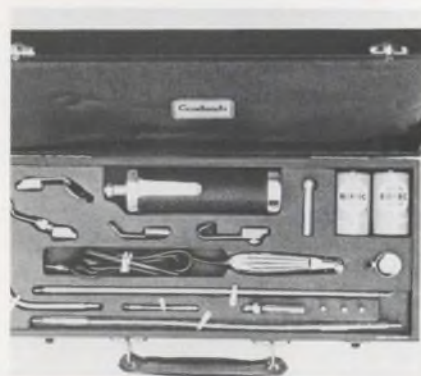
CIRCLE NO. 429

Jonard Industries Corp., Precision Tools Div., 3047 Tibbett Ave., Bronx, N.Y. Phone: (212) 549-7600. Price: \$39.50, \$51.50.

Only two tool kits, numbers KA-260 and KR-260, enable the insertion and removal of contacts for most connectors. They insert and remove contact sizes #12, #16 and #20. For ease of identification, tools are color-coded for different contact sizes. Each tool has a protective probe guard and meets federal and military specifications.

CIRCLE NO. 428

### Lighted-probes QC kit enhances inspections



◀ INFORMATION RETRIEVAL NUMBER 101





## What do you need in Multi-Conductor Cable?

**Victor**

will make it.

Get exactly what you need in multi-conductor cable. We'll design and produce multi-conductor cable to meet just about any individual requirement.

We have the plant, the equipment, the personnel and the know-how to solve your particular problem.

**Victor**  
Electric Wire & Cable Corp.  
WEST WARWICK, RHODE ISLAND

## YOUR WARRANTY SHOULD PROTECT YOU... AS WELL AS YOUR CUSTOMER

And a calendar can't do this!

A calendar is an old-fashion and extravagant way of warranting your product. It's usage that counts—and we count usage.

An ENM elapsed time indicator records actual hours of usage—from minutes to thousands of hours. And it can do this for as little as \$6.00 a unit. (Think of what this can save you!)

One customer's week could be another customer's year.

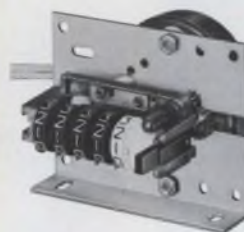
### ELAPSED TIME INDICATORS IN STOCK



**Model T4B**—Miniature use-time indicator. Scale to 9999.9 hours, with tenths in red. Non-reset. 110 V., 60 hz. Panel or bracket mount. 1.59" wide.



**Model T5BB**—Economical use-time indicator. Scale to 9999.9 hours, with tenths in red. Non-reset. 110 V., 60 hz. Panel mount. 2.88" dia.



**T30A**—Choice of hours, minutes or seconds scale—4 or 5 digits—tenths in red. Push button reset. 115 V., 60 hz. Universal bracket mount. 3.0" wide.



**T3B**—Double scale use-time indicator—99,999.99 hours total time and reset time. Tenths in red, hundredths with sweep hand. Reset scale knob resettable. 115 V., 60 hz. Panel mount. 1.87" square.

Many other standard elapsed time indicators carried in stock. Specials to fit your requirements. OEM discounts available. Also complete lines of electrical, mechanical and predetermined counting devices. Send for new 4-page Condensed Catalog and Price List 69A.

WRITE OR PHONE FOR DETAILS.



**ENM COMPANY**

5306 W. Lawrence Ave. • Chicago, Ill. • 60630 • (312) 282-8787  
Representatives in Principal Cities

Stocking Distributors: W. W. Grainger Co. & Newark Electronics



# the original ALCOSWITCH®

The original miniature ALCOSWITCH® has been the engineer's 1st choice for contemporary front panel designs.

When most every one was working with conventional switches of the 1930's, ALCOSWITCH® introduced the concept of mass-produced switches compatible with the new technology of miniaturization.

Ultra-miniature in size, the original ALCOSWITCH® combines high current capacity and exceedingly long life into a 1/2" size case. Contacts are solid silver and the phenolic body has high voltage barriers between terminals and contacts.

Since its introduction the original ALCOSWITCH® has withstood the test of time, where today it is the "most-asked-for" miniature switch.



This broad line of miniature switches includes toggles, push buttons and rotaries, all available in one, two, three and four pole in a single case construction.

*Read all about it in this 20-page catalog!*



# ALCO®

ELECTRONIC PRODUCTS, INC.  
Lawrence, Massachusetts 01843

## Evaluation Samples



### Chip capacitors

A sample packet of a new size of ceramic chip capacitors is now being offered as a free evaluation sample. The new chip measures 0.23 × 0.21 in. and will replace the old 0.23 × 0.23-in. size. Capacitance ranges from 1200 to 470,000 pF with capacitance tolerances of ±5, ±10 or ±20%. Standard voltage ratings are 50 V dc at 125°C and 100 V dc at 85°C; operating temperature range is -55 to +125°C. The new chips are available in both NPO and general-purpose dielectrics with noble-metal terminations. Vitramon Inc.

CIRCLE NO. 430



### Self-sealing bags

Kwik-Seal automatic-sealing corrugated bags are constructed of single-faced corrugated cardboard with adhesive-coated flaps. Their corrugated construction furnishes shock absorbing ribs for maximum protection with minimum weight, while their self-sealing flap ends the need to staple bags closed. The new bags, which are supplied in 10 basic sizes, can hold almost any shape, thereby making their usage universal. Free evaluation samples are available. United States Box Crafts, Inc.

CIRCLE NO. 431



### Spring-like packing

A new type of Teflon TFE plastic V-ring packing offers good sealing characteristics and long life due to its unique spring-action design. Series 6225 self-energizing lip-type rings have a 12-degree differential angle between the slopes of the top and bottom surfaces. When stacked and compressed, they demonstrate a controlled degree of springiness, expanding evenly for efficient sealing and long life. The rings can withstand operating temperatures to 500°F, remain flexible at low temperatures, neither age-harden nor flex-crack, and do not corrode metal parts. Free evaluation samples are available. Chicago Gasket Co.

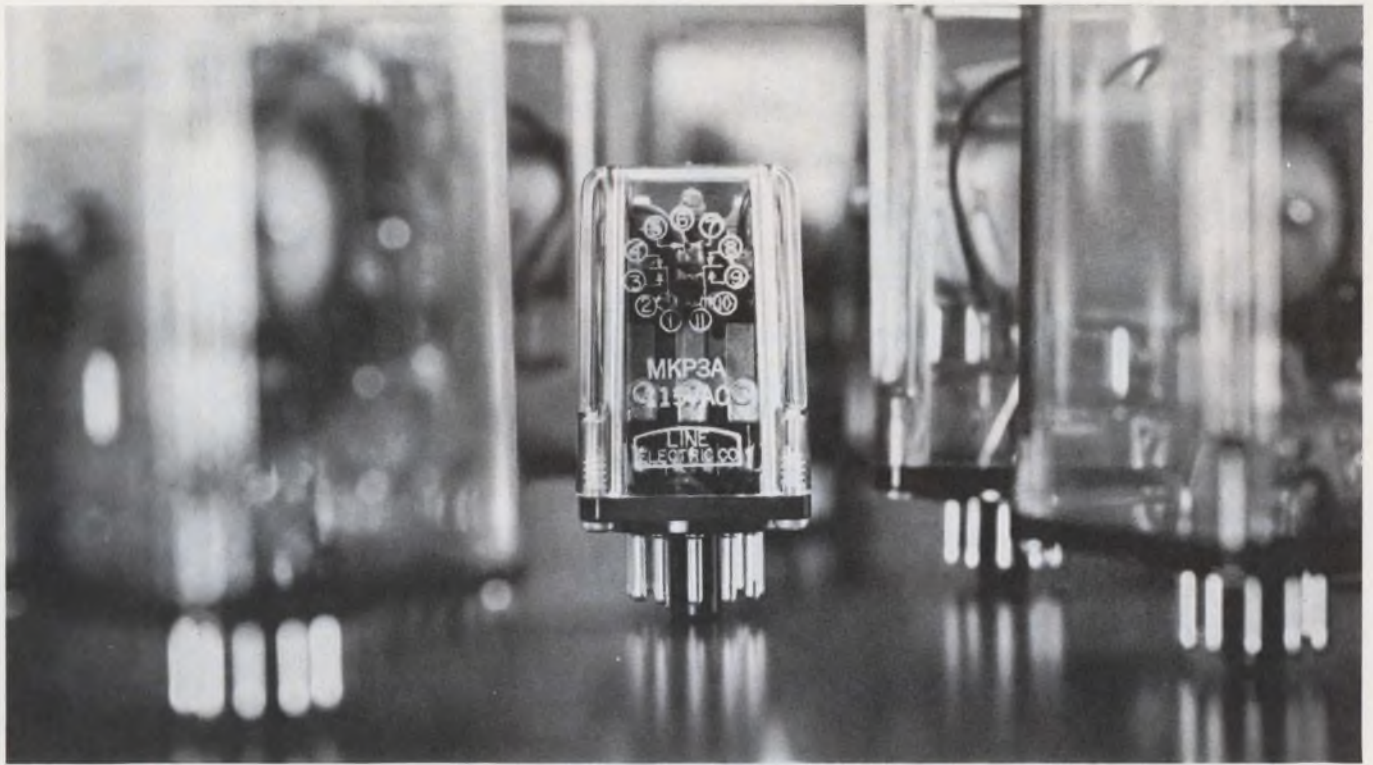
CIRCLE NO. 432



### Stick-on signs

Self-adhesive weather-proof emblems in a choice of co-ordinated sizes and designs for use on large, medium and small equipment are now available as free evaluation samples. These signs are printed on pressure-sensitive vinyl or Mylar in a choice of more than 11 colors. They eliminate the expense of specialized painting labor, and the cost and time involved to have equipment lettered. They are washable, will not wrinkle or buckle, and resist oils, solvents and acids. Seton Name Plate Corp.

CIRCLE NO. 433



## Does the work of relays twice its size.

Its applications are practically unlimited – this series MK medium power General Purpose Relay. A versatile little fellow who wears so many hats. For instance, he comes open, hermetically sealed, or enclosed in plastic dust covers made of Styrene, Butyrate, Polycarbonate-clear, translucent and opaque. Colors? A variety at no extra charge.

And in the matter of mounting you have four choices of terminals: solder lug, plug-in, printed circuit and .110 snap-ons. For chassis mounting – studs on side or base.

As you can see, it's a real space-saver. Yet electrically it stands "ten feet tall" with 5 and 10 amp. load contacts (AC & DC) and sensitivity down to 60 Milliwatts per pole DC – ideal for plate circuits.

Even the contacts are varied: Fine Silver or Silver Cadmium Oxide (gold flashed), Gold diffused in addition to 1, 2, and 3 PDT combinations. With a few extras like spotlights to indicate coil state and a true 10 amp. socket which can be used for PC boards, also solder terminals for .110 snap-ons.

And to top it off, this little giant has U.L. No. E36213.

About the price – as low as \$1.60 in quantity. For a prototype, please specify coil and contact requirements.

# SINGER

Line Electric Company, U. S. Highway 287, Parsippany, N. J. 07054 201/887-2200

INFORMATION RETRIEVAL NUMBER 105

# TRIPLE THREAT!



## BARNES UNIVERSAL MATING CONNECTOR FOR FLAT-PACKS, DIP'S AND TO'S

Confronted with a variety of Integrated Circuits to be tested? Enter Barnes versatile RD-86 Universal Mating Connector. Quick as a wink, you can insert a Barnes socket... for TO's... for DIP's... or for flat-packs. RD-86 Mating Connectors permit rapid interchange of sockets for maximum test flexibility. Features include positive polarization, wiping type contacts and  $-65^{\circ}\text{C}$  to  $150^{\circ}\text{C}$  or  $200^{\circ}\text{C}$  operating ranges. Write or call us for complete information. Lansdowne, Pa. 19050 • 215/MA2-1525



**barnes** / THE FIRST WORD IN CARRIERS, CONTACTORS AND SOCKETS FOR I.C.'S

INFORMATION RETRIEVAL NUMBER 106

## Design Aids



### Transistor charts

Chock full of charts, tables, and curves, a new 12-page design aid entitled "Economy Transistors" cross-references transistor type designations, specific direct replacements, preferred types, and nearest equivalents for easy simple selection by design engineers. Specifically, this guide details the Silect line of low-cost transistors, which includes plastic-encapsulated silicon bipolar transistors, uni-junction transistors, and field-effect transistors. In addition, an applications section shows recommended device uses and lists electrical parameters. Texas Instruments Inc.

CIRCLE NO. 434



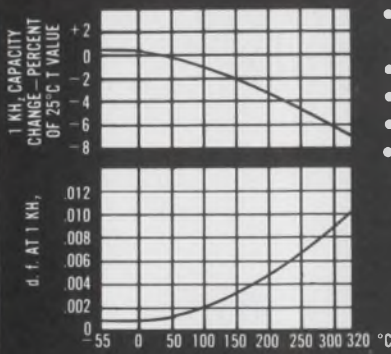
### Lettering wall chart

A convenient wall chart provides a handy reference guide to many styles and sizes of dry transfer lettering and symbols. Engineers, draftsmen, artists and others will find the chart a great time-saver when in need of a direct and simple selection guide. Tactype Inc.

CIRCLE NO. 435

# new!

## high temperature, high voltage CAPACITORS



CAPACITY AND DISSIPATION FACTOR VS. TEMPERATURE

- Operating temperature from  $-55^{\circ}\text{C}$  to  $310^{\circ}\text{C}$
- Low dissipation factor
- Good insulation resistance
- Resist radiation
- 100VDC to 10,000VDC

Because of their high energy density, the CLA Series of high voltage, high temperature mica paper capacitors are available in extremely small volumes. To suit specific application needs, these units are custom designed in epoxy housings, metal encased and uncased. They are constructed to meet the most stringent military specifications. Write or call today for comprehensive technical bulletin.



**GENERAL LABORATORY ASSOCIATES, INC.**  
Norwich, New York 13815. Telephone: 607-334-3264  
a subsidiary of Simmonds Precision

INFORMATION RETRIEVAL NUMBER 107

# A good news for VHF-UHF designers!

**NEW**  
Tunable non-reciprocal circuit elements



TDK HEXALATORS—new type circulators—come in 5 models for 3 tunable frequency ranges covering the region from 100 to 600MHz. Add a simple matching circuit (capacitors) to each port: that's all you have to do to select your frequency. HEXALATOR's gyro-magnetic component uses TDK ferrite and is very low in impedance—a feature that places HEXALATOR above other lumped-element parts. Small in size (3.3cm and 4.2cm). Easy to mount and connect. Usable even as isolators. TDK and ferrite— together the two never go wrong.

Tunable frequency range (MHz)	Model	Power (W)	Typical attenuation (band center)	
			Insertion loss (dB)	Isolation (dB)
100~200	CU311A	30	< 1	> 20
	CU312A	50	< 1	> 20
200~400	CU321A	30	< 1	> 20
	CU322A	50	< 1	> 20
300~600	CU331A	30	< 1	> 20

HEXALATOR is the latest development from the joint research work of NHK Technical Research Laboratory and TDK, and based on the NHK patents (US 3335374 & Japan 498885).



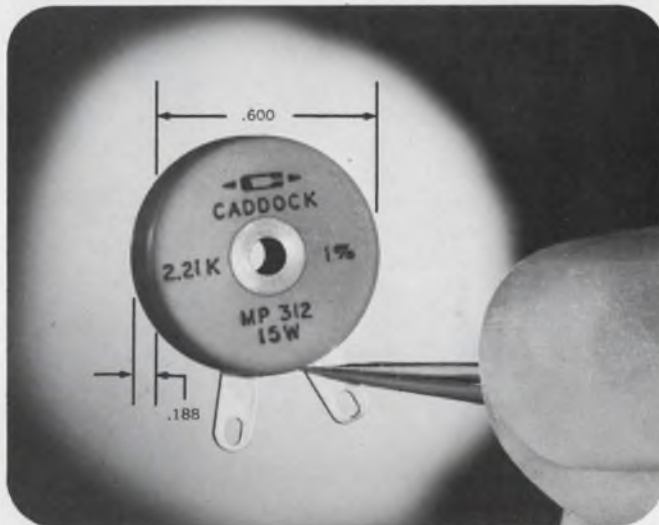
Write to MH&W for full technical data and information on applications Representative in U.S.A. & Canada for Ferrite Core for Communications  
**MH&W INTERNATIONAL CORPORATION**  
280 Midland Avenue, Saddle Brook, N.J. 07662  
Phone: (201) 791-6277 (212) 244-0695



**TDK**

TDK ELECTRONICS CO., LTD.  
2-14-6 Uchikanda, Chiyoda-ku, Tokyo Japan.

# MINIATURE POWER RESISTORS



**CHASSIS-MOUNT TYPE • NEW LAMINAR DESIGN • LOW PROFILE • 50% REDUCTION IN SIZE AND WEIGHT • COMPLETELY NON-INDUCTIVE • T.C.: 50 PPM/°C • RESISTANCE TOLERANCE: ±1%**

Model No.	Power Rating†	Max. Voltage	Diel. Str.	High Temp. TC‡	Resistance Range	Terminals
MP311	15 Watts	300	600	50	50Ω-200K	12" Min Teflon Leads 26AWG 7x34
MP312	15 Watts	300	600	50	10Ω-200K	Gold Plated Solder Lugs

†Power rating based on chassis mounting—MP311 and MP312 on 6"x4"x2"x.040 aluminum chassis

‡TC: 50ppm/°C Referenced to 25°C, ΔR taken at +150°C and +275°C. (Low temp. TC will be nominally -85ppm/°C at -55°C. See typical R-T curve.)

Resistance Tolerance: ±1% standard (Other tolerances on special order.)

Insulation Resistance: 10,000 Megohms, dry, Method—Mil-R-18546D, para. 4.6.8.

Solderability: Per Mil-R-18546D, para. 3.7, para. 4.6.4.

Terminal Strength: Per Mil-Std 202, Method 211, Cond. A (Pull Test), 5 lbs., and

Cond. B (Bend Test) Max. ΔR, .2% or .2Ω, whichever is greater.

Thermal Shock: Per Mil-R-18546D, para. 4.6.9, max. ΔR, .5% or .2Ω, whichever is greater.

Momentary Overload: 2 times rated power or 1.5 times max. allowable working voltage,

whichever gives the lower power, for 5 seconds. Max. ΔR, .5% or .2Ω, whichever is greater.

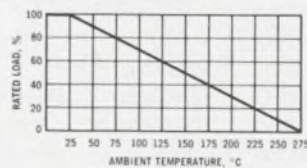
Moisture Resistance: Mil-Std-202, Method 106B, less steps 7a and 7b, max. ΔR, .5% or .2Ω, whichever is greater.

Life: Per Mil-R-18546D, para. 4.6.12, 1,000 hrs. Max. ΔR, .1% or .2Ω, whichever is greater.

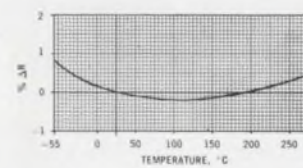
Shock, Medium Impact: 50G, per Mil-Std-202, Method 205, Cond. C.

Vibration, High Frequency: Per Mil-Std-202, Method 204, Cond. B. Max. ΔR, .2% or .2Ω, whichever is greater, through shock and vibration sequence.

DERATING CURVE



TYPICAL R-T CURVE



**CADDOCK**  **ELECTRONICS**

3127 Chicago Ave., Riverside, Calif. 92507 • Telephone: (714) 683-5361

# Application Notes

## Noise figures

A four-page brochure describes the value of noise figures as a tool in specifying the proper amplifier for a given low-level signal source. It provides specific examples of four typical amplifier matching problems, selection of the right preamplifier, determining optimal operating frequency and source resistance, approximating minimum detectable signals, and determining equivalent input noise resistance. Briefly described are the sources of amplifier noise, and a method for its experimental determination. Princeton Applied Research Corp.

CIRCLE NO. 436

## Computer corrosion

Corrosion control in computer facilities is the subject of a 12-page technical bulletin. The report briefly reviews the use of environmental control systems for removing gaseous pollutants and/or toxicants from corrosive interior atmospheres affecting computer operations. The systems discussed utilize an air purification medium—a blend of permanganate and activated alumina in pellet-form—that absorbs, adsorbs and oxidizes corrosive impurities in air passed through filter beds of pellets. Borg-Warner Corp., Marbon Div.

CIRCLE NO. 437

## Infrared detectors

"Technical Communications" volume 10, number 93, is a 120-page publication containing articles about systems that use infrared detectors. The 8-1/4 × 11-3/4 magazine-style publication is fully illustrated with charts, drawings and diagrams on a wide range of infrared detectors for designers of such systems as fire alarm (flame-detector), heat locator and closed-circuit television. Mullard, Inc.

CIRCLE NO. 438



## Diode design

Opportunities for improving discrete diode designs by means of multi-functional diode assemblies and monolithic arrays are outlined in a 24-page designer's guide. It shows how the multiple diode design approach achieves better performance at less costs, using standard or custom-mode products. Presented are several diode charts with electrical parameters, thermal ranges and matching data needed for the evaluation of assembly and array designs. Also included are typical applications and schematic drawings. Fairchild Semiconductor

CIRCLE NO. 439

## Storage tubes

"Extending Storage Time" is the title of a brochure with information on direct-view display storage tubes. It includes discussions on ion charging, means of extending storage time and flood-gun pulsing. Also discussed is periodic viewing, ion balancing and storage field compensation. A glossary of storage-tube terms is also included. Hughes Aircraft Co., Vacuum Tube Products Div.

CIRCLE NO. 440

## Silicon wafer defects

The various defects occurring during epitaxial growth on silicon and their possible causes are discussed in a six-page article. The defects are described and classified into groups. The brochure contains several photographs of surface growths and defects of silicon wafers. Hacker Instruments Inc.

CIRCLE NO. 441

## Metallizing ceramics

Low-temperature metallizing processes for alumina ceramics and other dielectric materials is described in a nine-page brochure. The processes are for plating nickel on non-conductive materials. Materials considered include alumina, beryllia, magnesium-oxide, steatite, barium titanate, ferrites and organic polymers. The compositions of reagents used are described and the plating process are detailed. The processes described present a new approach to the formation of conductive electrodes in microcircuitry and other important applications in electronics. Other means for metallizing are compared with the new metallizing processes. Transene Co., Inc.

CIRCLE NO. 442

## Passive repeaters


A 24-page engineering manual on passive repeater systems gives an extensive treatment to these reflectors of microwave energy. The text regards the antenna and passive repeater as effective point sources of radiated power and as a function of aperture and direction. This theoretical discussion is amply spiced with curves, equations, illustrations and tables. Microwave Systems Co.

CIRCLE NO. 443

## Energy capacitors

A four-page technical bulletin describes applications for a line of energy discharge capacitors. The bulletin provides curves, charts and formulae to aid in the selection of the proper energy discharge capacitor. In addition, information is provided on an expanded listing of standard units as well as a check list of data required when ordering special units. Aerovox Corp.

CIRCLE NO. 444



**That's our Molex Mini-Connector. It's doing big things. Like saving assembly steps. And time. And money. Getting wiring in place with greater production efficiency and operational integrity than you might think possible. Our business is creating these mini-devices to meet your system requirements. We take it seriously. And have the facilities, design capabilities, know-how and everything it takes to produce economical connections . . . fast!**

**If you would like a free sample of our Mini-Connector, please write. If you would like a sample of performance, you can make connections by calling (312) 969-4550**



# New Literature



## Resins and epoxies

A new series of illustrated technical bulletins enable the user to choose the best resin-catalyst combination for his application. Typical applications include large embedments and encapsulations such as power transformers, delicate electronic component encapsulations and dip coats for small electronic components. Various cured properties of these resins are listed in the technical bulletins. Emerson & Cuming, Inc.

CIRCLE NO. 445

## Thyristors

The reliability and performance of plastic encapsulated thyristors are covered in a 24-page reliability report. The report covers blocking and operating life, thermal and mechanical stress and corrosion and moisture resistance. It also shows solderability and lead-bend tests that are performed to a wide range of military-specification conditions. Also included are product specifications for planar thyristors. Transitron Corp.

CIRCLE NO. 446

## Silicon carbide rectifiers

Silicon carbide rectifiers operating at double the temperature and ten-times the radiation that disable conventional silicon rectifiers are covered in a four-page booklet. The illustrated publication gives design parameters and electrical properties of these rectifiers. It discusses elimination of their overvoltage spikes, encapsulation designs and radiation resistance and includes graphs which illustrate their properties. Westinghouse Astronuclear Laboratory.

CIRCLE NO. 447

## Lafayette catalog

The new 112-page 1970 Lafayette Radio catalog 702 is now available. It features the latest in high-fidelity components, systems and citizens-band equipment. Also included are portable radios, audio lights, stereo tape recorders, televisions and test meters. Other featured new items are cassette and cartridge tape recorders, speaker systems and mobile citizens-band transceivers. Lafayette Radio Electronics Corp.

CIRCLE NO. 448

## Instrumentation journal

The January issue of the Hewlett-Packard Journal is now available. It is packed with discussions on dc-to-vhf oscilloscope, a fast-writing high-frequency CRT, and a wideband oscilloscope amplifier. It also includes a discussion on monolithic transistor arrays for high-frequency applications, and a fast time base for a high-frequency oscilloscope. The discussions are supplemented with waveform photographs, circuit schematics, and product specifications. Hewlett-Packard.

CIRCLE NO. 449

## Thermocouples

A line of ultra-miniature thermocouples offering extremely fast-response and high-accuracy characteristics is contained in a new technical catalog. They are designed for use with temperatures ranging from cryogenic conditions to 5000° F. They have excellent resistance to thermal shock and are available with a variety of probe configurations. Miniature receptacles, probe holders and thermo wells are also presented. Also included is detailed information on design features, specifications, dimensional drawings, accessories and ordering. High Temperature Instruments Corp.

CIRCLE NO. 450



## Transformer materials

"Guide to Insulating Materials and Systems for Transformer Designers" is a four-color booklet that describes new transformer insulation materials. They were developed for new design and assembly techniques to meet aerospace industry requirements for thin, light weight materials. It tells what types of insulation are available for different temperature and voltage ranges and for special environmental conditions, and offers suggestions on how the materials may be used. 3M Co.

CIRCLE NO. 451

## Power converters

Solid-state ac-to-dc, dc-to-dc and dc-to-ac converters are described in a condensed four-page catalog. Shown are miniature, subminiature and high-voltage regulated types as well as miniature power transformers, inductors, current limiters and filters. Included are specifications, modifications, features and mounting dimensions. Arnold Magnetics.

CIRCLE NO. 452

## Paper capacitors

Custom, high temperature, mica paper capacitors are described in a new brochure. It explains major application areas, graphs of insulation resistance, dissipation factors and capacitance changes against temperature. In addition, a section on performance characteristics describes the radiation resistance, corona resistance, high energy storage, cost advantage and reliability of a line of wound-mica paper capacitors. General Laboratory Associates, Inc.

CIRCLE NO. 453



# antennas anyone?

from P-band  
through  
K-band frequencies

VEGA antennas meet and surpass the transmission needs of most airborne vehicles. More and more project engineers and technicians are looking to VEGA for high performance at extreme environmental conditions. See VEGA for: Slotted Blades, Quartz Cavity-backed Helixes, Stubs, Loop-Vees, Bi-conicals, Power Dividers, and Variable Power Dividers. Picture a VEGA antenna in your next airborne vehicle. In every way VEGA fits into the picture. Contact: VEGA PRECISION LABORATORIES, INC. 239 Maple Avenue, Vienna, Virginia 22180 (703) 938-6300



## New Oak Versatility



### OAK ECONO-LINE PUSHBUTTON<sup>T.M.</sup>

JUST 25¢ A BUTTON\*

\*For most applications

We've got the button... throws from 1 PST to 8 PDT per button; sizes: .388" sq., .388" x .585" or .388" x .782"; legends engraved to your specifications; black or white buttons are standard, other colors on special order.

Push Rod Stroke...  $\frac{3}{32}$ " plus  $\frac{3}{4}$ " overtravel; push rod lengths optional at  $\frac{1}{2}$ ",  $\frac{5}{8}$ " standard length,  $\frac{3}{4}$ ",  $\frac{7}{8}$ " and 1".

Easy to wire... clips are Oak-pioneered double-wiping. For printed circuit boards or wire-soldering, PCB terminals are  $\frac{3}{32}$ ",  $\frac{1}{8}$ ",  $\frac{3}{16}$ " standard length,  $\frac{3}{32}$ " and  $\frac{1}{4}$ " shoulder to tip. Choose terminals for wiring only or P.C. dual-purpose which have the wire hole in addition to the P.C. lug.

Compact Convenience... more buttons per area—24 on .394" centers, 16 on .591" centers, 12 on .788" centers. Any switching—momentary, push-push, interlock, or blockout or combinations. For full details, write today for Bulletin SP-346.



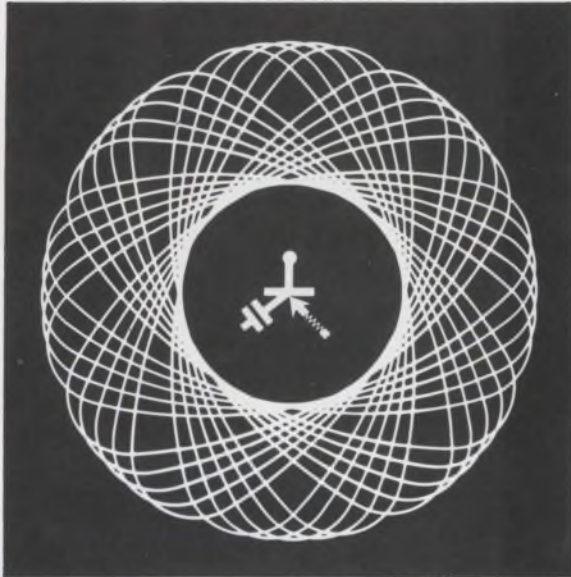
OAK MANUFACTURING CO.  
A Division of OAK ELECTRO/NETICS CORP.  
Crystal Lake, Illinois 60014  
Phone: 815-459-5000 TWX: 910-634-3353

Rendez-vous

## in Paris

Port de Versailles

April 3 - 8, 1970



100,000 technicians are expected to attend

## SALON INTERNATIONAL DES COMPOSANTS ELECTRONIQUES

Scientific, Technical and economic problems from April 6-10, 1970. - Paris - Conference Room of UNESCO Program, schedule and registration on request.

## INTERNATIONAL CONFERENCE ON ADVANCED MICROELECTRONICS

Under the supervision of the National Federation of Electronic Industries. 16 - Rue de Presles - PARIS (15°) - Tel. 273.24.70+

## NEW LITERATURE



### Torque motors

A comprehensive guide to a line of brushless dc torque motors is now available. It includes dc moving-coil torque motors, dc tachometers, dc torquer/tachometers, and dc torquer amplifiers. The brushless concept and its benefits and applications are given a concise definitive evaluation. Shown are specifications of typical types of motors, related performance curves and a table of conversion factors. Aeroflex Laboratories Inc.

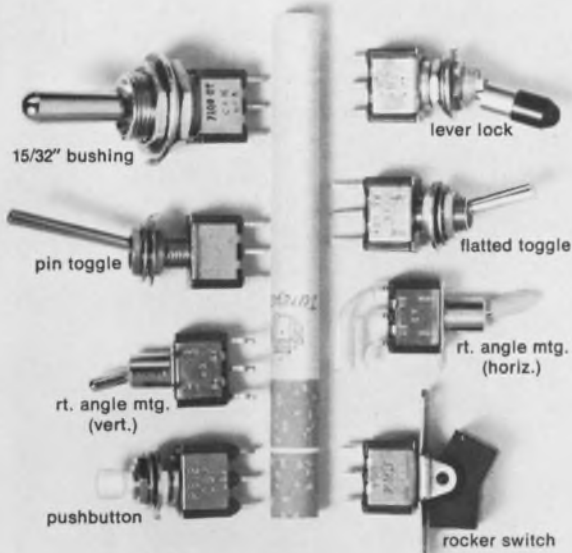
CIRCLE NO. 454

### Relays

A six-page brochure summarizes the specifications of TO-5 and solid-state ac relays. It presents specifications and drawings for several lines of relays including basic and hybrid military TO-5s, industrial TO-5s, and industrial solid-state relays. Lines include magnetic latching spdt, dpdt and 4pst, sensitive spdt and dpdt, and bi-filar relays. A page in the brochure describes hybrid TO-5 relays which may be ordered with transistor drives and/or operational amplifiers inside the TO-5 case. Teledyne Relays, a Teledyne Co.

CIRCLE NO. 455

SPDT DPDT 3PDT 4PDT



**We'd rather switch than fight.**

And have we ever switched! If you put any one of these 8 new subminiature switches on your "whatever", you'll have a better performing "whatever." All C&K switches are competitively-priced and Made-in-America. How's that for a switch? Ask for our new catalog.

**C&K COMPONENTS, INC.**

103 Morse Street, Watertown, Massachusetts 02172  
Tel: (617) 926-0800

INFORMATION RETRIEVAL NUMBER 114

*Fast-Connect PC BOARDS  
SAVE YOU MONEY!*



If latest developments of your products indicate use of PC boards, contact us BEFORE designing expensive etched terminals, custom connectors and costly new wiring harnesses!

Our technique of combining PC boards with STANDARD FAST-CONNECT TERMINAL TABS does the job inexpensively and well, and permits use of existing equipment for wiring.

We supply money-saving PC board SUB-ASSEMBLIES with solid state components wave or hand soldered, and basic boards with fast connect terminals of 0.110, 0.187, 0.205 and 0.250 in. from stock tooling — ready for immediate use with standard quick-connect style plug-ons.

**FREE Catalog and Designer's Guide**

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INFORMATION RETRIEVAL NUMBER 115

ELECTRONIC DESIGN 4, February 15, 1970

*we're  
BIG...*



*on  
small*  
**REED  
RELAYS**

Wheelock probably has the reed relay you're looking for. Write for catalog describing the Wheelock Big Family of Small Relays

*Wheelock*

SIGNALS, INC.  
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Long Branch, N. J. — 201-222-6880

INFORMATION RETRIEVAL NUMBER 116

Ferrite Shielded Air Core Yoke C5380. Designed for high speed precision character displays (nanosecond writing speeds). Undesirable magnetic coupling and stray fields eliminated by unique shield design.



# DESIGN DEVELOPMENT FROM *syntronic* THE YOKE SPECIALISTS

Syntronic engineers and manufactures the most extensive line of deflection yokes available . . . and continually develops new designs to satisfy the ever increasing requirements of the display industry. For large production or custom applications get the engineering control and production experience that only SYNTRONIC, the yoke specialists, can provide.



*syntronic*

**INSTRUMENTS, INC.**  
100 Industrial Rd., Addison, Ill. 60101  
phone 312-543-6444

INFORMATION RETRIEVAL NUMBER 117

# the **NEW** *Mighty-mini*

Schrack's **NEW MINIATURE STEPPING SWITCH, Type RTM**, is the smallest stepping switch available on the market today. Only  $\frac{1}{4}$  the size of comparable steppers, it combines high performance with economy of space and cost.

The RTM is equipped with 2 x 10 or 2 x 12 gold-plated contacts and mates with our socket which meets standard printed circuit spacings. Unique hold-down spring enables mounting in any position.

Write for free catalog today. Schrack also manufactures all types of relays, stepping switches and accessories. Catalogs upon request.



1 41/64" L x 13/16" W x 15/16" H

**SCHRACK** ELECTRICAL SALES CORP.

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tel: (212) 683-0790

INFORMATION RETRIEVAL NUMBER 118

## NEW LITERATURE



### Device reliability

Reliability report R-169 covers a line of fused-in-glass zener diodes, rectifiers and rectifier assemblies, thyristors and microwave p-i-n diodes. Contained in this informative report is a discussion of product design as it affects reliability, failure analysis and corrective action procedures. Also contained is information on material control and process control procedures, acceptance testing procedures and a discussion of reliability engineering as related to the effectiveness of stress screening. Unitrode Corp.

CIRCLE NO. 456

### Connectors

Two connector lines, qualified to MIL-C-83723 (USAF), are shown in a new catalog. They meet military aircraft needs for upgrading environment-resistant connectors. Shown are threaded-coupling connectors that are intermateable and interchangeable with MIL-C-5015 connectors, and bayonet-coupling connectors that are intermateable and interchangeable with MIL-C-26482 connectors. Both connectors operate in temperatures from  $-55$  to  $+175^{\circ}\text{C}$  and can be made to operate from  $-55$  to  $+200^{\circ}\text{C}$ . ITT Cannon Electric.

CIRCLE NO. 457

**For maximum frequency stability,  
get Motorola oscillators.**



**Currently available  
in production or prototype quantities.**

When the maximum in frequency stability is required, choose from Motorola's line of proportional ovenized precision oscillators. All are enclosed in an ovenized housing where the quartz crystal and its oscillator circuit are held to temperature changes of small fractions of a degree.

**High Stabilities.** To parts in  $10^{-10}$  vs: environmental factors.

**Wide Frequency Range.** From 60 KHz to 20 MHz normal. Extended ranges available on special order.

**Wide Temperature Range.** From  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

**Low Aging.** Less than  $5 \times 10^{-10}$ /day.

And if you need a non-standard oscillator, let us know your requirements. We'll design one specifically to meet your needs.

For complete information send for your free copy of Bulletin TIC-3401 today. Write Component Products Dept., Motorola Communications & Electronics Inc., 4501 W. Augusta Blvd., Chicago, Illinois 60651.

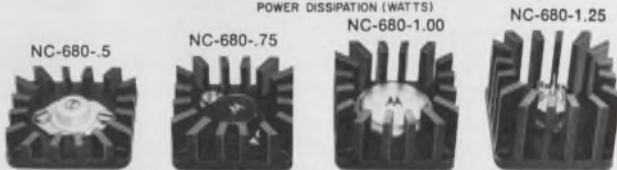
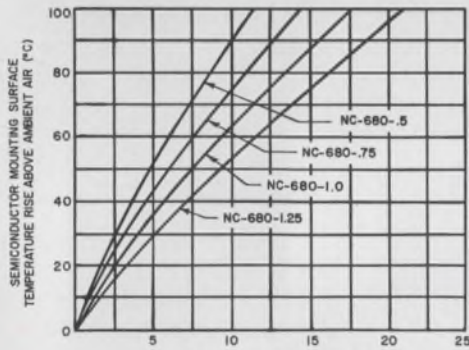


**MOTOROLA**

INFORMATION RETRIEVAL NUMBER 119

## Proven: Your most efficient circuit board heat sink . . . .

NATURAL CONVECTION CHARACTERISTICS



Most versatile line of 1100 aluminum heat sinks dissipates up to 15 watts with an  $80^{\circ}\text{C}$  rise. Free air circulation design permits mounting in any position. Accepts nearly all popular transistors.

Only 73¢ in lots over 500. Send for Bulletin 680.



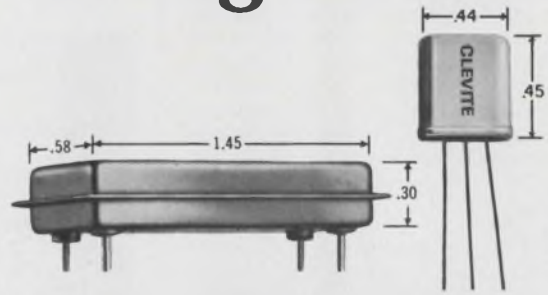
**WAKEFIELD**

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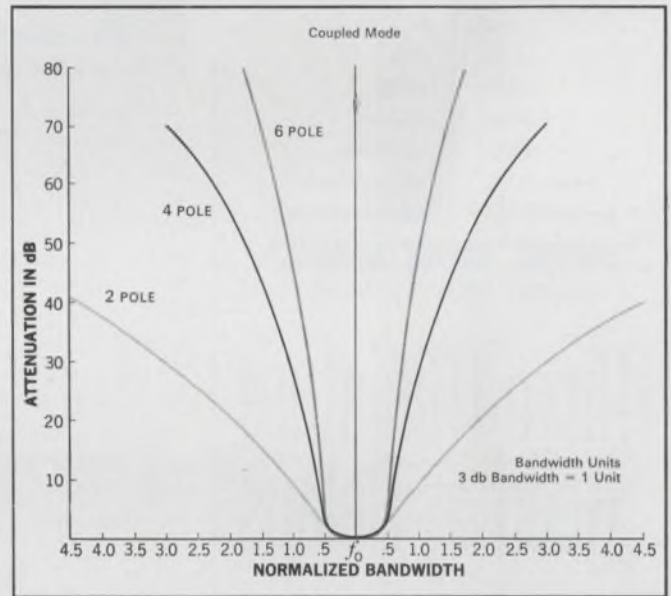
INFORMATION RETRIEVAL NUMBER 121

ELECTRONIC DESIGN 4, February 15, 1970

## Going to IC's? Or Higher IF's?



**Go with Clevite's  
off-the-shelf coupled-  
mode quartz filters.**



Now you can get *immediate delivery* on Clevite Uni-Wafer® coupled-mode Quartz Filters. Eleven models are available right off-the-shelf—two, four, and six pole; center frequencies of 10.7, 20.5, and 30 MHz; AM or FM bandwidths of 9, 14, and 30 kHz. And they're available in coldweld-sealed flatpacs or solder-sealed HC 18 cans.

Clevite's exclusive Uni-Wafer design uses trapped energy techniques to maximize resonant energy over arrays of resonators on a single quartz wafer. As a result, you get higher performance in a smaller package.

Clevite Uni-Wafer Filters are ideal for matching IC or conventional circuitry in VHF or UHF communications receivers, and radar, telemetry or aerospace systems. They're smaller and more reliable than discrete filters, have steeper skirt ratios, lower insertion losses, and better spurious mode rejection.

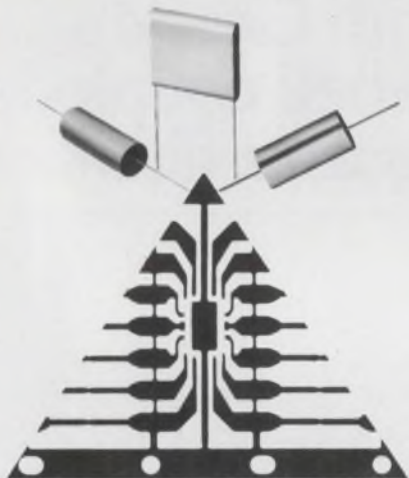
If you're going to IC's or higher IF's, Clevite Uni-Wafer coupled-mode Quartz Filters are the best way to go. For more information, including complete specifications, write Piezoelectric Division, Gould Inc., 232 Forbes Road, Bedford, Ohio 44146.

**GOULD CLEVITE**

INFORMATION RETRIEVAL NUMBER 120

The capacitor manufactured with close control process insures long-term reliability to the telephone communication industry standards. S&EI capacitors are utilized in many telephone line card and repeater circuits, with special purpose circuits for outlying areas that require modified apparatus. Our service to you makes available versatility of design capabilities, quick action on prototype and production needs, with process controls to assure you the confidence of utmost reliability to complement your design criteria. We invite you to call or write to give us an opportunity to demonstrate our service.

**S&EI** Manufacturing/Capacitors  
 18800 Parthenia Street, Northridge, California 91324  
 P.O. Box 832 • (213) 349-4111 • TWX 910-493-1252



INFORMATION RETRIEVAL NUMBER 122

## Micro-Miniature Reed Relays



Coto's New Micro-Miniature Series UM

- Extremely small size: .400" x .300"OD
- Occupies less than 0.03 cu. in.
- Ultra-high speed 100 Microseconds operate time excluding bounce
- Stock voltages 3, 6, 12 and 24 volts
- Available with either leads or pins with 0.2" spacing

Special voltages, resistances, electrostatic and/or magnetic shields available. Write for new Data Sheet MR-9.1



**COTO-COIL COMPANY, INC.**  
 59 Pavilion Avenue, Providence, R. I. 02905  
 Tel: (401) 941-3355

INFORMATION RETRIEVAL NUMBER 123

## NEW LITERATURE



### Precision components

Hundreds of new precision components are listed in a supplemental catalog. It includes miniature speed and motor reducers, ultra-precision gears, slip clutches and couplings, coreless plastic belts, plastic pulleys, portable power supply pulleys, portable power supply clamps and heavy-duty precision gears. In addition, many new fasteners such as metal inserts, Belleville washers, hardened dowel and cotter pins, retainer rings, lockwashers and assortment kits are included. PIC Design Corp.

CIRCLE NO. 458

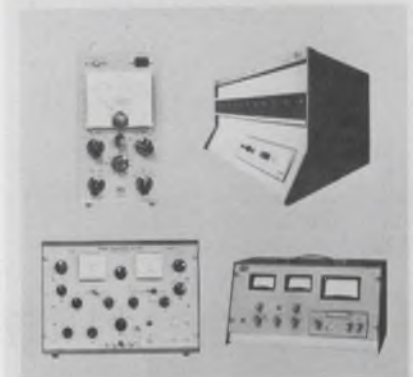


### Data acquisition

A new-generation digital data acquisition system is shown in a 16-page brochure. The entire system consists of a single compact housing containing all IC plug-in assemblies for the systems components. It includes a six-digit numerical display which serves as a time-shared readout for channel identification, time and calendar, and can scan up to 600 channels of analog signals. Lear Seigler, Inc., Cimron Div.

CIRCLE NO. 459

### transistor test equipment



### Transistor testers

Descriptions and specifications of four transistor-testing instruments are included in an eight-page bulletin. One model measures dc parameters of npn and pnp transistors on a go/no-go basis. It also tests many types of diodes, SRCs, and other semiconductors. A second model tests medium and high-power transistors under variable-duty cycle conditions. A third model measures transistor gain under high frequency operating conditions. A fourth model tests basic transistor parameters. Baird-Atomic, Inc.

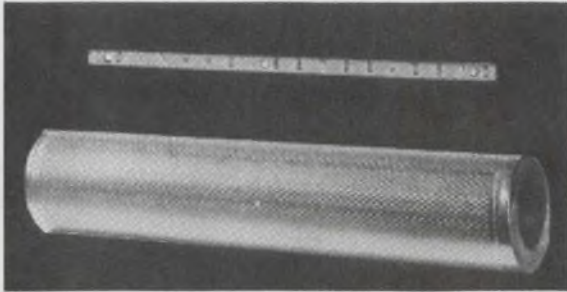
CIRCLE NO. 460

### Connectors

Twelve types of military-specification connectors used in military design are described in a 28-page manual. Categories include printed circuit, power, and communications connectors specified by eight major application specifications, which govern the design of airborne, missile, naval (ship and shore) communications, and test equipment. A tabular index illustrates the connectors and briefly indicates their characteristics and special features. The manual also contains complete descriptions and specifications of all connectors, as well as cross-reference data for QPL items. Elco Corp.

CIRCLE NO. 461

## For the Computer Industry



# Print Bars and Drums

At Buckbee-Mears we etch the entire drum in one operation. Costly assembly problems are eliminated because there are no segments to line up. We are also geared to etch print bars faster at lower costs. Our print drums and bars are made of hardened tooled steel for extra long life.

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INFORMATION RETRIEVAL NUMBER 124

# ENGINEERS

## Telecommunications SAN FRANCISCO BAY AREA

### ■ CIRCUIT DESIGN DEVELOPMENT ENGINEERS

We have openings for Engineers to work in frequency multiplex carrier, pulse code modulation and data development groups.

Responsibilities include electrical design and development of commercial communications products as they apply to microwave radio, trunk and subscriber systems. BS or MSEE required.

### ■ TRANSFORMER & INDUCTOR DESIGNER

Responsibilities include trouble shooting factory problems as well as writing test specifications for components designed. BSEE (or equivalent) required plus a minimum of 2 years experience.

LENKURT IS THE LEADER in the manufacture and development of communications systems for the Telephone, Industrial and Government markets. We offer stable employment with excellent opportunity for advancement . . . exceptional benefits . . . liberal vacation policy — in addition to spacious, modern Engineering Laboratories.

Applicants are invited to send complete resume, in confidence, to: Barrett D. Johnson, Employment Manager

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INFORMATION RETRIEVAL NUMBER 901

ELECTRONIC DESIGN 4, February 15, 1970

# DISPLAY CIRCUIT MODULES

## DYNAMIC FOCUS FUNCTION GENERATOR

FG100



Converts X and Y deflection current samples into parabolic voltage wave forms to maintain beam focus anywhere on the CRT face.

## LINEARITY CORRECTOR

LC101A



Gives on-axis linearity correction for geometric distortion occurring when a flat-faced CRT is used. Ideal for line-scan applications.

## CENTERING COIL CURRENT REGULATOR

CR200



Supplies highly stable constant current to two axes of centering, alignment or static astigmatic correction coils in CRT, storage tube or vidicon systems.

## VIDEO AMPLIFIER

VA105



Linear, featuring high output capability, fast rise and fall time, excellent full power output and bandwidth. Unique damping control.

## STATIC FOCUS CURRENT REGULATOR

SR1000



Provides a fully adjustable constant dc current supply to the static focus coil in magnetically focused systems. Low ripple, adjustable.



*Constantine*  
Engineering Laboratories Company

Mahwah, N. J.  
201-327-1123

Upland, Cal.  
714-982-0215

INFORMATION RETRIEVAL NUMBER 125

**Resistors**

Up-dated technical information on over 35 series of wirewound resistors as well as new advancements in the register field are the subjects of a new 1970 resistor handbook. It contains information on precision, power, special tem-

perature-coefficient, PC, miniature and economy types. Also shown are precision fuse resistors, ladder and summing networks, fast-rise-time, beryllium oxide and aluminum-housed models. An abundance of temperature curves is included. RCL Electronics, Inc.

CIRCLE NO. 462



**Coaxial components**

A new line of precision coaxial adapters and short circuits is contained in a four-page brochure. The new line of low-VSWR broadband adapters are available for IN and Between-series applications at frequencies up to 18 GHz. They comply with type N and proposed SMA specification MIL-C-39012A. The fixed short circuits are designed to provide a reflection coefficient of approximately one when used with the appropriate coaxial mating connectors. Precision Microwave Corp.

CIRCLE NO. 463

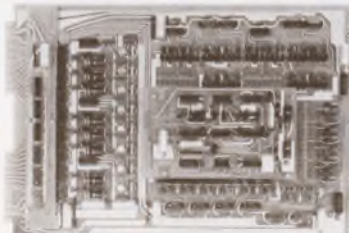


**Rectangular connectors**

Miniature rectangular connectors with crimp removable contacts are featured in a 24-page catalog. It includes a connector line with coaxial 0.0625-in. dia contacts along with a 0.040-in. contact line. An illustrated ordering chart shows each plug and receptacle combination with available hardware and catalog numbers. Detailed drawings, dimensions and tooling requirements are listed with each type of contact, and hand and automatic tooling is described. Burndy.

CIRCLE NO. 464

**Can you use  
1Kx8  
core memory  
systems for  
\$470<sup>00</sup>?  
(Available now)**



*For full information on all the different size UTE Memories at equally attractive prices, write:*

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NCR, Los Angeles, is the largest, fastest-moving commercial computer manufacturing facility in Southern California and one of the most advanced in the world. Here, you can share new fourth-generation challenges with men who have already placed some of the world's most advanced digital systems hardware and software on the market

# NOT SOMEDAY NOW

—people who have pioneered high-speed thin-film technology, advanced disc memories, monolithic integrated circuitry and automatic production techniques. NCR means business in 121 countries. The NCR Electronics Division can mean a non-stop, non-defense, no-limit future for you today.



## MAGNETIC HEAD DESIGN ENGINEERS

To design and develop flying magnetic recording heads and the required prototype tooling. Positions require BS or MS in EE, ME or physics plus three years of applicable experience. Knowledge of ferrite machining technology and ferrite heads desirable.

## ADVANCED DEVELOPMENT ENGINEERS

Positions available for senior MECHANICAL and ELECTRONIC engineers with strong experience in high-speed mechanisms and mechanical, hydraulic and electromechanical systems.

## LOGIC DESIGN ENGINEERS

Senior-level positions in logic design for persons with knowledge in MSI and LSI circuitry for fourth-generation computer systems. Also positions in manufacturing engineering for digital test equipment design. Positions require BSME/BSEE and five years' related experience.

## CIRCUIT DESIGN ENGINEERS

For design and development of LSI circuitry arrays, including detailed circuit design and extending through integrated fabrication. Will also evaluate LSI packaging con-

## BROAD-HORIZON, PRESENT-TENSE, NON-DEFENSE, NON-STOP ENGINEERING AND PROGRAMMING OPPORTUNITIES AT NCR, SOUTHERN CALIFORNIA

cepts and interface with semiconductor vendors. Prefer BSEE and several years of related experience.

## SYSTEMS ANALYST ENGINEERS

Junior and senior level positions available for ENGINEERS, ANALYSTS and PROGRAMMERS who have several years' experience in any of the following areas:

Systems analysis and evaluation of business systems. Selected applicants will determine and participate in the establishment of either small processor systems or a large multi-processing system.

Study and development of on-line systems in business data communication environment.

Evaluation of multi-programming, multi-processor time sharing systems using simulation techniques.

## SOFTWARE PROGRAMMERS

To design, code, de-bug and document operating systems software or on-line executive software modules. Prefer degree in business or a science discipline and/or experience in systems programming.

## DIAGNOSTIC PROGRAMMERS

Positions involve the writing of diagnostic programs for checkout, acceptance test, file maintenance of EDP systems. Requires previous programming experience.

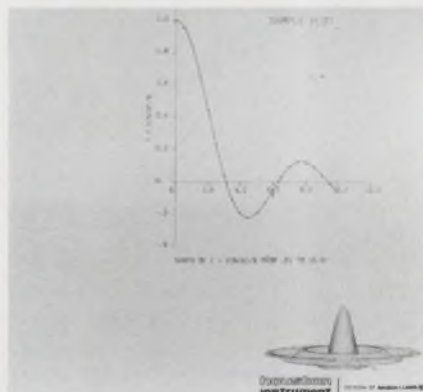
## NOW INTERVIEWING

Positions are open at NCR Los Angeles and San Diego facilities. To schedule an interview in your area or at the IEEE International Convention in New York City, March 21-24, send resume, including salary history, to Steve Williams at the address below.



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ELECTRONICS DIVISION  
2817 West El Segundo Boulevard,  
Hawthorne, California 90250  
*An equal-opportunity employer*

INFORMATION RETRIEVAL NUMBER 902



### BASIC programming

A new BASIC-plotting software brochure attempts to standardize the software required by the user of Complot plotting hardware. It describes in detail the latest version of the BASIC plotting software plus two new subroutines in addition to extensive changes made to existing subroutines. An initialize routine has been added to the BASIC software to accomplish the task of setting the routines to handle the desired computer, plotter, and communications configuration. Houston Instrument.

CIRCLE NO. 465



### Dc components

A four-page short form catalog contains a list of digital panel meters, galvanometer drivers and dual dc power supplies. It also includes dc data, differential and voltage-to-frequency converters. Covered are over 30 models and 12 options of DPMs for dc and ac voltage, current, and ratio, in two, three and four-digit types. Described are dc data amplifiers with models featuring four-pole active filtering, switchable bandwidths, and multiple buffered outputs. Applications for photomultiplier and dc differential amplifiers, ac-to-dc converters and dc power supplies are also included. Newport Laboratories, Inc.

CIRCLE NO. 466



### Connectors

A full line of connectors with 18 different types is included in a new 48-page catalog. Included are printed-circuit, rack-and-panel, side-mount, umbilical and round-keyed shell types. Among the new styles listed is an SHP modular-style PC connector designed to meet requirements of the U.S. Navy's Standard Hardware Program. Also included are two new Edgeboard additions to a PC line for 1/32-in. and 1/16-in. boards with 0.050-in. centers. Complete dimensional information and ordering details on all models is shown. Dale Electronics, Inc. Connector Div.

CIRCLE NO. 467



### Industrial safety

An important safety eyeglass message for the industrial employee is available on an attractive series of 13 bulletin board posters. They are extremely suitable for a continuing year-round safety education program. Each 8-1/2 x 11-in. poster features the case history and photograph of a person who was saved from serious injury because he wore safety eyeglasses. Entitled "The Eye Protection Pay-Off," the series features individuals employed in a variety of industries from the Atlantic to the Pacific. Bausch & Lomb.

CIRCLE NO. 468



**ELECTRICAL/ELECTRONIC ENGINEERS**—Develop and evaluate a wide variety of product concepts, systems, and associated test equipment involving solid state devices, memory systems, control logic, integrated circuits and logic design.

**ELECTRONIC DESIGN ENGINEERS**—Will deal with a wide variety of solid state devices and laboratory test equipment, using basic logic theory to design control logic circuitry. Responsibilities include all phases of electrical layout, packaging and documentation in areas of circuit layout, interconnectors, control systems and components specification. Will involve liaison with vendors, design drafting groups and manufacturing.

**ELECTRICAL DEVELOPMENT ENGINEERS**—Initiate novel approaches for the development of new products and develop and validate product concepts through design, test and prototype evaluation, keeping in mind quantity production. Experience in business machines, appliances, photographic equipment or other precision equipment desirable.

**COMPONENTS ENGINEERS**—Will provide component sourcing, testing and evaluation. Experience should include practical electro-mechanical/electronic design or sourcing work. BSEE or BSME.

**INSTRUMENTATION TECHNICIANS**—Repair, calibrate, test and evaluate standard laboratory electrical and electro-mechanical instrumentation throughout all phases of product development. 2 year AAS degree required in electronics, electro-mechanical or instrumentation technology. Experience will be considered in lieu of degree.



## Xerox: For engineers who think of more than engineering.

It's a custom in some quarters to have a child's first pair of shoes bronzed. Around Jim MacKenzie's house, you're more likely to find pairs of skates in bronze. Thirteen pairs, in fact.

By title, Jim's a Special Assistant to the President of the Business Products Group. Off the job, too, he works hard at a special concern. The development of youngsters... his own and others. It's a sizable task. He and his wife have 13 children of their own (7 girls and 6 boys).

"And they all skate" says Jim proudly.

"Y'see, I was born in Canada where youngsters learn to skate as soon as they can walk. Long ago, I decided that if I was going to work with young people, I might as well do it in an area I was proficient in. That way I could contribute more."

Since Jim arrived in Rochester, he's been active in the Genesee Figure Skating Club and the Junior Lions Hockey Club program. The latter program now has almost 500 boys between 6 and 18 years of age.

"We have all sorts of youngsters in the programs. Not just the deprived ones from

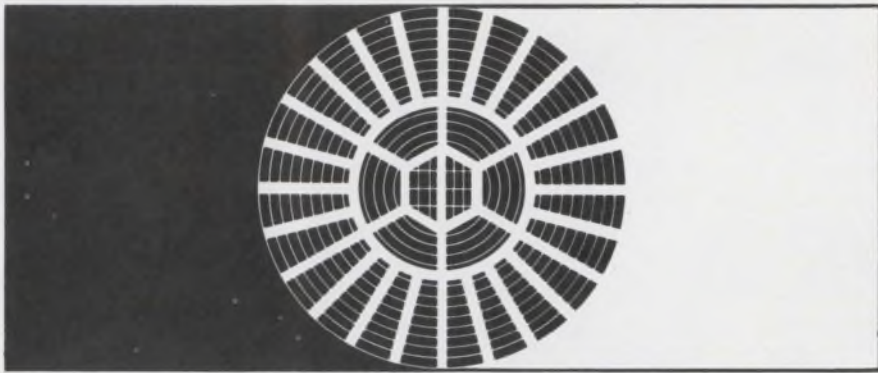
the inner-city area, but also those whose families have monetary advantages. Our programs are open to everybody. I feel it's equally important for all youngsters to develop physically and to build a sense of what teamwork can do not only in sports but in life."

Ask the boys and girls and they'll tell you Jim MacKenzie's quite a guy. We agree.

We like to attract engineers who can see beyond engineering. Who can spot a need and help fill it. Who can put their talents to work for the benefit of others.

If you're this kind of engineer, we'd like to talk to you. Specific openings at our suburban Rochester, New York facilities are outlined at the left. Please forward your resume to Mr. Robert Hines, Dept. MZ-32-B3, Xerox Corporation, P.O. Box 1995, Rochester, New York 14603. An Equal Opportunity Employer (m/f).

# XEROX



## ANTENNA ENGINEERS

Antenna design, development and test including large aperture unfurlable antennas. Background in electromagnetic theory, with experience in the design and development of sophisticated, broadband feed systems. Knowledge of computer programming and applications of computer techniques to antenna problems is desirable. For more information write to Mr. H. W. Bissell, Professional Placement Manager, P.O. Box 504, Sunnyvale, California 94088. Lockheed is an equal opportunity employer.

## LOCKHEED

MISSILES & SPACE COMPANY  
A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION

INFORMATION RETRIEVAL NUMBER 903



## COAXIAL SWITCH

## BEST VALUE



Still the best value and the most reliable. One-five price shown, lower prices in quantity.

Transco Products, Inc., 4241 Glencoe Ave., Venice, Calif. 90291

INFORMATION RETRIEVAL NUMBER 127

## NEW LITERATURE

### Cooling devices

Analyzing and explaining fan-selection criteria is a six-page two-color short-form catalog and engineering-data bulletin for cooling devices for industrial and scientific equipment. Three of the six pages are devoted to a technical exposition of how and why certain design features of a fan affect its reliability and effectiveness as a cooling device. Selection criteria are developed from this theoretical exposition. Also covered is an entire line of subminiature, miniature, and larger fans, grouped according to size, volume of air-flow, or special application. Pamotor Inc.

CIRCLE NO. 469

### Magnetic tape heads

A detailed and comprehensive 24-page catalog presents specifying information for a line of magnetic heads for a number of applications. In addition to detailed technical data and full physical and electrical specifications, it provides comprehensive ordering information and other head selection aids. Design helps incorporated in the catalog include a new cross-reference between OEM and distributor part numbers and a convenient chart of recording track configurations that is suitable for wall hanging. Nortronics Company, Inc.

CIRCLE NO. 470

### Nuclear equipment

A new 16-page catalog contains a wealth of nuclear instruments and materials for sale. It includes such items as nuclear detectors, foils, gloves and boots, isotopes, lead products, license-exempt products, monitors, pipettes and planchets. Also included are pulse-height analyzers, ratemeters, scalars, scintillators, sources and references, survey meters, training systems, vials and warning tags, tapes and signs. All products are shown with photographs, specifications and prices. Nuclear Equipment Chemical Corp.

CIRCLE NO. 471

# Free Career Inquiry Service

## Absolutely Confidential

Respond to the career opportunities advertised in this issue. Fill out and send us this handy resume. **Electronic Design** will do the rest – neatly typed copies of this form will be mailed to the companies of your choice, indicated by the circled Career Inquiry Numbers at the bottom of this page.

4

<b>Name</b>		<b>Home Phone</b>	
<b>Home Address (Street)</b>		<b>City</b>	<b>State</b>
			<b>ZIP Code</b>
<b>Age</b>	<b>U.S. Citizen</b> <input type="checkbox"/> Yes <input type="checkbox"/> No	<b>Security Clearance</b>	

Prime Experience	Secondary Experience

<b>Desired Salary</b>	<b>Availability Date</b>
-----------------------	--------------------------

**Employment History – present and previous employers**

Company	City, State	Dates	Title
		to	
		to	
		to	

**Education – indicate major if degree is not self-explanatory**

Degree	College	City, State	Dates
			to
			to
			to

**Additional Training – non-degree, industry, military, etc.**

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**Professional Societies**

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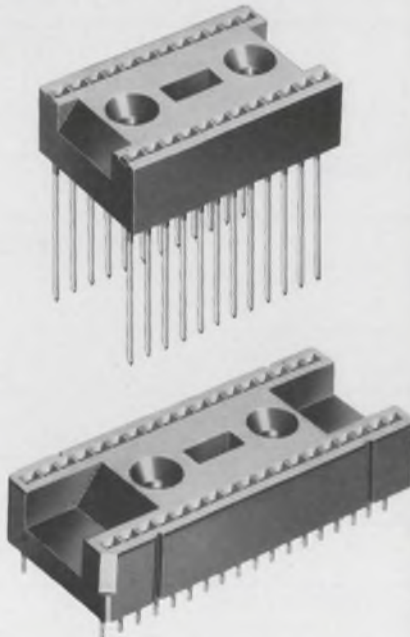
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900	901	902	903	904	905	906	907	908	909	
910	911	912	913	914	915	916	917	918	919	925

**ELECTRONIC DESIGN**  
850 Third Avenue  
New York, New York 10022

# L.S.I. SERIES IC PACKAGING SOCKETS

- Designed for use with 24 and 36 lead I.C.'s on .600" between rows.
- Accepts packages with round or flat leads.
- Contoured entry holes for easy, damage free I.C. insertion.
- Available in Diallyl Phthate with gold plated contacts.
- Wire Wrap or printed circuit termination.

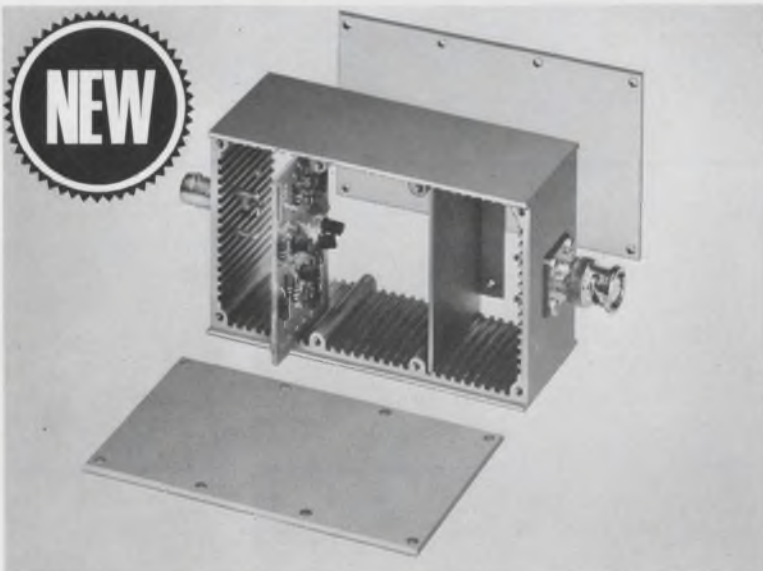


Request Data Sheet 166D

**AUGAT**  
INC.

TEL: 617/222-2202  
31 PERRY AVENUE, ATTLEBORO, MASS. 02703

INFORMATION RETRIEVAL NUMBER 128



## SHIELDED BOXES with CARD GUIDES

Rugged die-cast aluminum boxes, slotted to accept  $\frac{1}{16}$ " circuit boards and shielding dividers. Excellent for packaging electronic circuitry. Boxes have removable top and bottom covers. Useable inside space: 4"x2"x1 $\frac{1}{2}$ ". Several models with various connectors.

Write for 1969 Catalog



**POMONA ELECTRONICS CO., INC.**  
1500 E. Ninth Street, Pomona, California 91766

INFORMATION RETRIEVAL NUMBER 129

## NEW LITERATURE

### Thermistors

Specifically designed for electronic engineers, designers and purchasers is a condensed 12-page thermistor catalog. It includes a selected list of a wide variety of solid-state thermistors, varistors and related components. Tables of characteristics, dimensioned outline drawings, product discussions and operating curves are thoroughly detailed. Victory Engineering Corp.

CIRCLE NO. 472

### Counters

A complete line of electrical impulse counters, accessories and drivers is described in a new six-page catalog. It consolidates information formerly contained in 14 separate technical bulletins. Included is such information as illustrated counter photographs with complete case dimensions, a listing of counters with model numbers and pertinent technical descriptions. Kessler Ellis Products Co.

CIRCLE NO. 473

### Equipment installation

The sound benefits of protection derived from an installation and erection service for electrical power equipment is shown in a new four-page bulletin. It explains the advantages offered by this service such as technical familiarity, assurance of approved assembly, apparatus inspection and on-site updated modifications. Westinghouse Electric.

CIRCLE NO. 474

### Modular program system

The characteristics of an advanced modular programming system are described in a four-page brochure. It contains a complete outline drawing and dimensional information about the individual module. Included are a rendering of system buildup, and diagrams of the shorting pins and diode holders which can be used interchangeably with it. Programming Devices Div. of Sealectro Corp.

CIRCLE NO. 475

## Coding keyboard

A no-bounce coding keyboard that requires no circuit boards or soldered connections is described in a new brochure. The brochure contains a discussion of the keyboard's operating principles, its applications, detailed specifications, features and available options. It also contains photographs and an exploded mechanical view of the keyboard. Mechanical Enterprises, Inc.

CIRCLE NO. 476

## Passive repeaters

Flat ground-mounted passive repeaters is the subject of a four-page booklet. It discusses design loading and stresses of passive repeaters. It also discusses the repeater reflecting face design, supporting structure, erection and alignment. A system block diagram, two data tables for eight and 15-foot repeater models and information on how to order passive repeaters is contained. A discussion of foundations and soil with graphical representations round out the booklet. Microwave Systems Co.

CIRCLE NO. 477

## Metal seals

An economical new extreme-environment metal seal, which is reusable and is designed for counter-bore or fitting applications, is the subject of a 16-page design manual. It details the seal's operation, its temperature and pressure range, materials and plating, flange loading, and sealing surface designs and finishes. Complete seal dimensional information and installation data and dimensions for counter-bore, bolt-head and fitting applications is included. Advanced Products Co.

CIRCLE NO. 478

# Design Data from Manufacturers

Advertisements of booklets, brochures, catalogs and data sheets. To order use Reader-Service Card. (Advertisement)

## Free — Brushless Torque Motor Guide



A comprehensive guide to the Aeroflex line of Brushless DC Torque Motors, DC Moving Coil Torque Motors, DC Tachometers, DC Torquer/Tachometers and DC Torquer Amplifiers. Includes a concise, definitive evaluation of the "Brushless" concept, its benefits and application directions. Complete specification guide of typical types, related performance curves and a "Table of Conversion Factors" provide the Design Engineer of Direct Drive DC Devices with the graphic facts to make specifying decisions.

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South Service Road  
Plainview, L.I., N.Y. 11803

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## Quality Fasteners For All Designs



This 8-page catalog provides design data on the complete group of DZUS 1/4-turn self-locking fasteners for standard, high speed and panel applications, as well as universal high strength multiple thread fasteners for high tensile and shear stresses. Dzus stud assemblies, wire forms and receptacles offer an exceptional, wide variety of combinations from stock to fit specific fastening requirements. Diagrams and tables give full details for rapid, unlimited design selection. Condensed or complete Catalog available on request.

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425 Union Boulevard  
West Islip, L. I., N. Y. 11795

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## CRT AND SHIELD CATALOGS



Two information-packed catalogs are available from Inter-Tech to give you data on CRTs and the shields to go with them. One is a catalog of more than 100 proven-quality British CRTs now available in the U. S. It's a 32-page summary of valuable facts on tubes for: radar, oscilloscopes, data display, and TV. The second brochure gives you data on a complete line of shields. Send for your CRT catalog and you'll automatically receive both.

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## NEW RELAY SOCKET ASSEMBLIES CATALOG



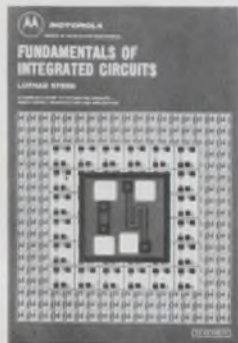
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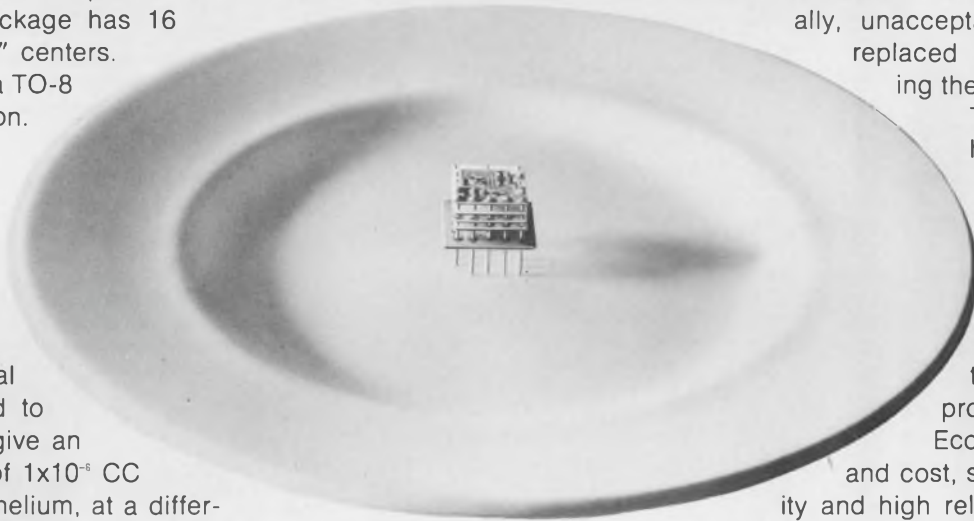
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RCA's ESP (Exceptional Switching Performance) type 2N5805 and its companion 2N5804 are veritable "switch hitters" through an unusual combination of capabilities: *both transistor types have excellent current handling—at high voltage—in economic TO-3 packages.* For example, the 2N5805 can switch 375 volts and 5 amperes in less than 2  $\mu$ s.

You'll find that for efficient and economical power conversions, these two new triple-diffused n-p-n units will excel for use in military and industrial applications.

Rounding out a transistor line that already makes RCA the industry leader in silicon power, these ESP devices—the 2N5804 (formerly TA7130) and 2N5805 (formerly TA7130A)—feature:

- Current capability to 8 A
- Controlled beta at 5 A
- $V_{CEX}$ —375 V (2N5805); 300 V (2N5804)
- $V_{CEO}$ —300 V (2N5805); 225 V (2N5804)
- Fall time—2  $\mu$ s @ 5 A
- Full safe area operating protection

If your requirements are for a high-voltage transistor family that has more than ordinary power, try RCA's new 2N5804 and 2N5805. As switch hitters,

they're ideally suitable for such applications as: switching inverters, switching regulators, converters, solenoid and relay drivers, modulators, deflection amplifiers, and motor controls.

For more information on these and other RCA silicon power transistors, just contact your local RCA Representative or RCA Distributor. For technical information, write: RCA Electronic Components, Commercial Engineering, Section I-G-2-15 / UT6, Harrison, N. J. 07029. In Europe: RCA International Marketing, S. A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

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