VOL. 18 NO. 4

Electronic Design

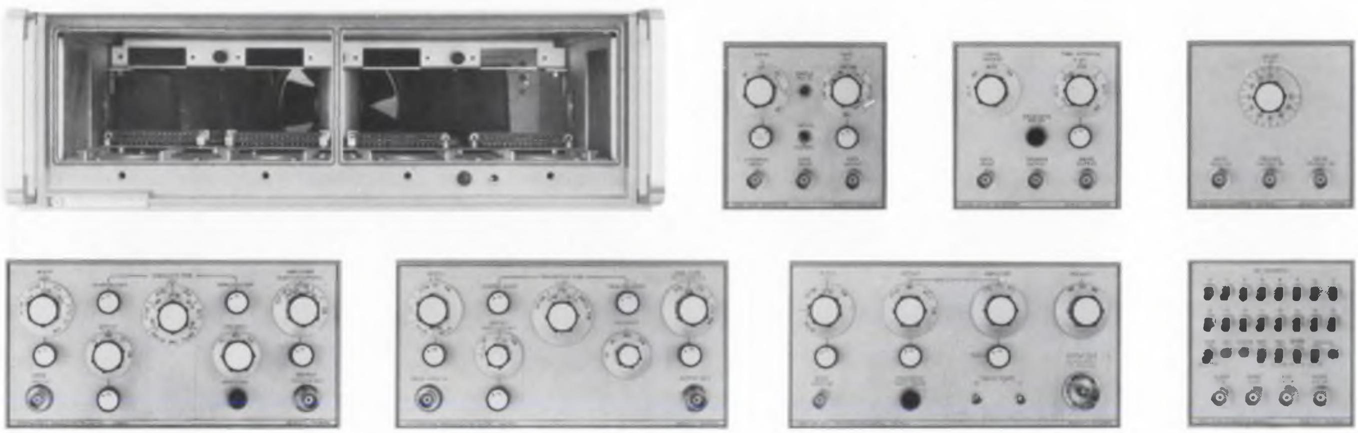
FOR ENGINEERS AND ENGINEERING MANAGERS

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

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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 μs, 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.

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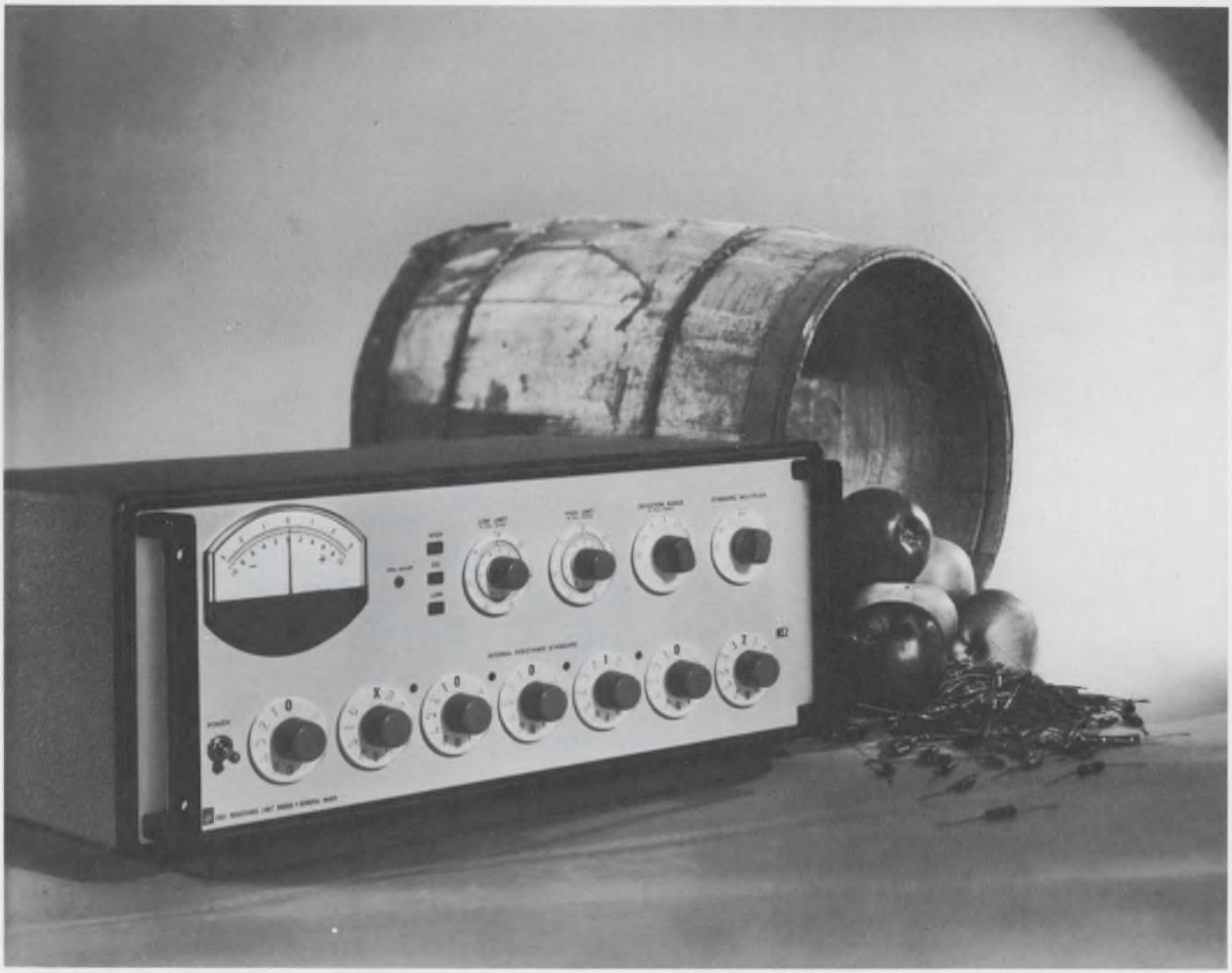
SIGNAL SOURCES



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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

INFORMATION RETRIEVAL NUMBER 2

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.

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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.

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Electronic Design

VOL. 18 NO. 4

FOR ENGINEERS AND ENGINEERING MANAGERS

FEB. 15, 1970

NEWS

TECHNOLOGY

PRODUCTS

Departments

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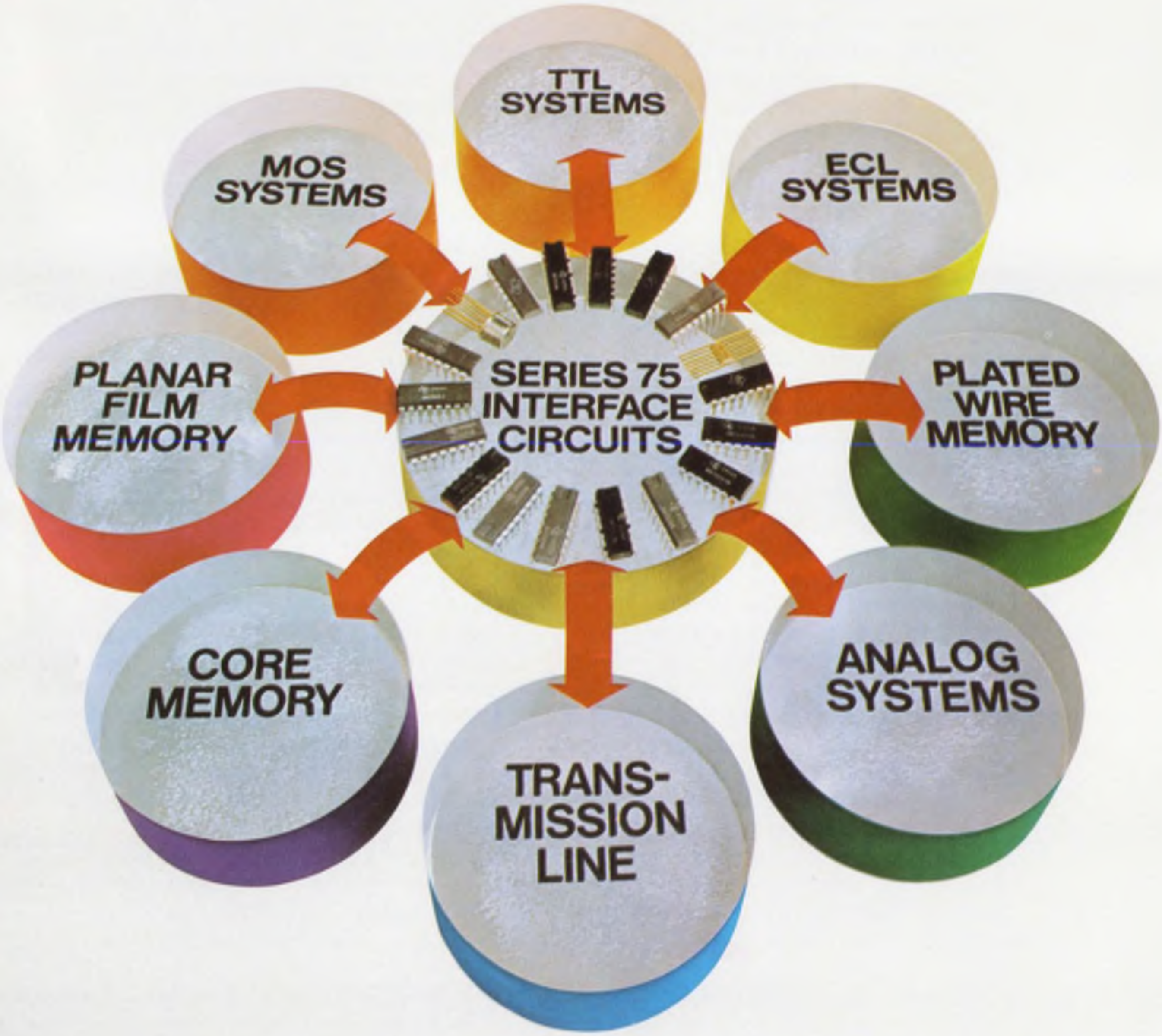

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We'll include a data sheet on the state-of-the-art MLED600.

Both should be seen to be appreciated.

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—where the priceless ingredient is care!

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INFORMATION RETRIEVAL NUMBER 8

Designer's Calendar

MARCH 1970

S	M	T	W	T	F	S
1	2	3	4	5	6	7
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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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19	20	21	22	23	24	25
26	27	28	29	30		

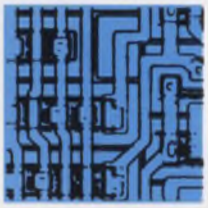
Mar. 31-Apr. 2
International Symposium on Submillimeter Waves (New York City) Sponsor: IEEE et al. J. Fox, Microwave Research Institute, Polytechnic Institute of Brooklyn, 333 Jay St., Brooklyn, N. Y. 11201

CIRCLE NO. 322

Mar. 31-Apr. 2
Symposium on Law Enforcement Science and Technology (Chicago) Sponsor: U.S. Dept. ot Justice. IIT Research Institute, Law Enforcement Science & Technology Center, 2024 West St., Annapolis, Md. 21401

CIRCLE NO. 323

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.

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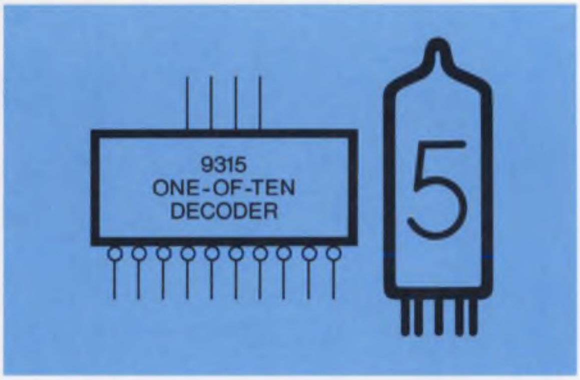

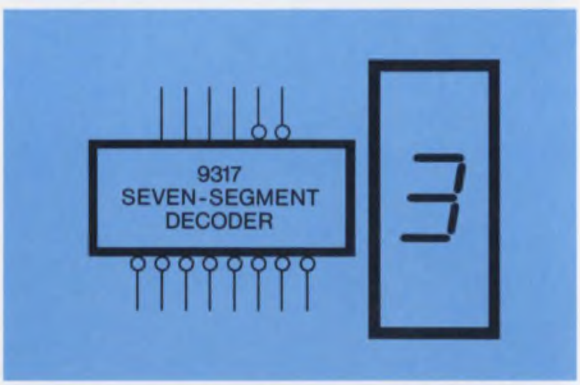

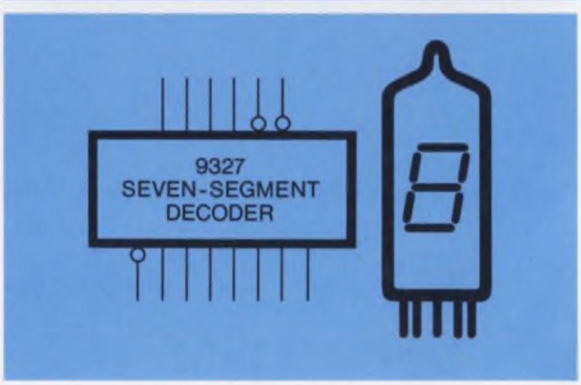

*NIXIE is a registered Trademark of Burroughs Corporation.
**DIGIVAC S/G is a registered Trademark of Wagner Electric Corporation.

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

PART NUMBER	PACKAGE	TEMPERATURE RANGE	PRICE (1-24)	(25-99)	(100-999)
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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.

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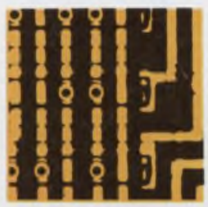
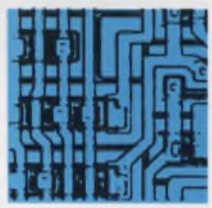
LATCHES
9308 – Dual 4-Bit Latch
9314 – Quad Latch

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 – Hexidecimal Counter

ENCODERS
9318 – Priority 8-Input Encoder

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INFORMATION RETRIEVAL NUMBER 10

NOW...
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For instance, the voltage ranges cover from 0.005 to 600 V DC in 6 steps at 10 megohms and 0.1 to 600 V AC in 5 steps at 5,000 ohms per volt . . . 4 resistance ranges from 1 ohm to 5000 megohms with 50 ohms at the centerpoint of the low resistance scale . . . current in 2 ranges from 0.002 to 1.2 mA DC. With its optional clamp-on ammeter attachment, the Model 310-FET will read AC from 0.2 to 300 A in 6 steps. Accuracy on DC ranges is 3% . . . 4% on AC.

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Value? It's priced at only **$74** suggested USA user net, and it's available right now at your Triplett distributor. Ask him or your local Triplett sales representative for a demonstration. Triplett Corporation, Bluffton, Ohio 45817.

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INFORMATION RETRIEVAL NUMBER 11

INFORMATION RETRIEVAL NUMBER 191 ►

MOS BRIEF 9

John Vennard
National Semiconductor

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 capacitive coupled.

When it is direct-coupled as shown in Figure 2 (most people use it capacitive coupled), the NH0009 will follow the input. That is, the driver output will remain at the MOS "1" level (near V2) for as long as the input is at the TTL "1" level. The output will be MOS "0" (near V3) 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-

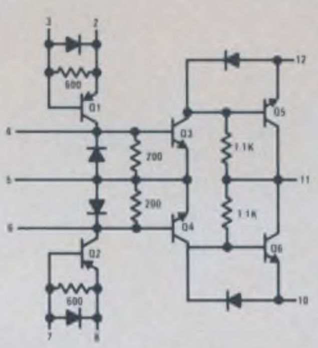

FIGURE 1. NH0009 Dual MOS Clock Driver

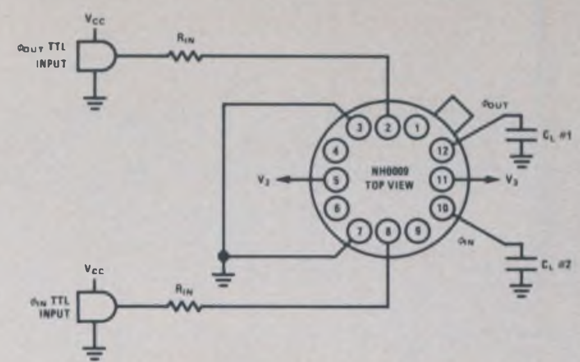

FIGURE 2. Directly Coupled Dual Driver

Characteristics of National MOS Clock Drivers

TYPE	PACKAGE	OUTPUT PHASES	INPUT COUPLING	INPUT LEVEL TRANSLATOR	MAX REP RATE–MHz	MAX OUTPUT SWING–V	I_{OUT}–mA	P_{MAX}–mW @25°C/@70°C	P_{OFF} 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

MOS BRIEF 9 MOS CLOCK DRIVERS Write: National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, California 95051

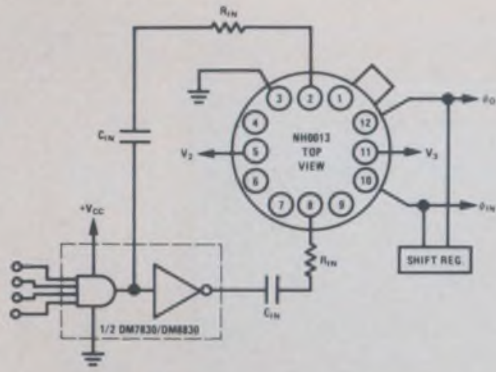

FIGURE 3. Capacitively Coupled Dual Driver

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

$$\text{P.W.} \;\alpha\; C_{IN} \times V_{drive}/I_{drive}$$

As soon as the input rises about 0.5V, the output is driven to the MOS "1" level (V2). The output returns to the MOS "0" level (V3) 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."

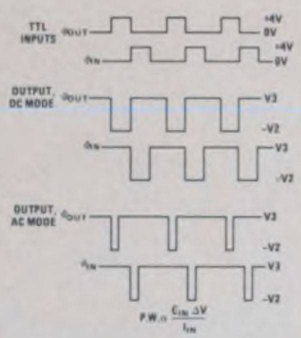

FIGURE 4. Waveforms, Each Half of Dual Driver

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	$V_2 = -16V$
t_r = 50 ns	$V_3 = 0V$
P.W. = 200 ns	$T_A = 70^\circ C$
$V_{CC} = +5V$	

where t_r is the rise time and P.W. the pulse width of the input signal.

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

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

The only significant P_{dc} in National's two-phase drivers occurs during the "1" output, so P_{dc} in half a direct-coupled NH0009 is

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

where I_{IN} from the TTL driver averages 20 mA and R_b is the output collector load resistor of 1.1 kΩ. Therefore,

$$P_{``1"} = (21 \times 20 + 16^2/1.1) \times 0.4 \times 10^{-3}$$
$$= 261 \text{ mW}$$

This allows P_{ac} 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 $P_{``1"}$ is only 125 mW and P_{ac} can be 375 mW. In all drivers,

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

where C_L 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 $C_{L(max)}$ would be 1,875 pF at $V_2 = -16V$, $V_3 = 0V$ and $t_r = 50$ ns. Techniques such as lowering the duty cycle or making both V_3 and V_2 more positive can be used to work C_L up toward $C_{L(max)}$. But don't exceed it (a precaution that has sometimes been overlooked on the data sheets of rival devices).

National Semiconductor Corporation
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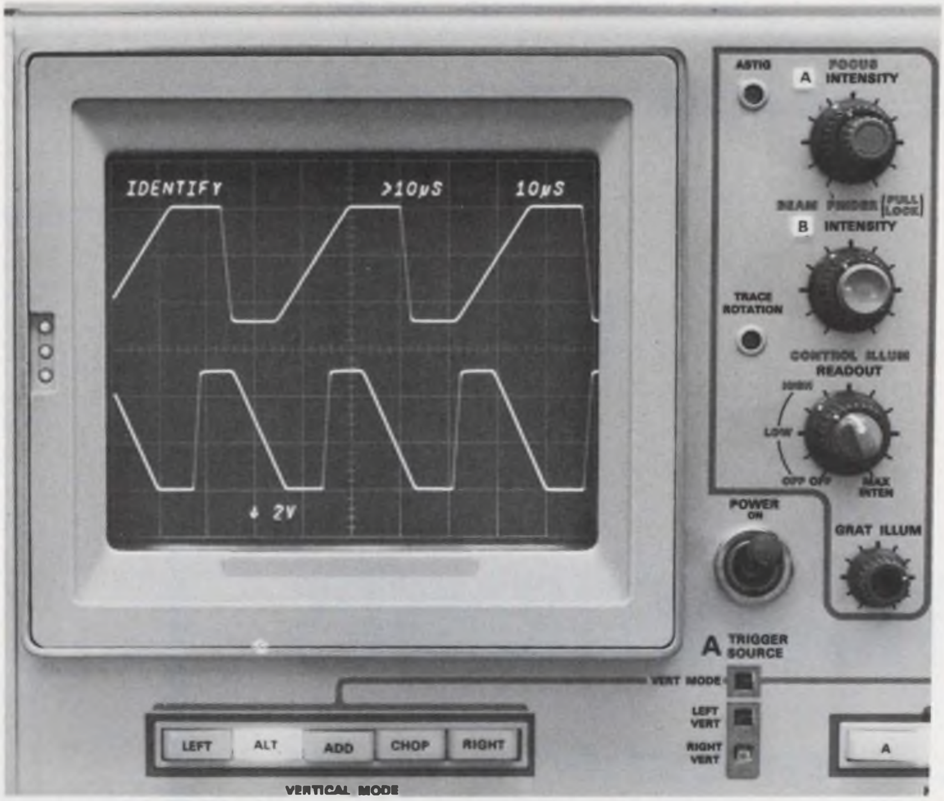
Auto Scale-Factor Readout



means faster measurements with fewer errors

The New Tektronix 7000-Series Oscilloscope System has AUTO SCALE-FACTOR READOUT—just one of many new convenience features which refine waveform measurement ease. Auto Scale-Factor Readout labels the oscilloscope graph with deflection factors and sweep speeds, invert and uncalibrated symbols, and identifies the trace and its data. When magnified sweeps and the New P6052 or P6053 10X probes are used, the readout is automatically corrected. Press either a probe-tip or front-panel switch, the trace shifts vertically and its deflection factor is replaced by the word IDENTIFY to associate waveforms with scale factors. Scale factors of *inverted* and *uncalibrated* displays are prefixed by invert (↓) and uncalibrate (>) symbols. Now, you can forget the inconvenience of hand labeling photographs. With AUTO SCALE-FACTOR READOUT you look in only one place for accurate data. On the CRT where it's displayed automatically . . . with the waveforms!

New Convenience, a Wider Performance Spectrum, and Four Plug-In Flexibility are some factors which make the New Tektronix 7000-Series Oscilloscopes an asset to your measurement capabilities.

Prices of Instruments shown:

7704	DC-150 MHz Four Plug-In Oscilloscope	$2500
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7A16	Single Trace Amplifier Plug-In	$ 600
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Note: 7504 DC - 90 MHz Four Plug-In Oscilloscope with Auto Scale-Factor Readout $2000

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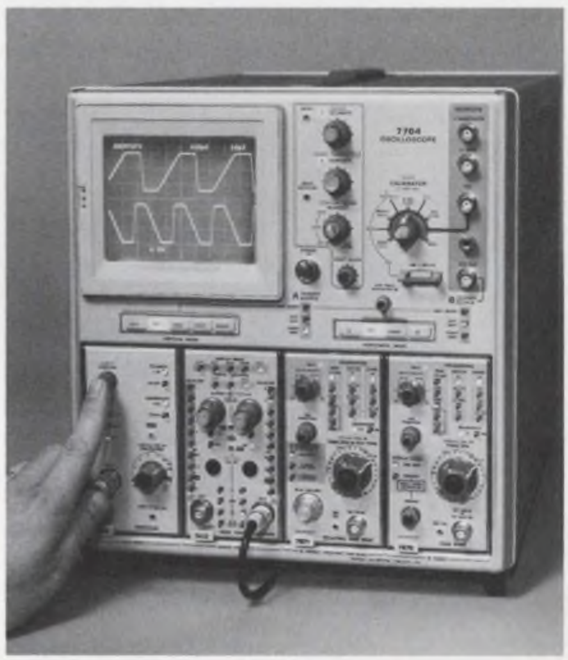
For information, call your local Tektronix Field Engineer or write: Tektronix, Inc., P. O. Box 500, Beaverton, Oregon 97005.



The Readout System presently displays up to 49 symbols and responds to various functional instructions. Less than half of the symbols are needed for today's plug-ins.

Tektronix, Inc.

committed to progress in waveform measurement

INFORMATION RETRIEVAL NUMBER 12

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

INFORMATION RETRIEVAL NUMBER 14

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 antimissile 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 increases 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 minicomputer market with two 8-bit models. The CIP/2000 is a microprogrammable, 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 possibiilty 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-improvment 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, Fabrimental, 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 "bluebook 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 MSEEs—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.

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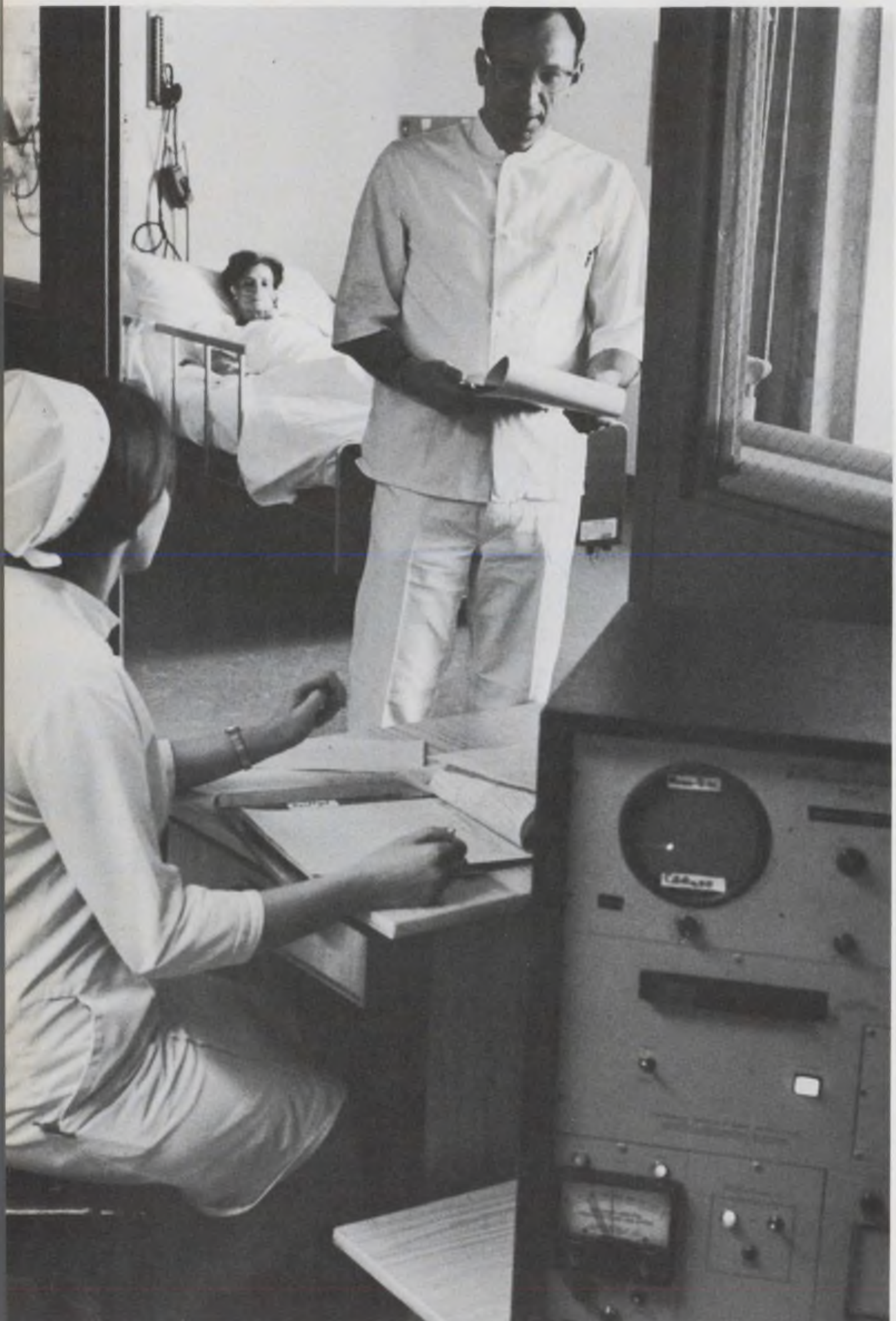
John N. Kessler, News Editor



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

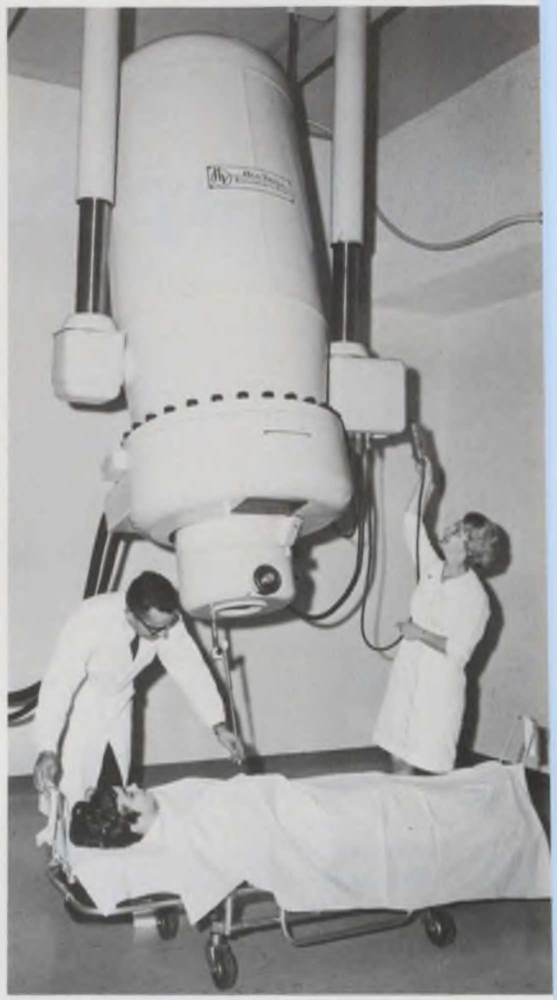
At least five types of electronic equipment are available in ICU, and each can have a significant bearing on whether or not a patient will recover:

- **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 ±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 and a slave scope in the nursing station. A high-low alarm pulsemeter 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-pacemaker 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 food 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.

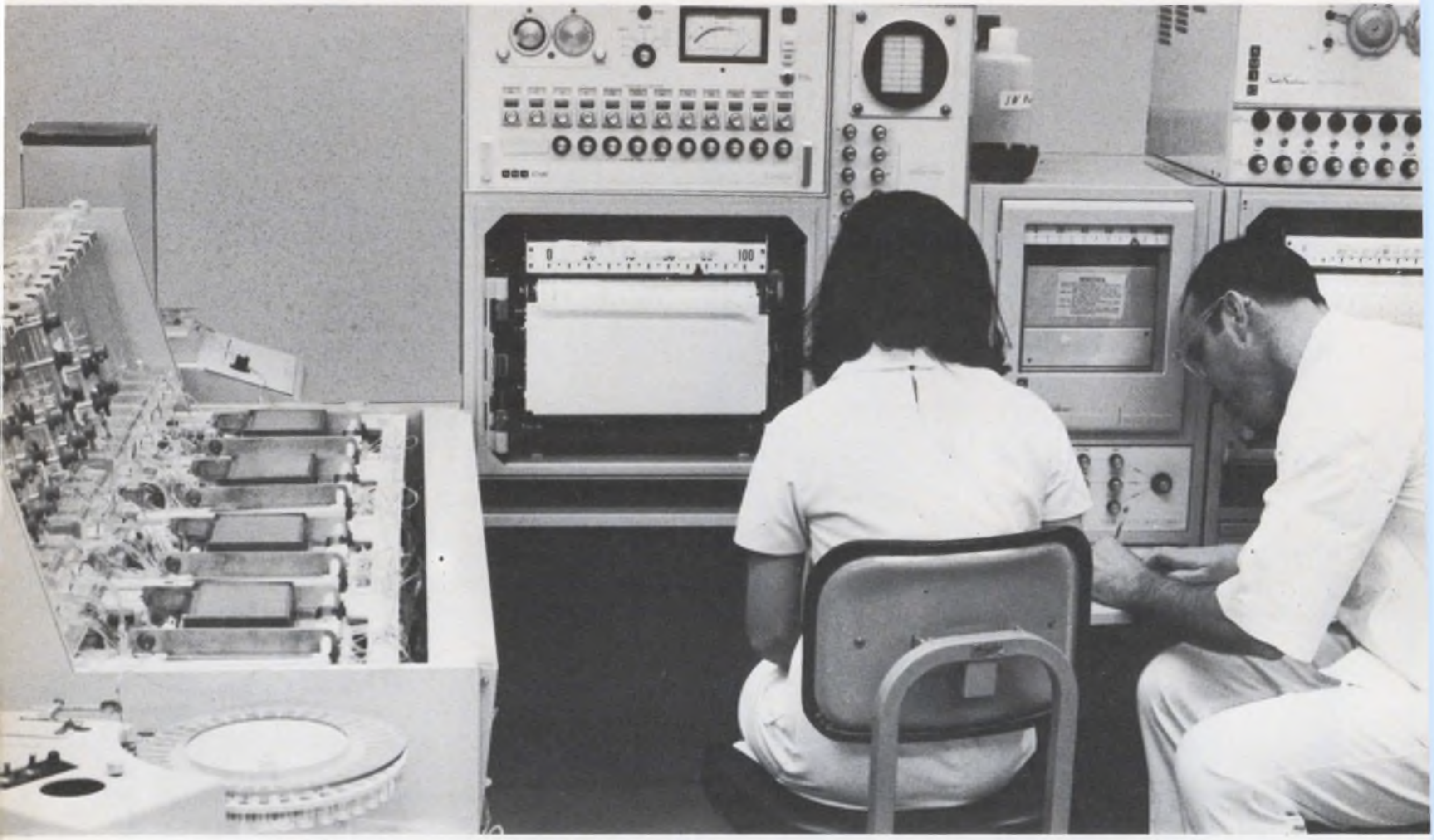
11 a.m. Next to one wing of operating room is a small darkroom. Joseph Barefoot, chief inhalation therapist, is developing a paper roll containing an EKG and a phonocardiograph. Both tracings are made by light beams scanning photosensitive paper. "Light beams—rather than a pen recorder—are used," says 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 breaths 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_2 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.

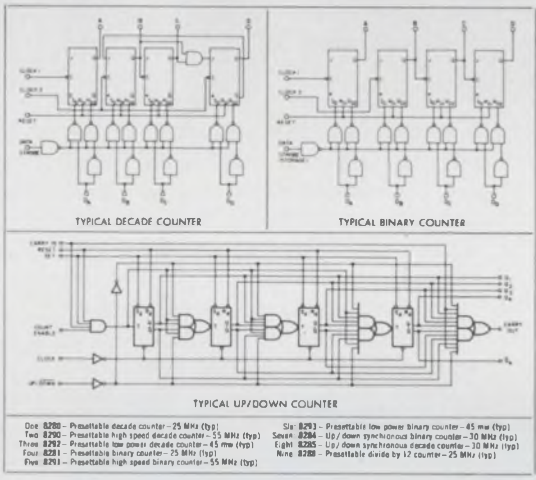
"But," says Heinlein, "we're not biomedical engineers. We have a difficult time evaluating equipment. The purchase of new electronics is decided on by a committee of doctors and nurses who will be using it.

"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. ■■

The little things that count.



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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.

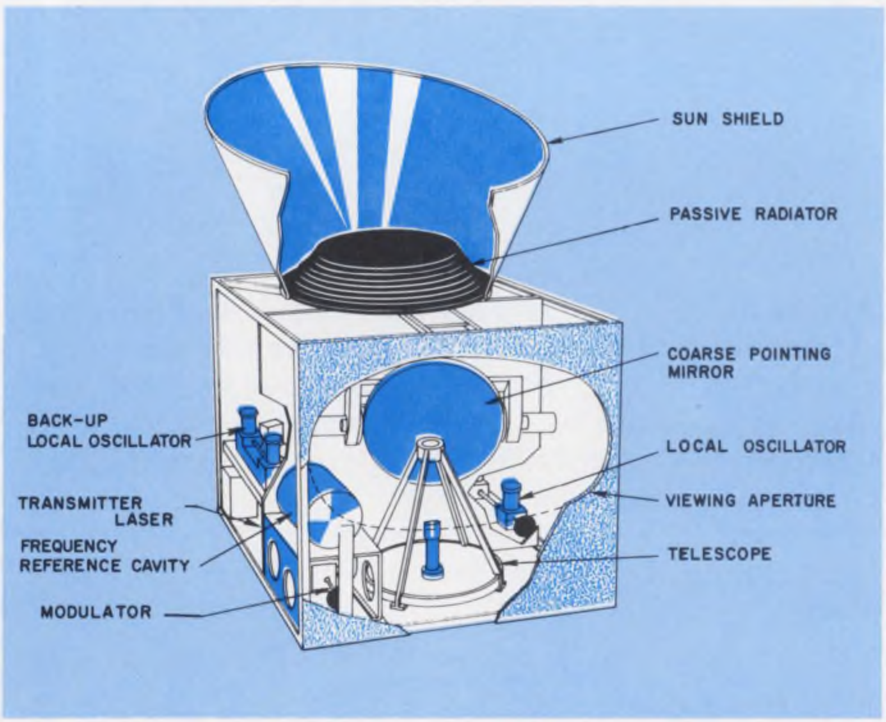
The system will employ CO_2 lasers. The output power of the transmitter laser will be 547 mW at a transmitter wavelength of 10.6 microns (P-20 line). A 5-cm GaAs piezoelectric crystal in the laser cavity will be used to modulate the laser. The modulation will be fm, with a signal bandwidth of from 30 Hz to 5 MHz.

If the system is successful, it will make possible the first broadband, 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_2 laser subsystem.

"CO_2 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_2 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 systems. In addition the bonus of greatly increased bandwidth may one day enable deep-space transmission of live television pictures over millions of miles.



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

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^{-12} W in a 10-MHz bandwidth. The receiver signal-to-noise ratio will be 23 dB. ■■

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. ■■

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 suprising 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."

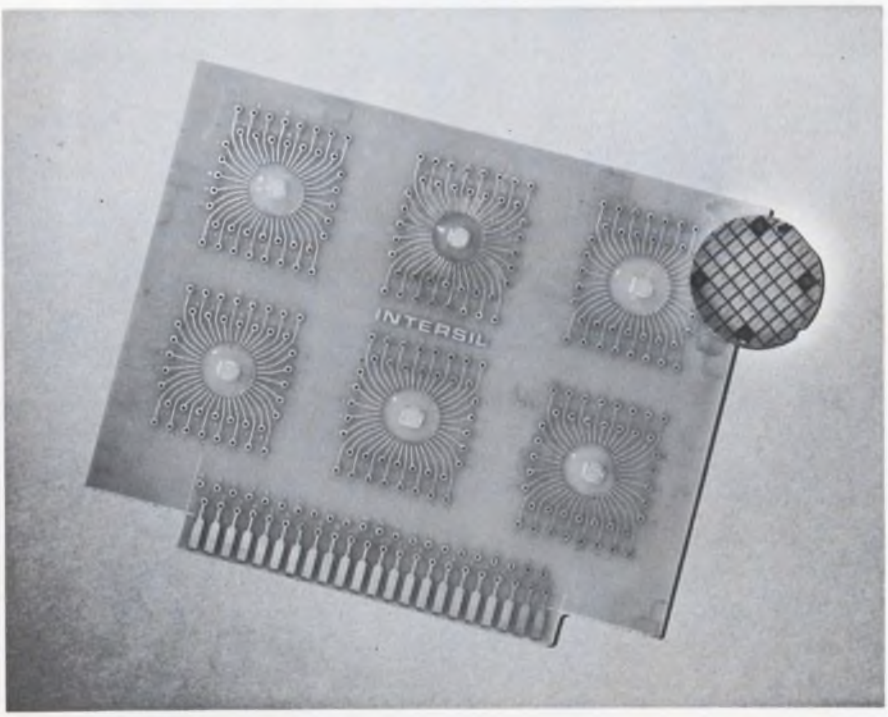
A packaged system of this type has to be custom, says Rogers, because every customer has different system needs. To produce it at the lowest possible cost, Intersil works with its systems customers from the early conceptual stages.

"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 × 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 × 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 Circuit 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

IDEAS

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.

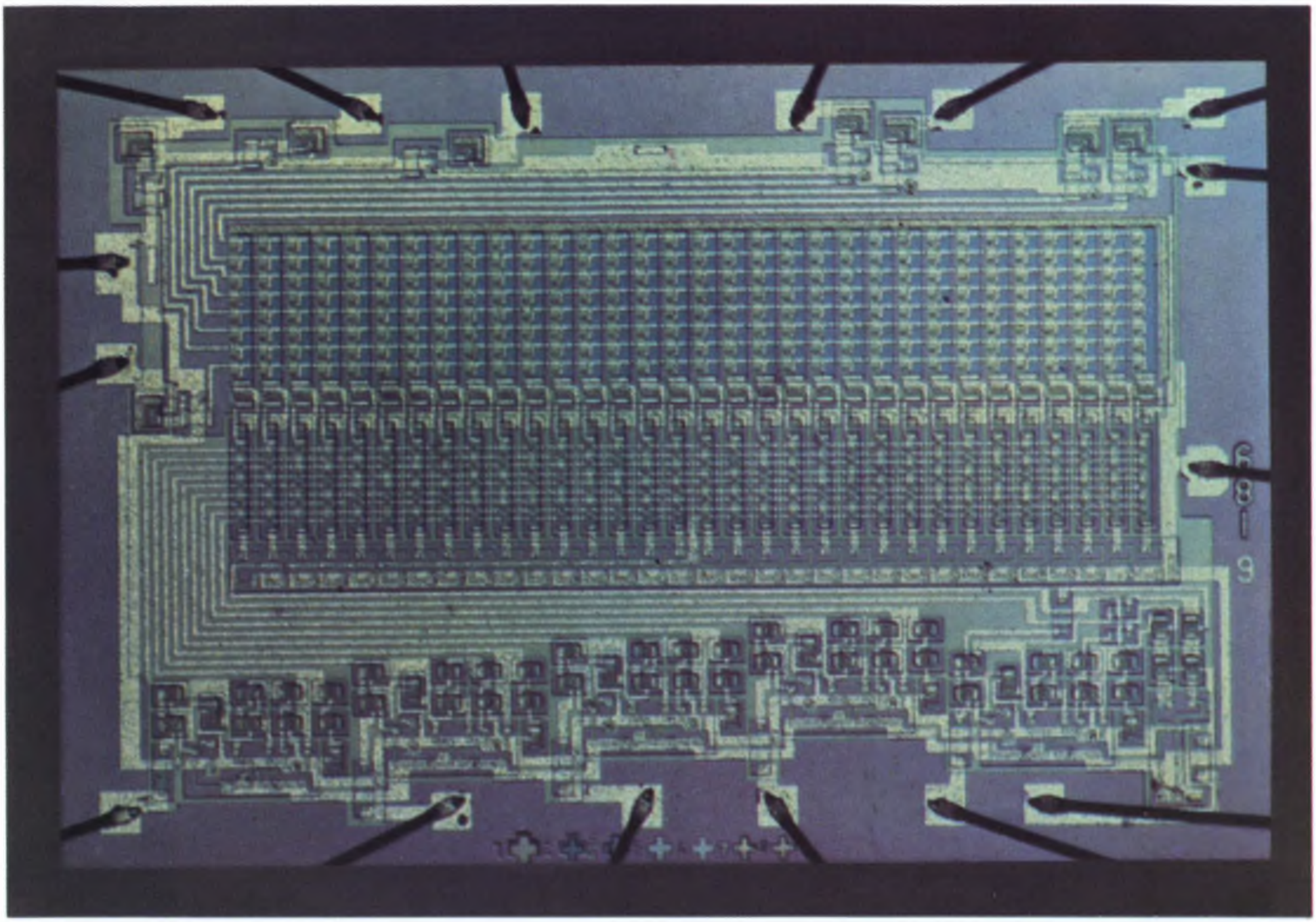
In a larger system using more than one device, the chip enable can be used to select individual units or groups of units. In this manner, for example, data in multiples of 8 bits can be sequenced onto a serial bus line. Decoding of appropriate units, as in character generation, can also be implemented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

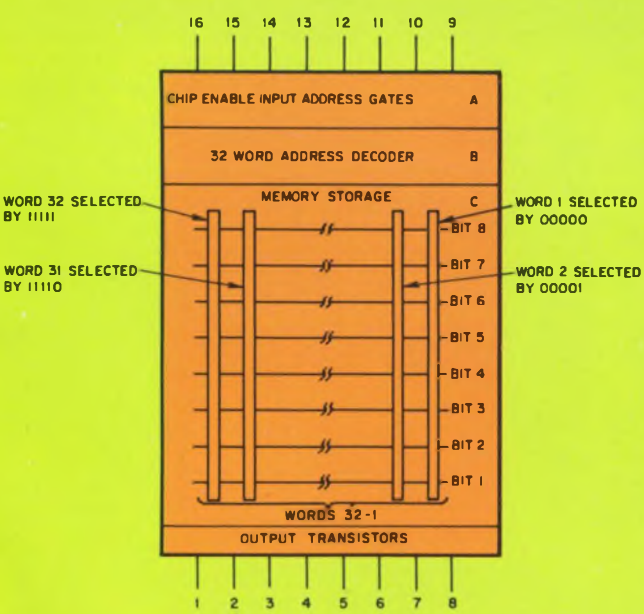


Fig. 1. Organization of SM-320 read-only memory in block form.

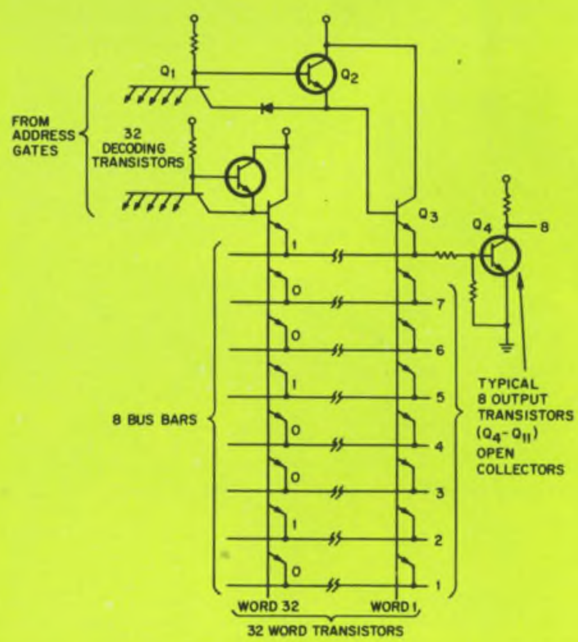


Fig. 2. Circuit configuration of SM-320 read-only memory.

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	Remarks
Pre-seal Visual Inspection	100% (91-928)	100% (91-917)	Sample (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 10-8 cc/sec. (91-163)	5 x 10-8 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)* Reliability Level A	B	Std.	Remarks
Electrical Verification				Conditions and limits on test spec sheet for appropriate type
DC at 25°C	5 / 2	10 / 3	10 / 3	
AC at 25°C	5 / 2	10 / 3	10 / 3	
DC at High Temperature	10 / 3	Not Required	Not Required	
DC at Low Temperature	10 / 3	Not Required	Not Required	
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)

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

Table 3. Design Assurance Tests (for information only)

Test	Acceptance Criteria per Subgroup LTPD/a (max)* Reliability Level A	B	Std.	Remarks
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

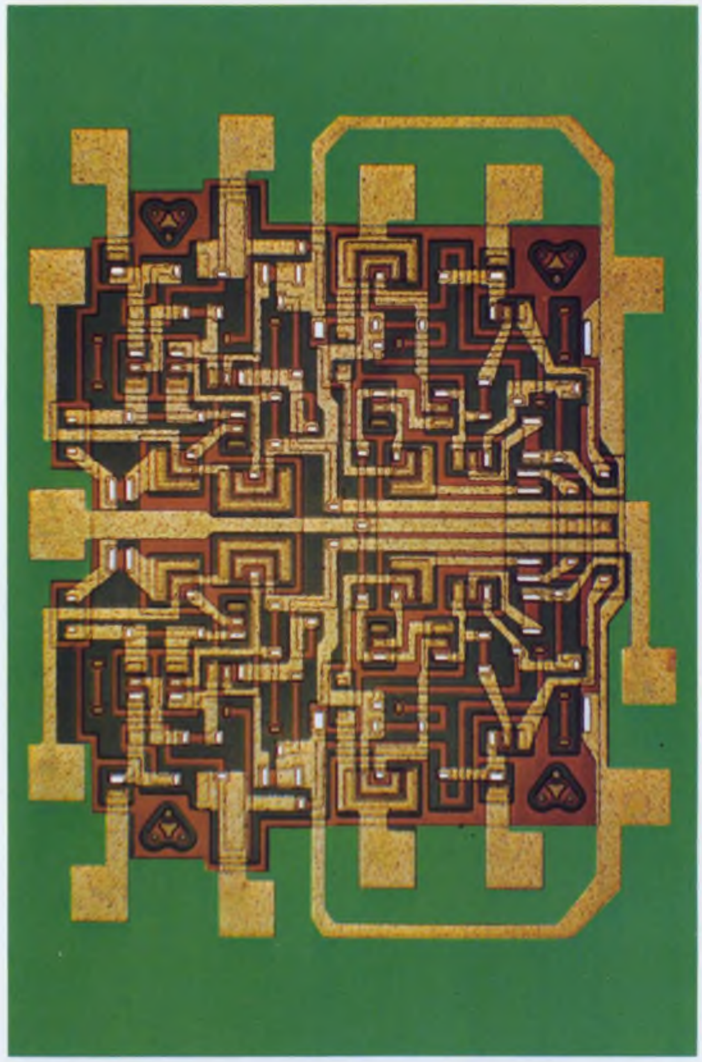
Interface family solves transmission-line noise problems.

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.

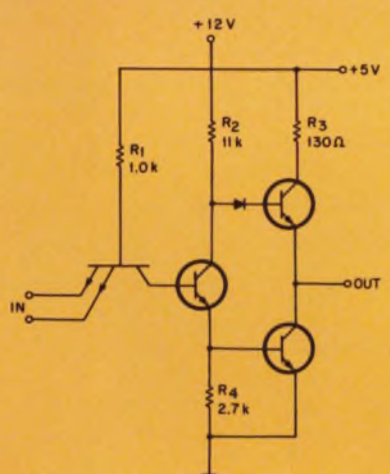


Fig. 1. Single transmitter unit of quad logic-level driver.

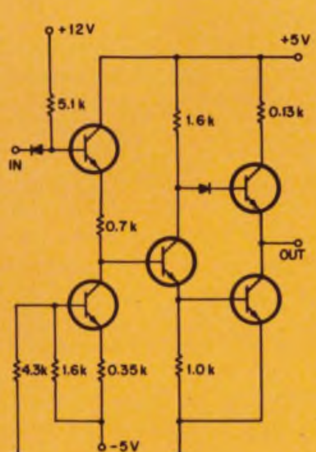


Fig. 2. Receiving element used in quad logic-level receiver.

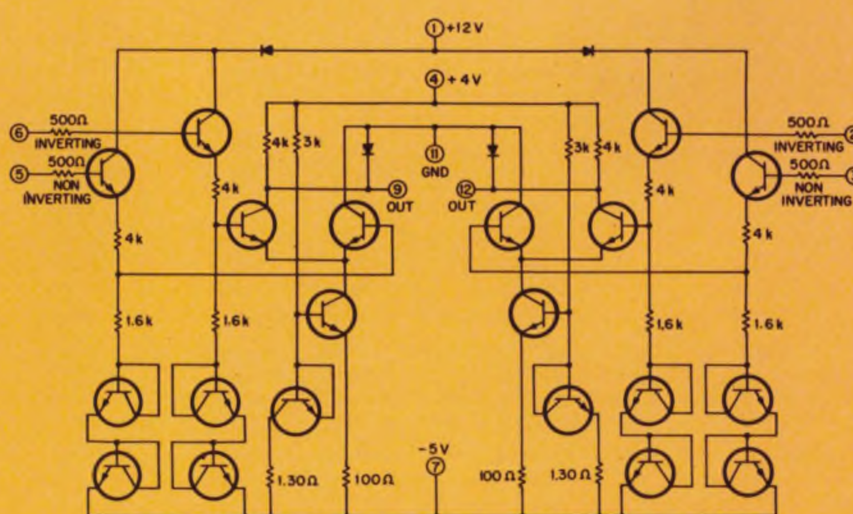


Fig. 3. Complete circuit of dual differential receiver.

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 μA 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, $\overline{Q}$ 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

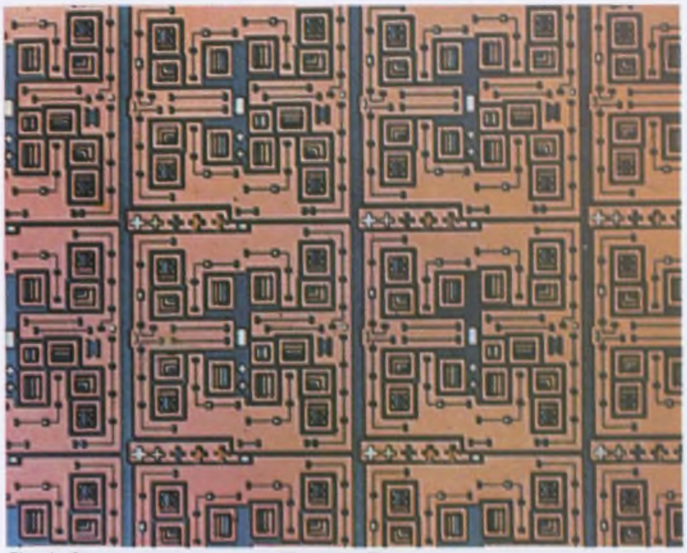


Fig. 1. Section of an uncommitted Uni-Cell wafer ready for metallization.

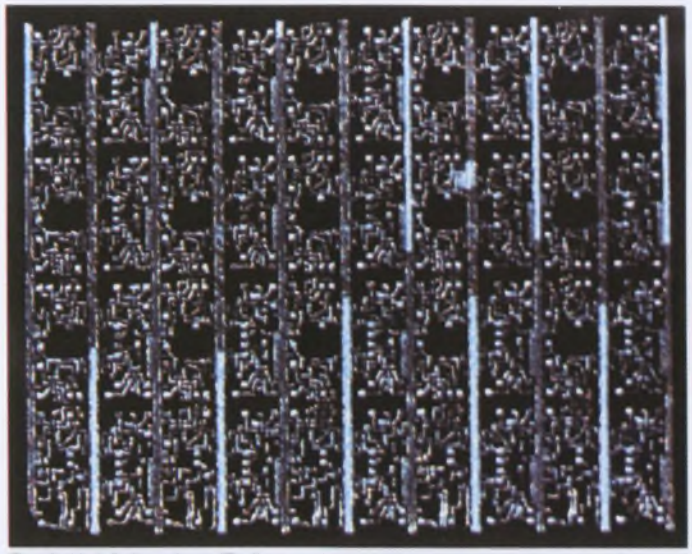


Fig. 2. Uni-Cell wafer with first and second metallization steps completed.

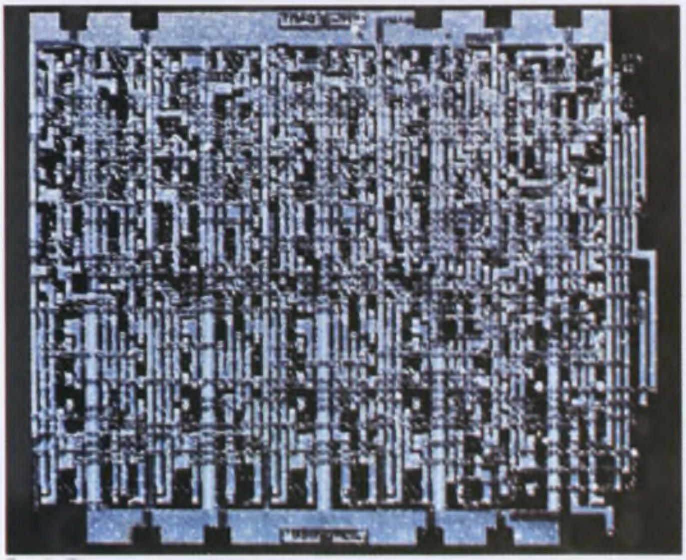


Fig. 3. Third metallization step brings connections out to bonding pads.

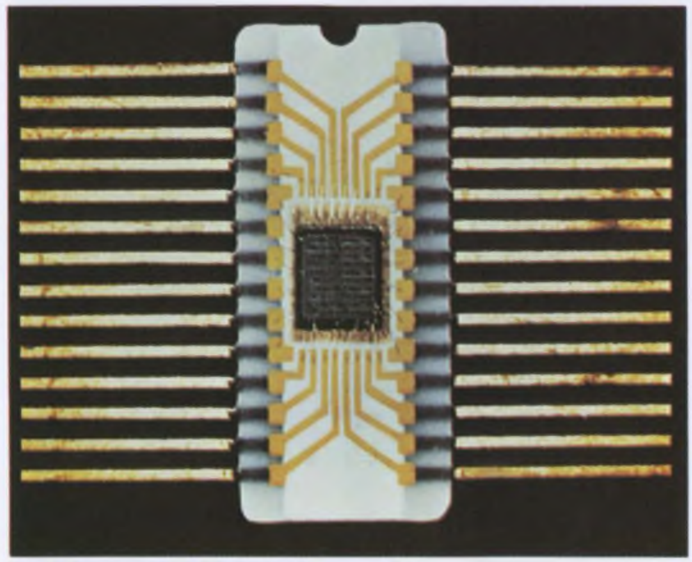


Fig. 4. Completed Uni-Cell circuit mounted in 28-lead package ready for testing and capping.

Fold and seal with tape or glue. (Do not staple.)

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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, thermocompression 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

H. K. Ishler
Director, Integrated Circuit Engineering

This information in Sylvania ideas is furnished without assuming any obligations.

No other multimeter gives you all this

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

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INFORMATION RETRIEVAL NUMBER 18

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 nonresonant electronic attenuator that passes signals from 10 Hz to 40 kHz, with essentially zero phase shift.

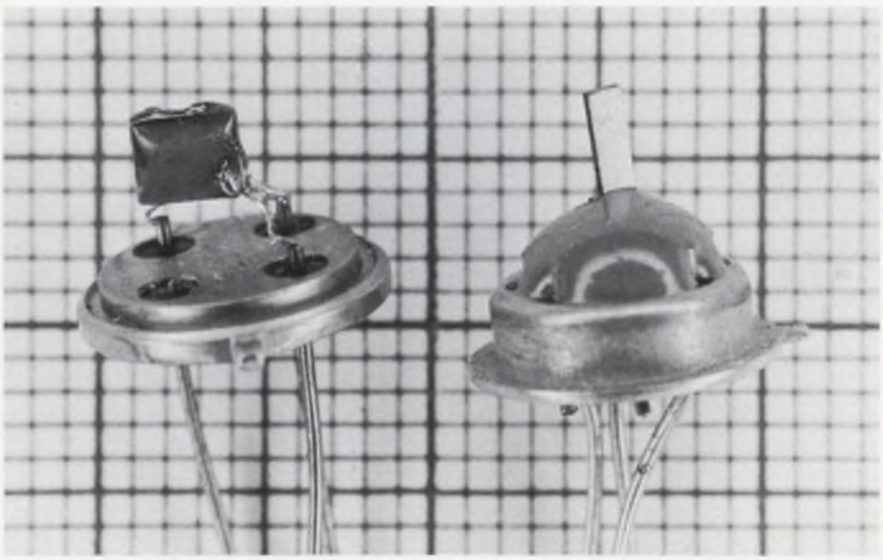
Both devices are of sandwich construction, similar to the familiar Bimorph phonograph cartridge element, and they should sell for less than a dollar when eventually produced in quantities, according to RCA.

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.)

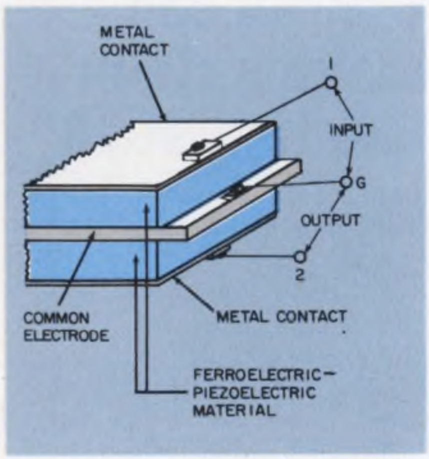
When a signal is applied to the input wafer, it vibrates because of its piezoelectric properties, and these mechanical vibrations are transmitted to the second wafer, which converts them back to an electrical output signal.

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.

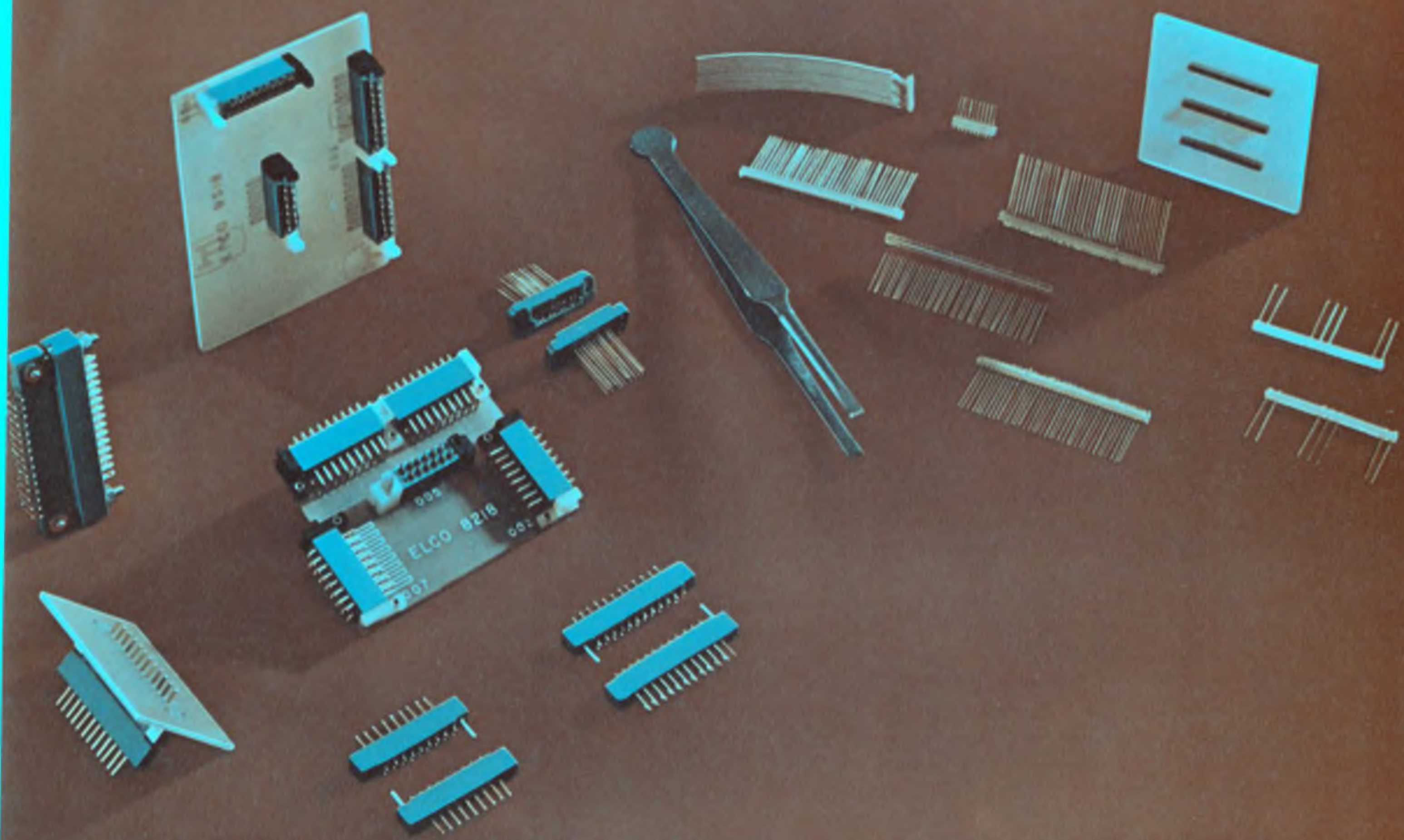
But polarization of this type of material can be changed by apply-



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.


ELCO 8216

(**adaptive device,** *continued*)

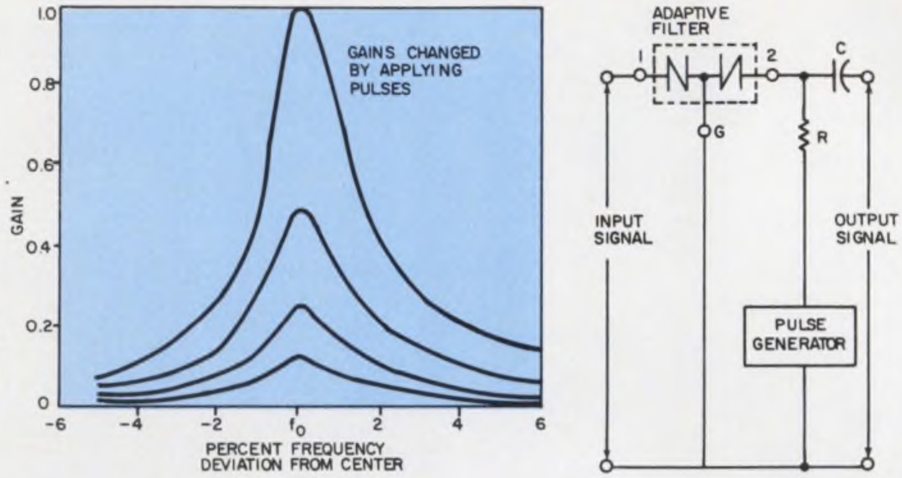
ing 100 to 300-V pulses. For one polarity of the pulses, the polarization is increased, while reversing the pulse polarity reduces the polarization. By pulsing either the input or the output side (or both) of the wafer, the gain of the device can be set to either maximum or minimum attenuation or anywhere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



2. Gain of adaptive filter is changed by output of pulse generator. The higher the voltage, the greater the change. The effect is reversible.

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 from its audio response unit.

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

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. ■■

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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.

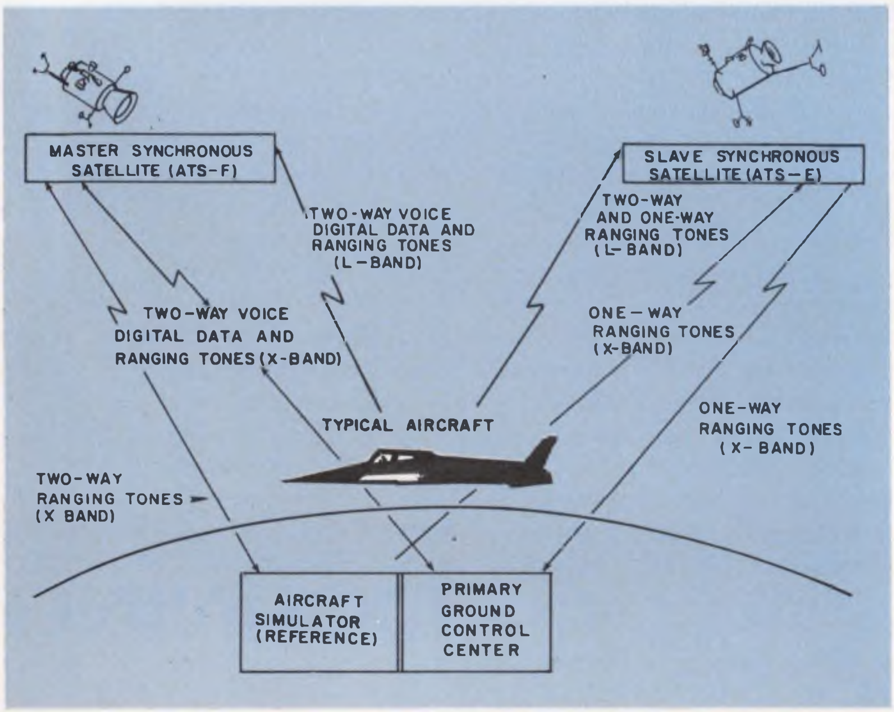
The satellite effort involves the PLACE (Position Location and Aircraft Communications Equipment) concept and is being directed by the Goddard Space Flight Center, Greenbelt, Md. Initial tests were to begin late last year, using L-band relay and ranging techniques through Applications Technology Satellite-V.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



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.

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-

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.

ATS-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.

ATS-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. ATS-VI will carry a 30-foot-diameter deployable dish with a 28-dB gain. The ATS-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 measurment 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 ATS-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 side-tone 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 side-tones 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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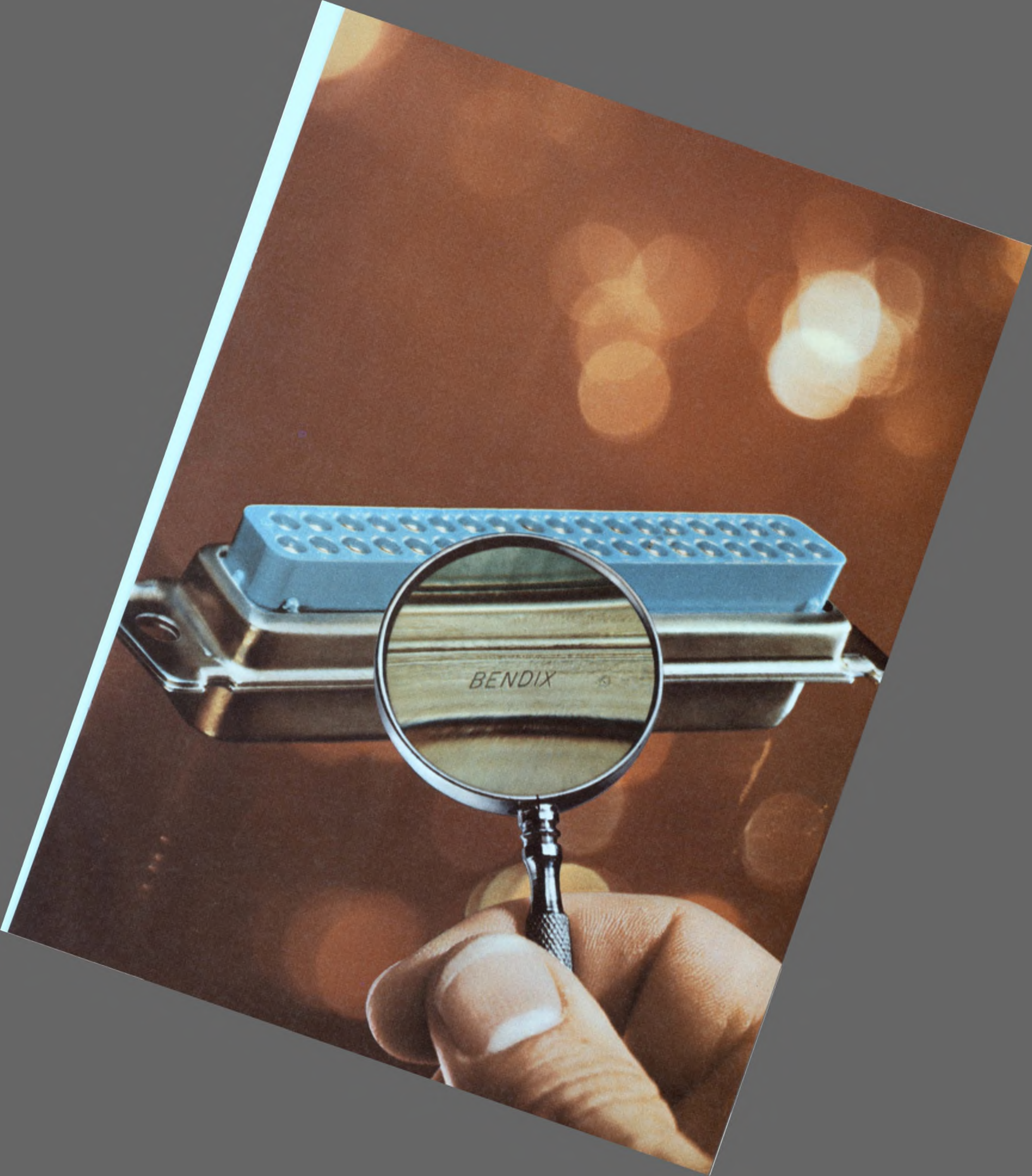
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Washington Report

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 Washingon 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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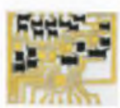

Centralab's new thick film chip hybrid

PECs are still being used extensively for industrial, military and consumer applications. But continued technological developments have brought a new degree of sophistication to the art of thick film microcircuitry. So we've developed our new thick film chip hybrid microcircuits. Chip active devices — diodes, transistors, and ICs — are combined with fired on resistors, wiring and capacitors to provide a reliable circuit module. These are smaller, harder working, more sophisticated devices that are custom designed for specific applications.

We're uniquely qualified to provide thick films because our 25 years of experience have given us an intimate knowledge of materials, technology, design, production and service. Following, in more specific terms, is what we mean:

Materials to service: The Centralab capability

Basic to the ultimate performance of thick film chip hybrid microcircuits is the evaluation, selection and development of materials that will withstand sophisticated manufacturing processes as well as demanding applications. The Centralab Material Sciences Group of specialized technical personnel determines what materials will best support the special requirements of our design and production facilities.

Materials developed specifically by Centralab

One example of the work of this group is the ceramic substrate used in our thick film circuits. To meet design parameters for maximum thermal conductivity and mechanical strength, as specified by our engineers, an exclusive thin sheet ceramic production process was developed that produces substrates of unexcelled surface finish and reliability. These are so superior to others available, that Centralab is a leading supplier to other microcircuit manufacturers. Our ceramic capability has also provided high performance hermetic packages.

Centralab substrates and packages

Another joint effort of our materials and engineering development personnel resulted in a monolithic chip capacitor (Mono-Kap) that has virtually eliminated pin holes that destroy capacitor reliability and long life.

Micrographs of Mono-Kaps and competitive units

Mono-Kap | Competitor A | Competitor B | Competitor C

We've also produced molybdenum/gold substrates with amazingly complex pattern geometry. These substrates, and our proprietary process (patent applied for) for producing them, permit thicker gold deposits and are ideally suited to ultrasonic and thermocompression bonding methods.

Molybdenum/gold substrates

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All of our experience and technological skills are reflected in the design and production of Navy Standard Hardware Modules. These plug-in modules combine circuit functions to constitute a complete electronic system that is reliable, flexible and economical.

Navy Standard Module

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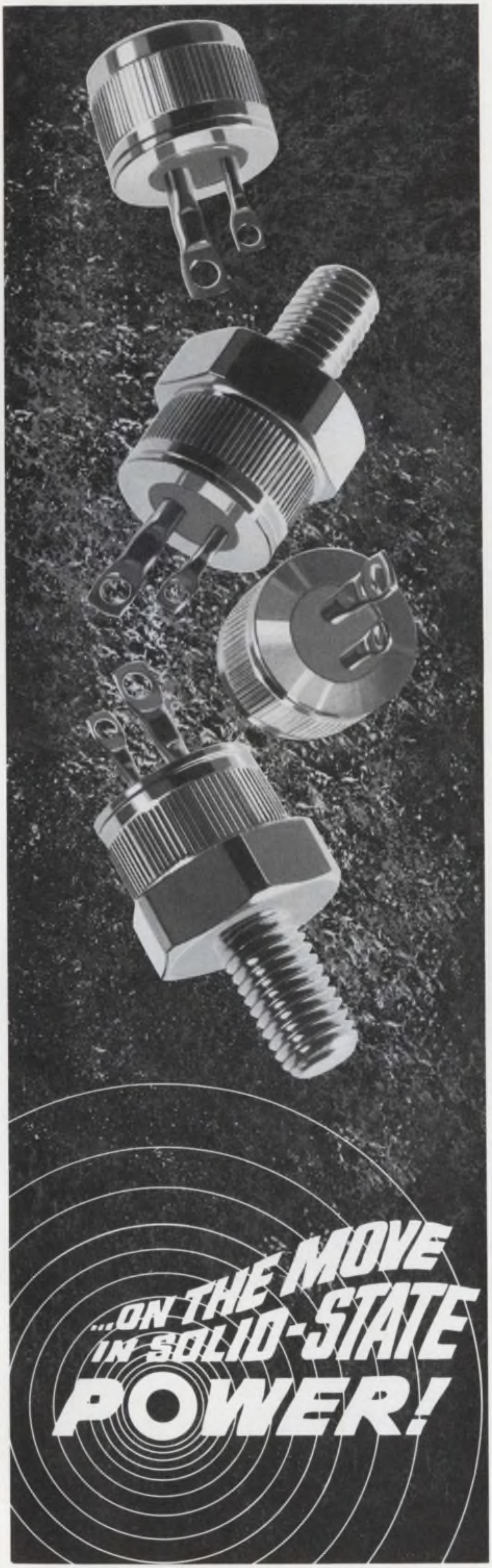

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Even when cost is the prime consideration, the MAC35 series ensures optimum balance between price and continuous control performance — prices start as low as $1.70, 100-up!

If you're now looking at Circuit Applications for the Triac, we have a new application note by the same name we'll send along with complete technical data on the MAC35/36. AN-466 discusses basic theory with control methods and circuit applications — a comprehensive guide to new and better ways to control power in today's thyristor circuits . . . with Triacs!

See your franchised Motorola distributor for stud or pressfit evaluation units now . . . or any of 155 other Motorola standard power thyristors!

Series	Package	V_{DRM} Range V	$I_{T(RMS)}$ A	I_{GT} (typ) mA	I_H (typ) mA
MAC35-1 to -7	Pressfit	25 to 500	25	20	10
MAC36-1 to -7	Stud				

–where the priceless ingredient is care!

MOTOROLA
Power Thyristors

INFORMATION RETRIEVAL NUMBER 26

Now Burr-Brown IC op amps to MIL-STD-883

Four units meet Class B requirements of MIL-STD-883

Two new ±3μV/°C (max.) drift units have been added

New lower prices

MODEL	RATED OUTPUT Volts mA	BANDWIDTH FULL POWER kHz Min.	INPUT VOLTAGE DRIFT μV/°C Max.	OFFSET CURRENT DRIFT nA/°C Max.	MIL STD 883	NEW 100 UNIT PRICE
3050S*	±10 @ ±10	20	±3	±0.2	X	$30.75
3050*	±10 @ ±10	20	±5	±0.2	X	$18.00
3051	±10 @ ±10	20	±5	±0.2	X	$16.50
3052	±10 @ ±10	20	±10	±0.3	X	$12.75
3054S*	±10 @ ±5	20	±3	±0.2		$27.00
3054*	±10 @ ±5	20	±5	±0.2		$14.25
3055	±10 @ ±5	20	±5	±0.2		$12.75
3056	±10 @ ±5	15	±10	±0.3		$ 9.00

All units have minimum Open Loop Gain of 93 dB.
Package: TO-99 (low profile TO-5), interchangeable with 8-pin 709 type amplifiers.
*Low noise units.

All units are 100% tested for guaranteed performance

And, prices reduced up to 45%, delivery from stock!

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or use this publication's reader service card.

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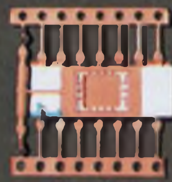
ALL CERAMIC

PACKAGES



AlSiPak®
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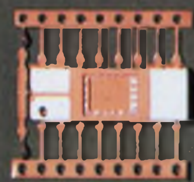
14 lead package
with device area
.170 x .200



AlSiPak®
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16 lead package
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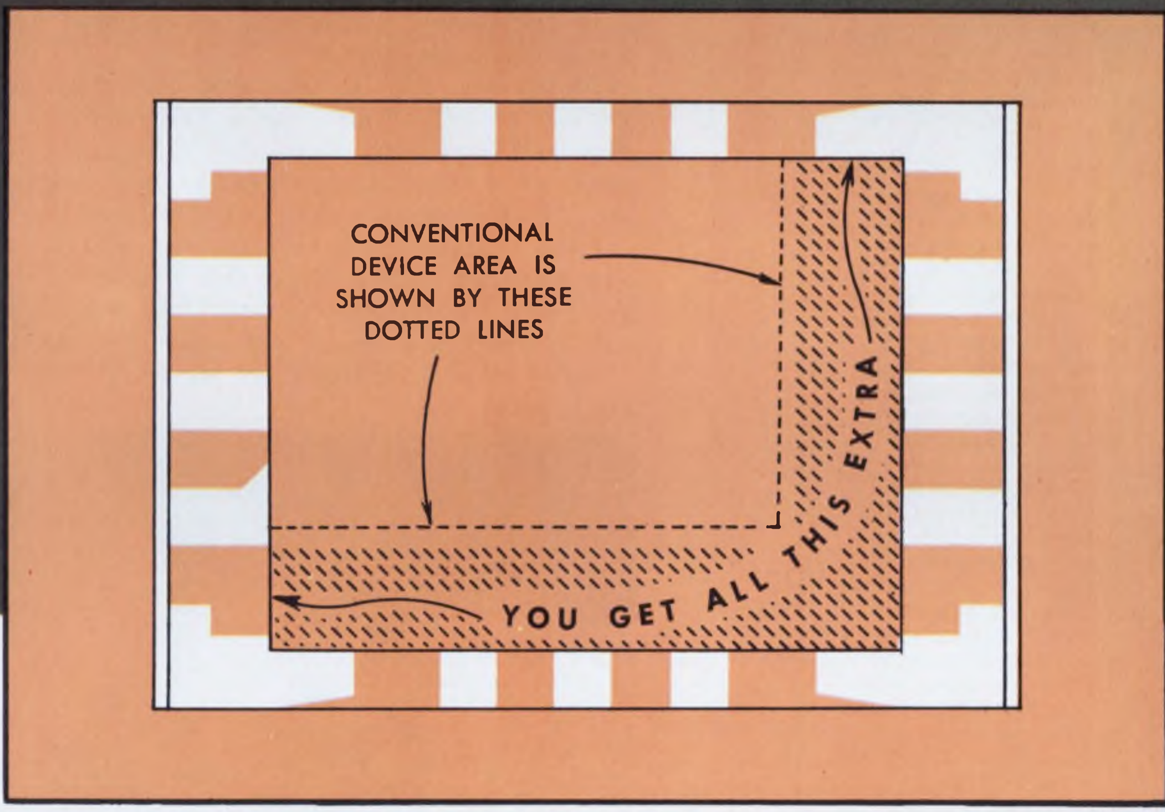
SHOWN ACTUAL SIZE.
LEADS ON .300 ROW CENTERS.



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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 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.
Type HB 2 watts
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Here's the latest Allen-Bradley resistor—the Type BB ⅛ 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, ½ watt, ¼ watt, and ⅛ watt. A clear demonstration of the type of leadership you've come to expect from Allen-Bradley.
An exclusive Allen-Bradley hot-molding technique ensures high uniformity from resistor to resistor—billion after billion. Their predictable performance makes them ideal for critical military applications.
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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.

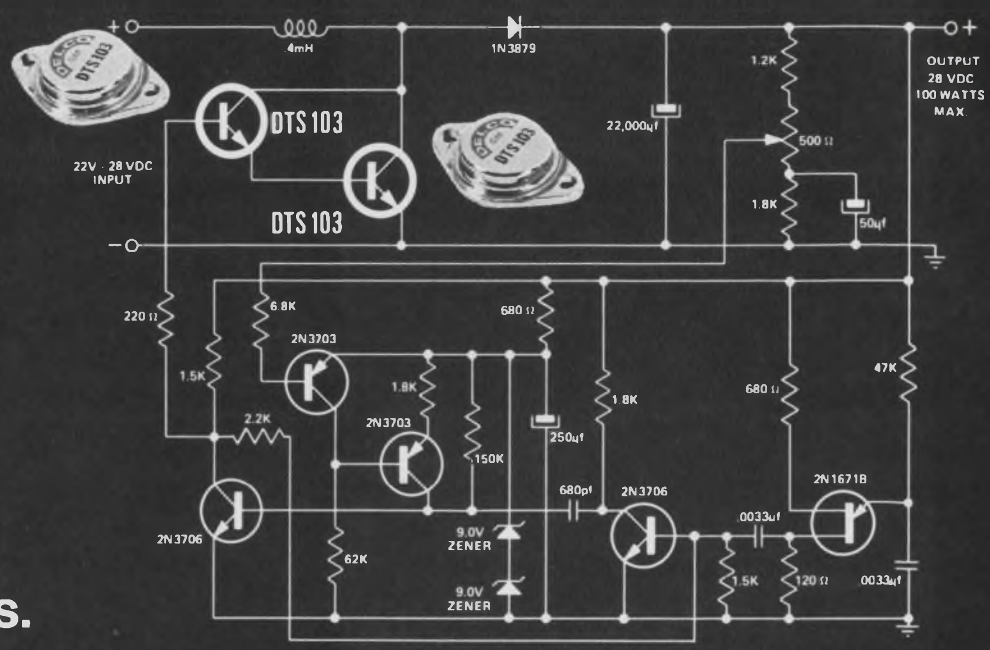
Oh well! Things will be different when you get out of here. No more carrying the ball all by yourself at work. They pay you to be a group leader, and that's what you'll be. Fifty-hour weeks and 800-mile overnight trips are out. More time with the family. That's what you're going to do.

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



Our new high energy silicon power transistors.

15 Amperes. 80 to 120 Volts.

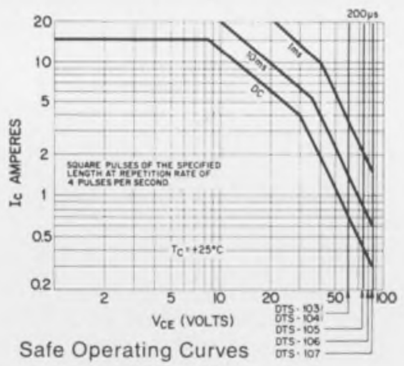
For Switching.

The Delco Radio DTS-100 series. NPN. Triple diffused. Rugged.

All the experience gained from our very high voltage silicon power line has gone into the development of these new transistors.

They were especially designed for the extreme under-the-hood environment of our I.C. voltage regulator. We found these devices ideal for applications requiring high efficiency switching or high power amplification.

The Delco triple sequential diffusion gives the DTS-100 series the high 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.



Safe Operating Curves

In the direct coupled audio amplifier above right, the DTS-107 displays the excellent frequency response, gain linearity and transconductance of this family. This circuit is covered in our application note No. 43.

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.

Like more information? Just call us or your nearest Delco Radio distributor. All our distributors are stocked to handle your sample orders.

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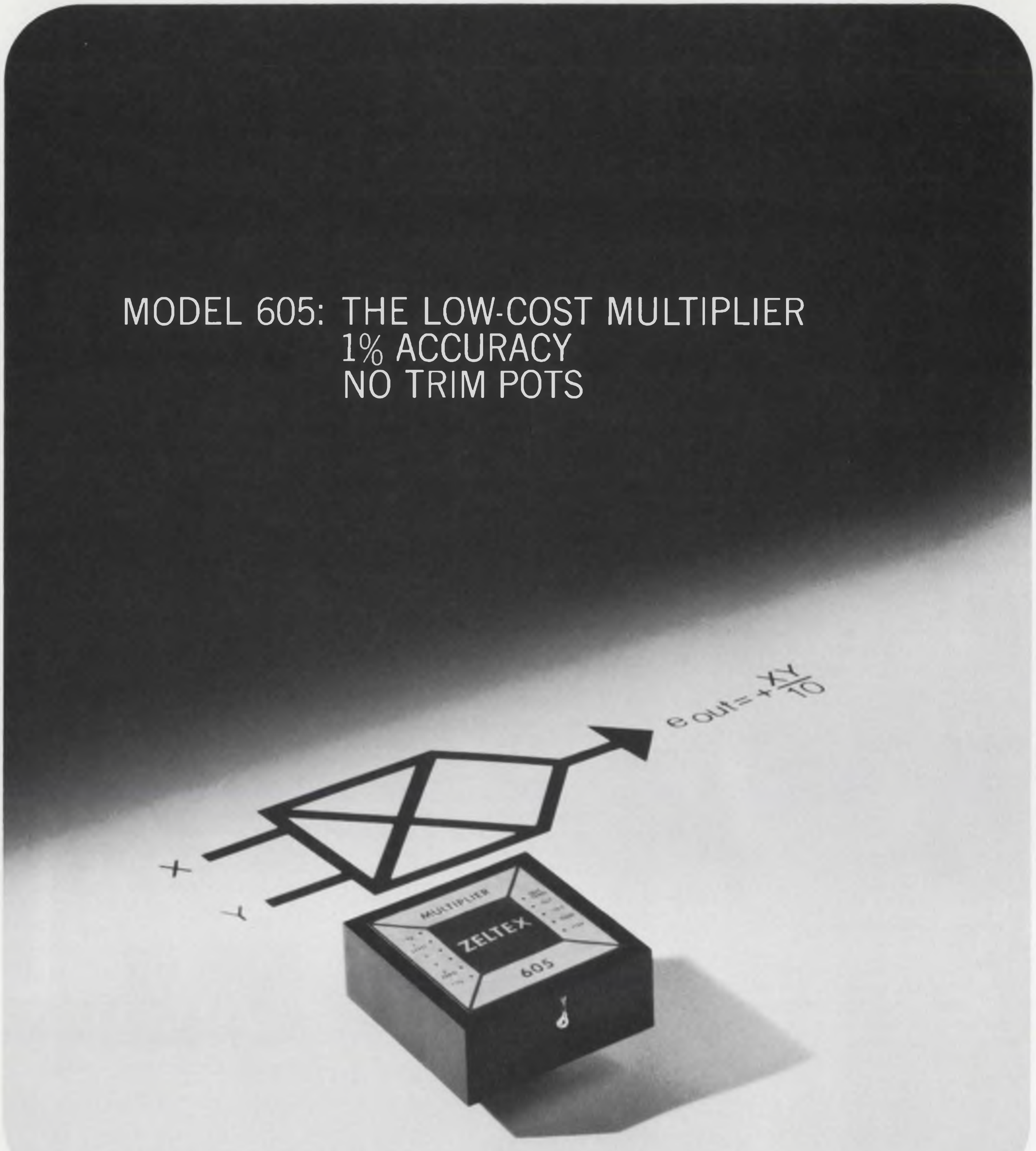

Compare specifications and you'll see that the Zeltex 605 beats every other low-cost multiplier on the market. It provides full-power output to 100 kHz, and small-signal frequency response is 500 kHz. *Yet the price, in quantity, is only $39!*

To get your copy of Bulletin 1056C containing complete specifications and Applications Bulletin 1063A, circle the reader service number below, or write or phone

Other key specifications include:

Output	10 V @ 4 mA
Noise	2 mV rms
Slew Rate	6 V/μs
Size	1.5 x 1.5 x 0.62 inches

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INFORMATION RETRIEVAL NUMBER 35

Test up to 50 KVDC. With accuracy you can bet on (without gambling safety).

0 to 50 KVDC. That's our range. And our measuring and testing instruments are the safest and fastest, with comparable accuracy, in that range.

Our Ripple Detectors for measuring AC ripple on top of High Voltage DC, provide all the flexibility and accuracy of any lab-made detectors, yet can compete with them on cost. Plus ours are much safer. Prices from $73.

The same is true of our High Voltage Dividers. Our nine models of dividers (some double as extenders) combine a 10 or 20 KVDC voltage with 25 to 100 microampere current drains to give you a wider choice for your specific requirements. Prices from $285.

Ripple Detector—50 KV
- Maximum 50 KVDC plus peak to peak ripple.
- Optional surge protection.
- 20,000 Megohms minimum DC input impedance.
- Maximum Ripple: 30,000 V. (500 V with surge protection.)

High Voltage Divider—20 KV
- 9 selectable division ratios.
- 20 KVDC maximum voltage in.
- 100 VDC maximum voltage out.
- Calibrated to an accuracy of 0.01% traceable to NBS at 25°C.
- Can also be used as a voltmeter.

High Voltage Divider—10 KV
- 10,000 : 1 fixed division ratio.
- 10 KVDC maximum voltage in.
- 1.0 VDC maximum voltage out.
- Accurate to ±0.25% at 20°C. to 30°C. or ±0.50% at 0°C. to 50°C.

Ripple Detector—20 KV
- Maximum 20 KVDC plus peak to peak ripple.
- Optional surge protection.
- 20,000 Megohms minimum DC input impedance.
- Maximum Ripple: 12,000 V. (500 V with surge protection.)

For prices and descriptive literature on these and other off-the-shelf High Voltage instruments, write **Capitron Division, AMP Incorporated, 155 Park Street, Elizabethtown, Pennsylvania, 17022.** In Canada, AMP of Canada Ltd., Esna Park Drive, Don Mills, Ontario.

AMP
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INFORMATION RETRIEVAL NUMBER 36

The more complicated it gets...

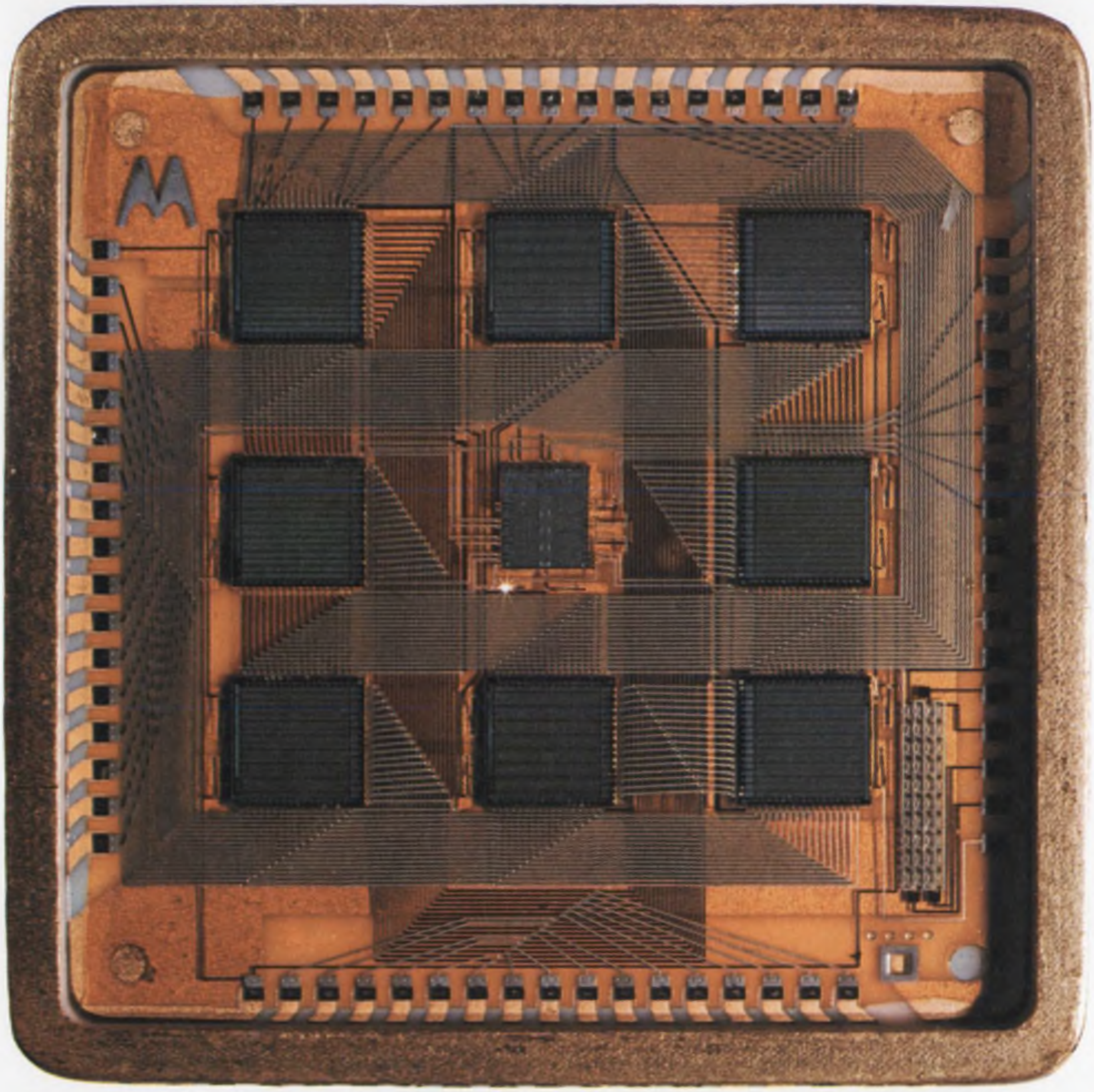
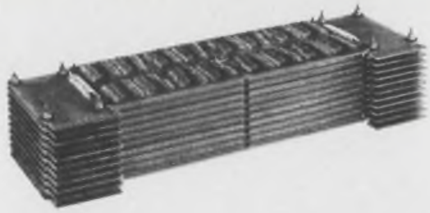


Photo courtesy of Motorola Semiconductor Products Inc., Phoenix, Arizona

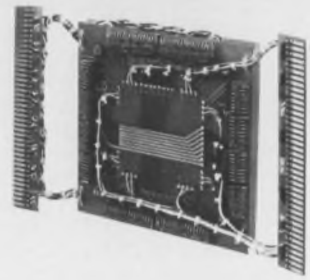
High speed commercial memory system —**NANOMEMORY 2600**. Full cycle time of 600 nanoseconds, and word capacities of 16K by 18 or 8K by 36. It's all done with a second-generation 2-1/2D drive system with efficient circuit and logic design, for reduced component count and high MTBF, and wide operating margins—the real feature of the 2-1/2D configuration. It is easily expandable in the field, and comes in a standard 19" rack.



Perfect for high speed, large capacity mainframe memory systems... **NANOSTAK 3020**...technology breakthrough in 3W, 2-1/2D stacks. Stackable, compact size is an amazing 25% of competitive planar stacks and offers a significant advantage in form factor for system packaging. Extremely fast 650 nanosecond cycle time for 8K or 16K by 40, or 32K by 20 word memories.

Five new memory cores for your next stack or system. All are medium or high drive, all coincident current, and all are fast switching for your high speed applications. Four new cores available in 18 mil, 20 mil, and two types of 30 mil sizes for use from 0° to 70°C. Also, a new wide temperature range 18 mil core for severe environments of —55° to +100°C.

Compact, ATR compatible memory system **SEMS-6** for use in military and rugged commercial aircraft applications. Reliable performer is optimized around 8K or 16K with maximum capacities of 8K by 40 or 16K by 20. Full cycle time of 2 microseconds, with access time of 700 nanoseconds. Meets MIL-E-5400, low power consumption and lightweight.



Rugged design for ground based mobile equipment, **NANOSTAK 020** commercial memory stack. High speed 850-nanosecond full cycle time for 4K memories. Features 3W, 3D organization with word capacities to 16K by 40. Built-in reliability and dependability. Available with wide temperature range cores for operation in severe environments.

Who else but Electronic Memories could introduce five brand spanking new memories—at once

Only Electronic Memories, the technology leader, could introduce five important new memories at once. Each one offers significant advances to provide you with faster, more reliable, and lower cost memories. Each one is loaded with outstanding new design features to give you faster access, larger capacity, and more economical operation. From cores and stacks to megabit memories, Electronic Memories has the memory products for your next, faster, more powerful computer system. For more facts and figures, just write.

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INFORMATION RETRIEVAL NUMBER 37

INFORMATION RETRIEVAL NUMBER 193 ▶

COMES WITH EVERY GE
WET-SLUG CAPACITOR

A woman's touch

When tender loving care is needed for optimum reliability in high-volumetric efficient tantalum wet-slug capacitors, what do you do? You use the deft hands of a woman. Careful assembly of the tantalum anode and its fine silver case demands exacting personal attention.

A woman's touch is needed to protect the delicate dielectric coating of tantalum oxide during final assembly. Through gentle care and a spider support for the anode in its case, a consistently low stable leakage current characteristic for GE wet-slug units is obtained. This extra effort to prevent tantalum oxide damage has proved out in reliability analyses of over 10,000 hours at rated conditions. GE wet-slug capacitors meet or exceed the requirements of MIL-C-3965 and MIL-C-39006. They are also available in subminiature sizes down to .312 inch by .112 inch, with acid or non-acid electrolyte.

Choose from standard ratings (No voltage derating necessary to assure reliability)

Voltage Ratings:	6VDC to 150VDC
Capacitance Ratings:	3.3uf to 2400uf
Temperature Ratings:	−55C to +85/125C

or let GE's 20 years of experience special-design a tantalum wet-slug capacitor to fit your slim, trim circuit needs.

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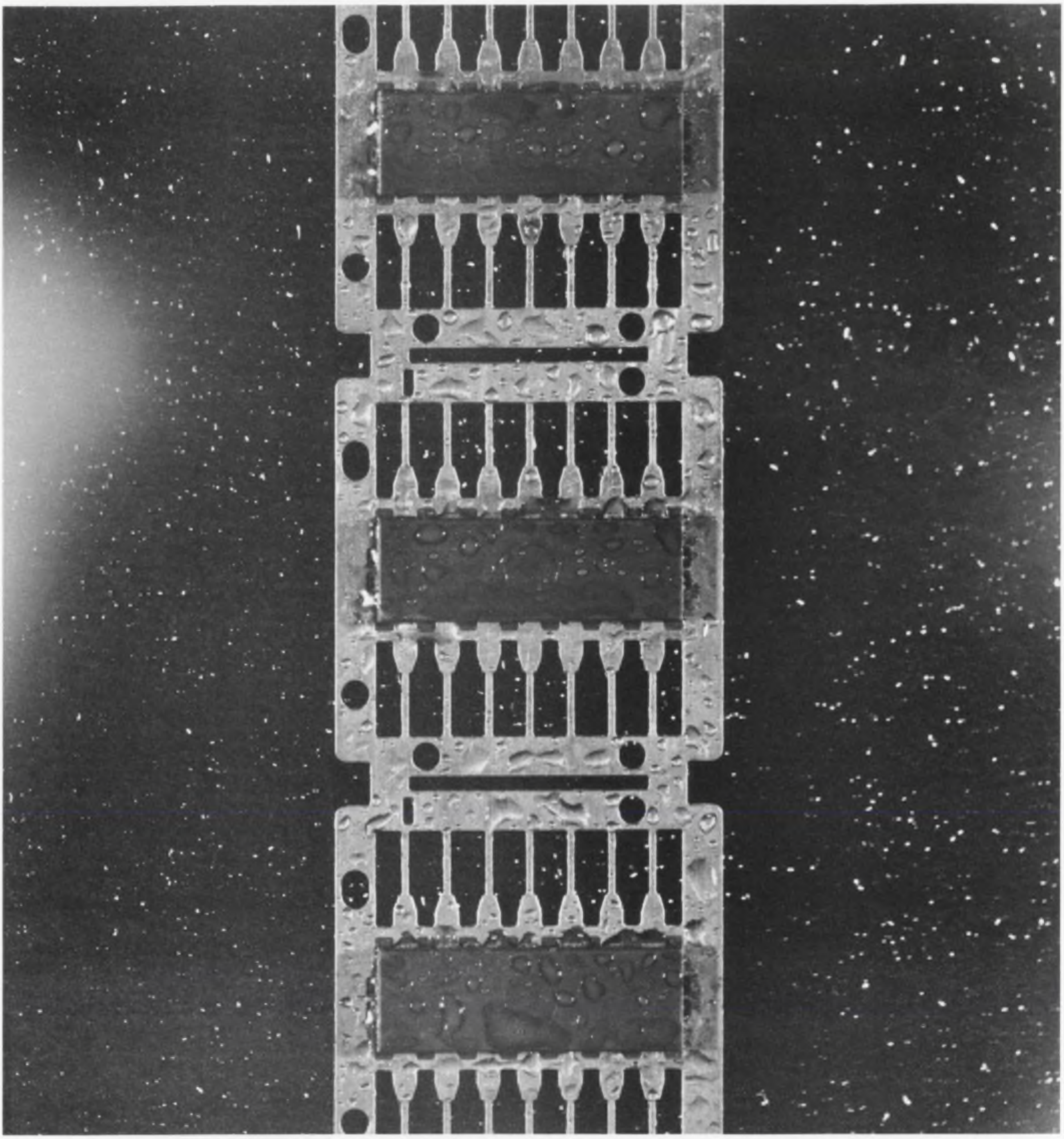
GENERAL ELECTRIC



Keep your power dry

DUAL FETS

Chips or cans...
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Get the high performance and low cost advantages of dual FETs as your op amp input. Our nearly three dozen different duals are specifically designed for your applications, and they're available off-the-shelf. What's more, the specs are guaranteed by the world's leader in FET development. Here are typical applications, features and specs of the more popular Siliconix duals:

APPLICATION	Outstanding Features	$\frac{\Delta\lvert V_{GS1} - V_{GS2}\rvert}{\Delta T}$ (μV/°C)	$\lvert V_{GS1} - V_{GS2}\rvert$ (mV)	I_G (pA)	g_{fs} (μmho)	$\bar{e}_n$ (nV/$\sqrt{Hz}$)	$\lvert g_{oss1} - g_{oss2}\rvert$ (μmho)	Conditions	Pkgd. Series	Chip Type
GENERAL PURPOSE	Meets most OP AMP requirements where low I_G and low noise are important.	5–40	5–15	15	700	20 (1 kHz)	1.0	$I_D = 200\ \mu A$ $V_{DG} = 20\ V$	2N5196–2N5199	CDNP01°
ELECTRO-METERS	Ultra-Low I_G.	5–40	5–15	1.0	50	200 (100 Hz)	0.2	$I_D = 30\ \mu A$ $V_{DG} = 10\ V$	U248A–U251A	CDNT01°
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°
WIDEBAND DIFFER-ENTIAL AMPLIFIERS	High g_{fs} and low noise to very high frequencies. High g_{fs}/C_{iss} ratio.	20–40	10–15	100	5,000	20 (10 kHz)	20	$I_D = 5\ mA$ $V_{DG} = 10\ V$	U252–U253	CDNZ01°
BALANCED MIXERS		—	100	—	5,000	30 (10 kHz)	20	$I_D = 5\ mA$ $V_{DG} = 12\ V$	U257	CDNZ01°

° Specifications apply to packaged devices but are generally representative for chips. Detail chip specifications are available on request.

You'll want complete data and pricing information, of course, so just write to us or phone any of our regional sales engineers:

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INFORMATION RETRIEVAL NUMBER 38

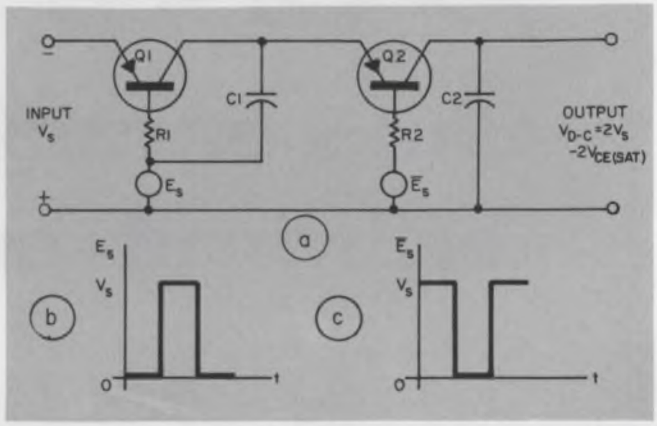
Need a low-voltage dc converter?

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 $\overline{E}_s$ 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 $(V_s - V_{cel(sat)})$. With E_s equal to V_s and $\overline{E}_s$ equal to 0 V, the voltage at point A reaches $(2V_s - V_{cel(sat)})$, and C_2 charges to $(2V - 2V_{cel(sat)})$, 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.

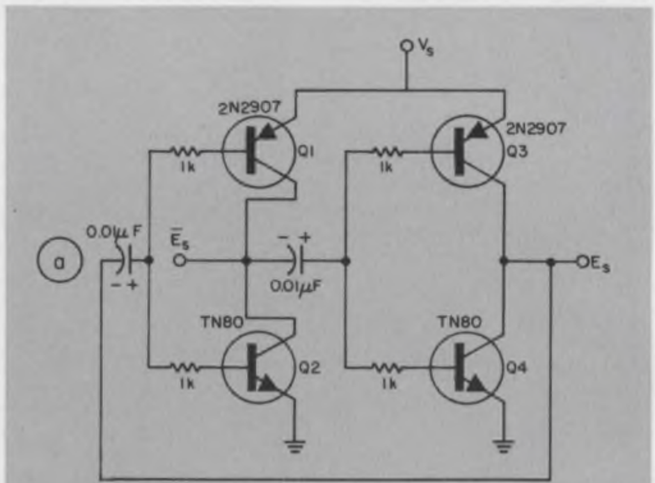


1. **A simple low-voltage doubler circuit** uses pnp transistors as rectifiers (a). The forward voltage drop across each transistor is $V_{ce(sat)}$, roughly 15 mV, and the circuit can work well with source voltages as low as 100 mV. Voltages E_s and $\overline{E}_s$ [(b) and (c)], vital to the operation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

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 $\overline{E}_s$. 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 $\overline{E}_s$, whereas Q_2 and Q_4 saturate for large positive values of E_s and $\overline{E}_s$. Since E_s and $\overline{E}_s$ are 180° out of phase, this means that for

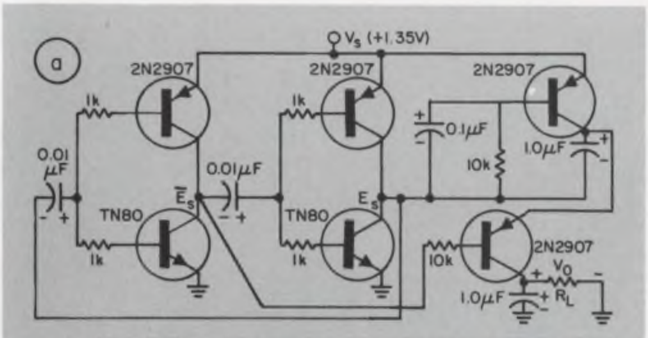


b

INPUT VOLTAGE (VOLTS)	INPUT CURRENT (ma)	RISE TIME (ns)	FALL TIME (ns)
1.25	0.5	50	20
1.35	1.0	50	20
1.45	1.7	50	20

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).

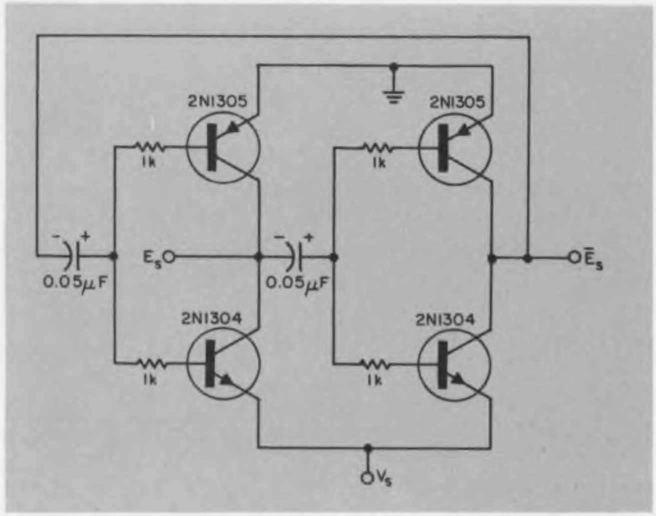
N. Poirier, Research Associate, and **B. L. Cochun,** Associate Professor, Northeastern University, Boston, Mass.



b

LOAD (OHMS)	INPUT CURRENT (mA)	OUTPUT VOLTAGE (VOLTS)	EFFICIENCY (%)
∞	2.0	2.623	0.0
20K	2.2	2.609	11.5
10K	2.4	2.598	20.8
5K	2.8	2.577	35.2
3K	3.5	2.548	45.8
2K	4.2	2.516	55.7

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.



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 μs.

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 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.

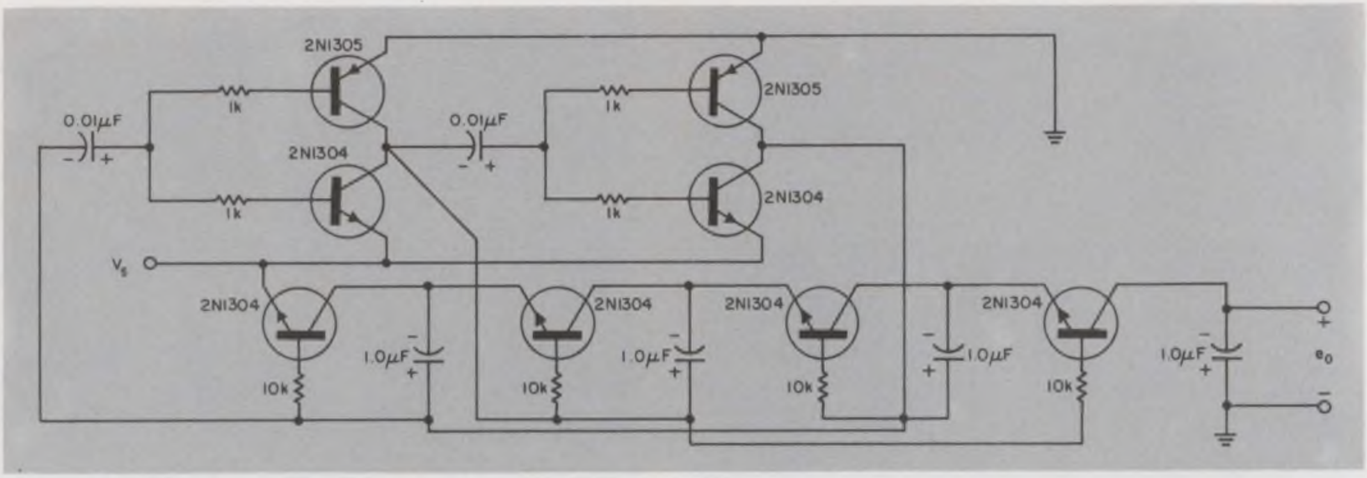
Operation of the circuit of Fig. 4 is possible from supply voltages as low as 0.1 V. With $V_s = 0.3$ V, the rise and fall times of the output square wave are both 0.8 μs, with an input current of 0.31 mA.

Instrumentation needs low-voltage multipliers

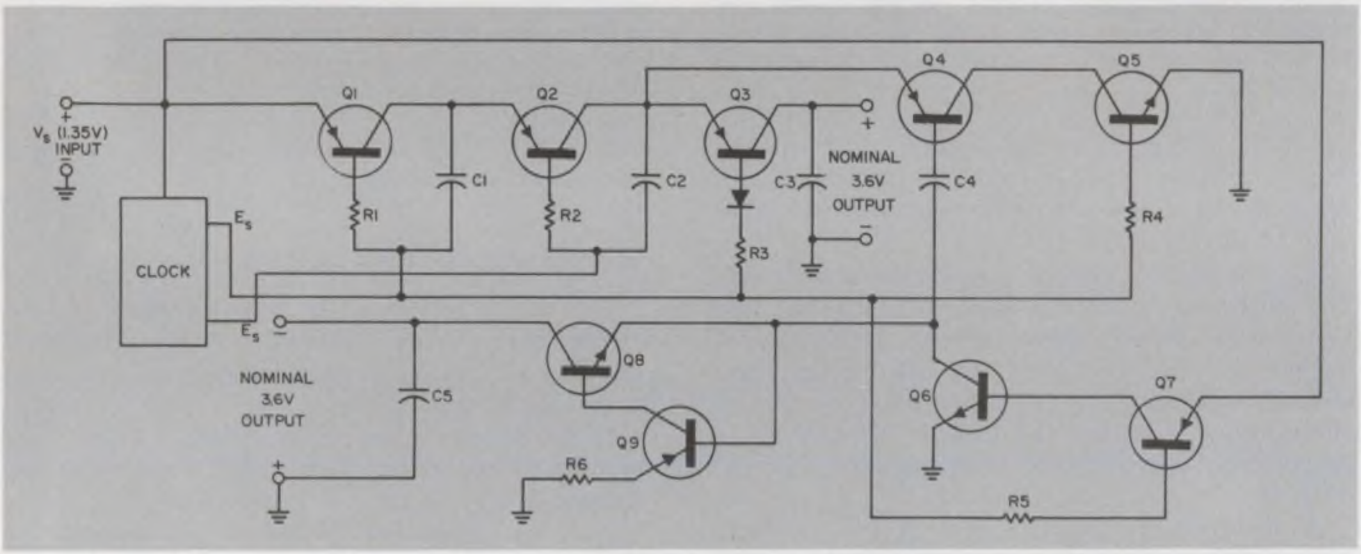
There is a rapidly growing need for small power sources—especially in biomedical and instrumentation work—which will provide enough voltage to drive solid-state circuitry.

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 requires 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 ±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_4 is charged to 3.6 V through Q_4 and Q_6, since with E_s equal to 0, Q_7 will bias Q_6 into saturation. With $E_s > 0$ and positive, Q_4, Q_6 and Q_7 are open and Q_5 is in saturation. Transistor Q_5, in saturation, grounds the positively charged side of C_4, which effectively shunts the collector Q_8 and the base of Q_9 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

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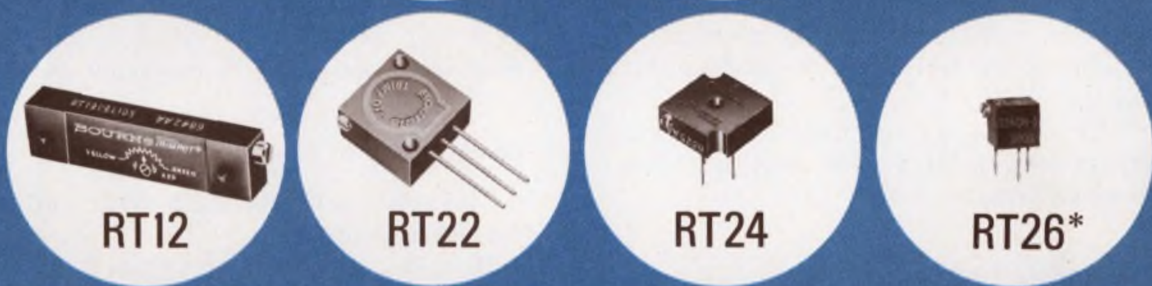

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Decipher the Gray code.

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 convetnional 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,"[1] and "reflected" are other designations for this type of code. The most common, though, is the Gray[2] 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.[3] This feature of Gray code permits a given size of shaft encoder to contain twice the information that could be contained in binary.

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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[3] 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.

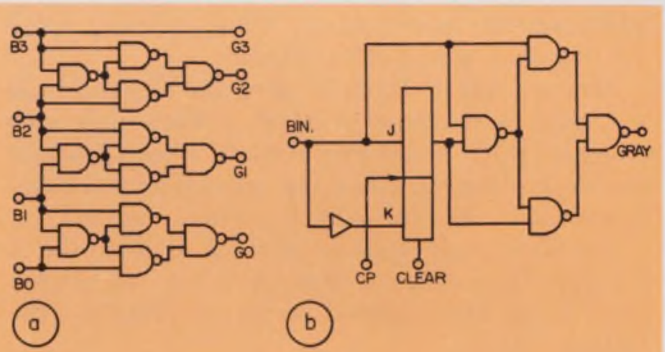
It can be seen that the parallel binary-to-Gray and Gray-to-binary circuits in Fig. 2 and 3 are quite similar. The same circuit configuration and number of gates are used for each encoded bit. The only difference between the circuits is that the binary-to-Gray uses the nth input bit as an input to the (n-1)th encode gate, while the Gray to binary used the nth 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[4] circuits shown in Fig. 2 and Fig. 3 are also quite similar. The only difference between the two cir-

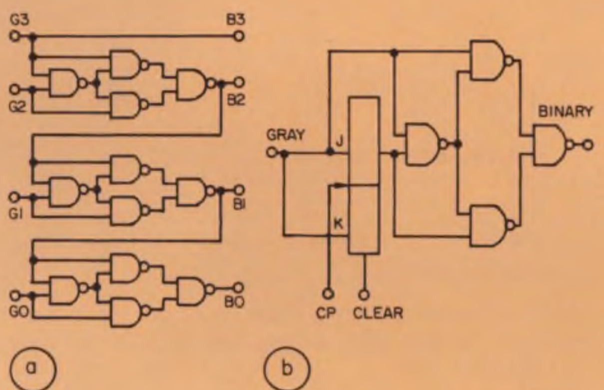
GRAY D	C	B	A	DECIMAL
0	0	0	0	0
0	0	0	1	1
0	0	1	1	2
0	0	1	0	3
0	1	1	0	4
0	1	1	1	5
0	1	0	1	6
0	1	0	0	7
1	1	0	0	8
1	1	0	1	9
1	1	1	1	10
1	1	1	0	11
1	0	1	0	12
1	0	1	1	13
1	0	0	1	14
1	0	0	0	15

BINARY 8	4	2	1	DECIMAL
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15

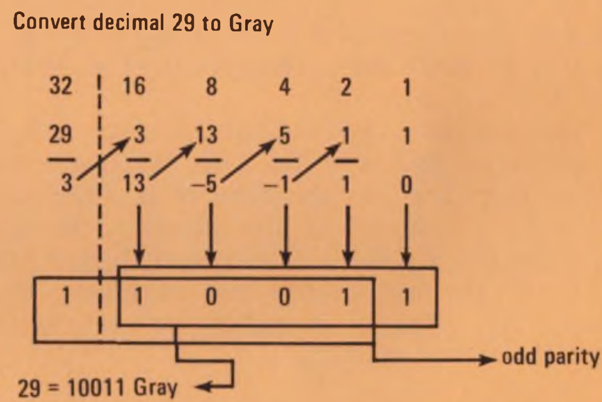
1. **The Gray-code counting sequence** differs from binary. Gray with decimal equivalent is on the left; binary is on the right.



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.



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.

cuits 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.[5,6]

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.[7]. One method of correcting this is to use a Gray-code counter.[8,9]

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 directy 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.

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 Gray = 128 − 32 + 16 − 8 + 2 − 1 = 105

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

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

or $2(2^n-2^p+2^r-\ldots)-1$ 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 Gray = 127 − 31 + 15 − 7 + 1 = 105

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

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).

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.[10]

In the process of converting a Gray number to 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.

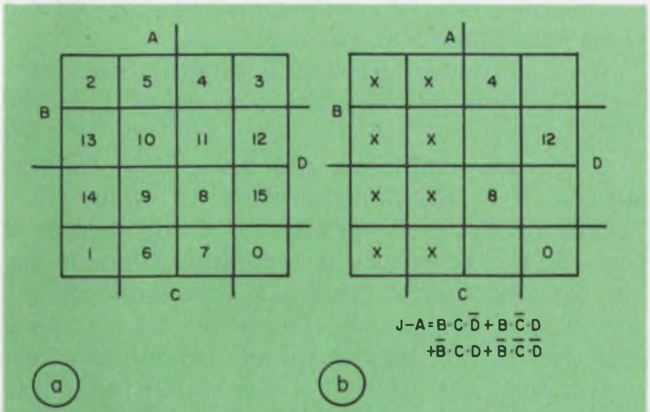
To decode a Gray number, it is necessary to differentiate between the negative and positive read-out of each 1 bit. A Gray counter with this characteristic is possible, using three states rather than two for each bit. Of course, a minimum of two flip-flops are necessary for three states.

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.

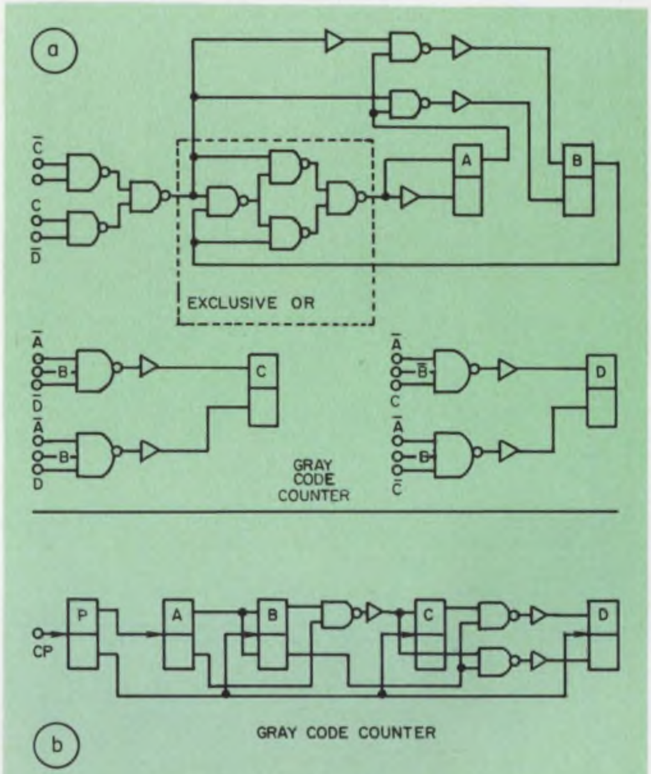
In the actual design, a 2-bit Johnson partition is used. Other partitions are possible but the Johnson appears to be the most efficient. Figure 9 shows the counter with the decoded read-out and truth table.

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).



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).

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[11] 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 decribed. 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 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)

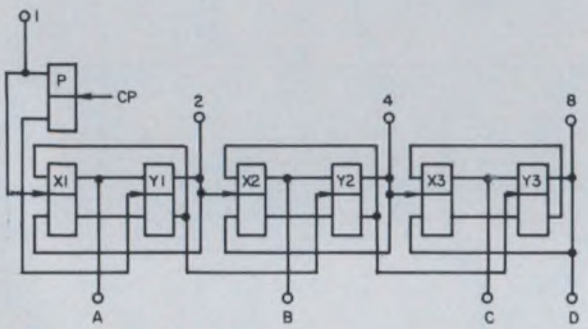
(1) Write the multiplicand (A) in modified form and multiply by the most significant 1 of the multiplier (B).

16	8	4	2	1	
D	C	B	A	P	
0	0	0	0	0	0
0	0	0	1	–1	1
0	0	1	–1	0	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 .

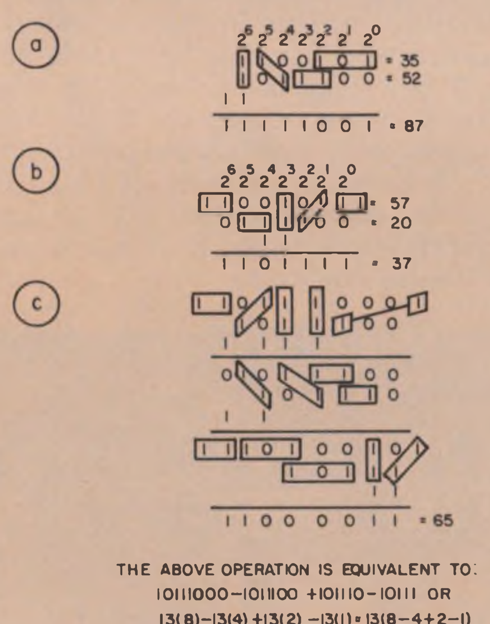
Y3	X3	Y2	X2	Y1	X1	P	
0	0	0	0	0	0	0	0
0	0	0	0	0	1	1	1
0	0	0	1	1	1	0	2
0	0	0	1	1	0	1	3
0	1	1	1	0	0	0	4
0	1	1	1	0	1	1	5
0	1	1	0	1	1	0	6
0	1	1	0	1	0	1	7
1	1	0	0	0	0	0	8
1	1	0	0	0	1	1	9
1	1	0	1	1	1	0	10
1	1	0	1	1	0	1	11
1	0	1	1	0	0	0	12
1	0	1	1	0	1	1	13
1	0	1	0	1	1	0	14
1	0	1	0	1	0	1	15

(a)



(b)

9. **The Johnson partition counter** can decode Gray considered as trinary. The truth table is (a) and the circuit is (b).



10. **Arithmetic operations** can be carried out in Gray code. Addition is given in (a), subtraction in (b), and multiplication in (c).

(2) Subtract (A) multiplied by the second most significant 1 of (B).

(3) Continue alternately adding and subtracting (A) multiplied by the decreasing 1 orders of (B).

Gray code arithmetic can be used to convert decimal to Gray. Multiplication by 10 in Gray is difficult, but multiplication by 8 and then by 2 and adding the results is not. The technique for the conversion is to rewrite the decimal number as a sum of decimal digits multiplied by 8 and 2 and then to use Gray arithmetic to complete the conversion. For example, decimal 35 which is $3 \times 10 + 5$ becomes $3 \times 8 + 3 \times 2 + 5$ or $101000 + 1010 + 1111$ in Gray. (Note that parity bits have been added.) Completing the addition gives 110010 as the equivalent of 35. ■■

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Test your retention

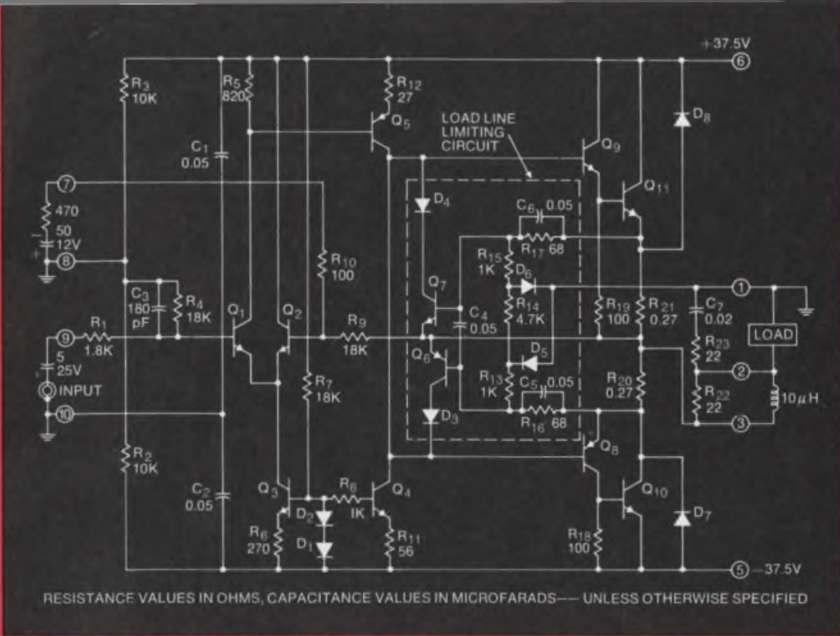
Here are questions based on the main points of this article. Their purpose is to help you make sure you have not overlooked any important ideas. You'll find the answers in the article.

1. What is the basic advantage of the Gray code over binary?

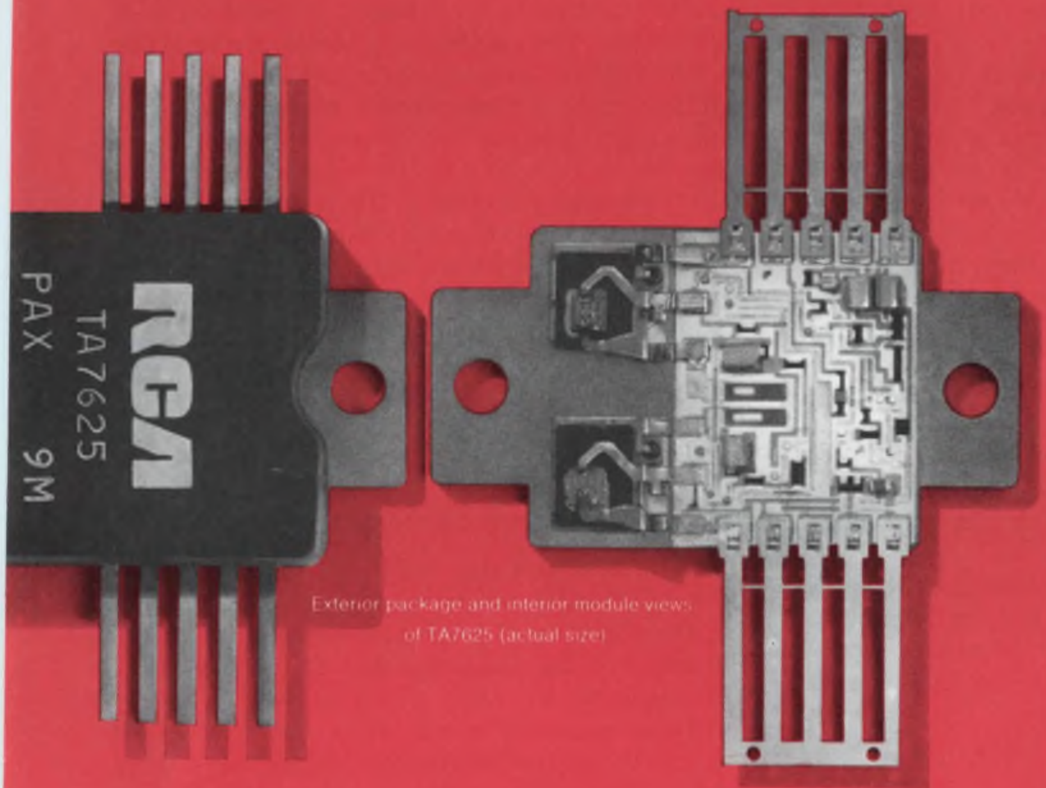
2. In what kind of equipment is one likely to encounter the Gray code?

3. What is the disadvantage of carrying out arithmetic operations in Gray code?

4. What number system is suggested by Gray code?



Schematic diagram of unencapsulated TA7625



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.

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

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-


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.

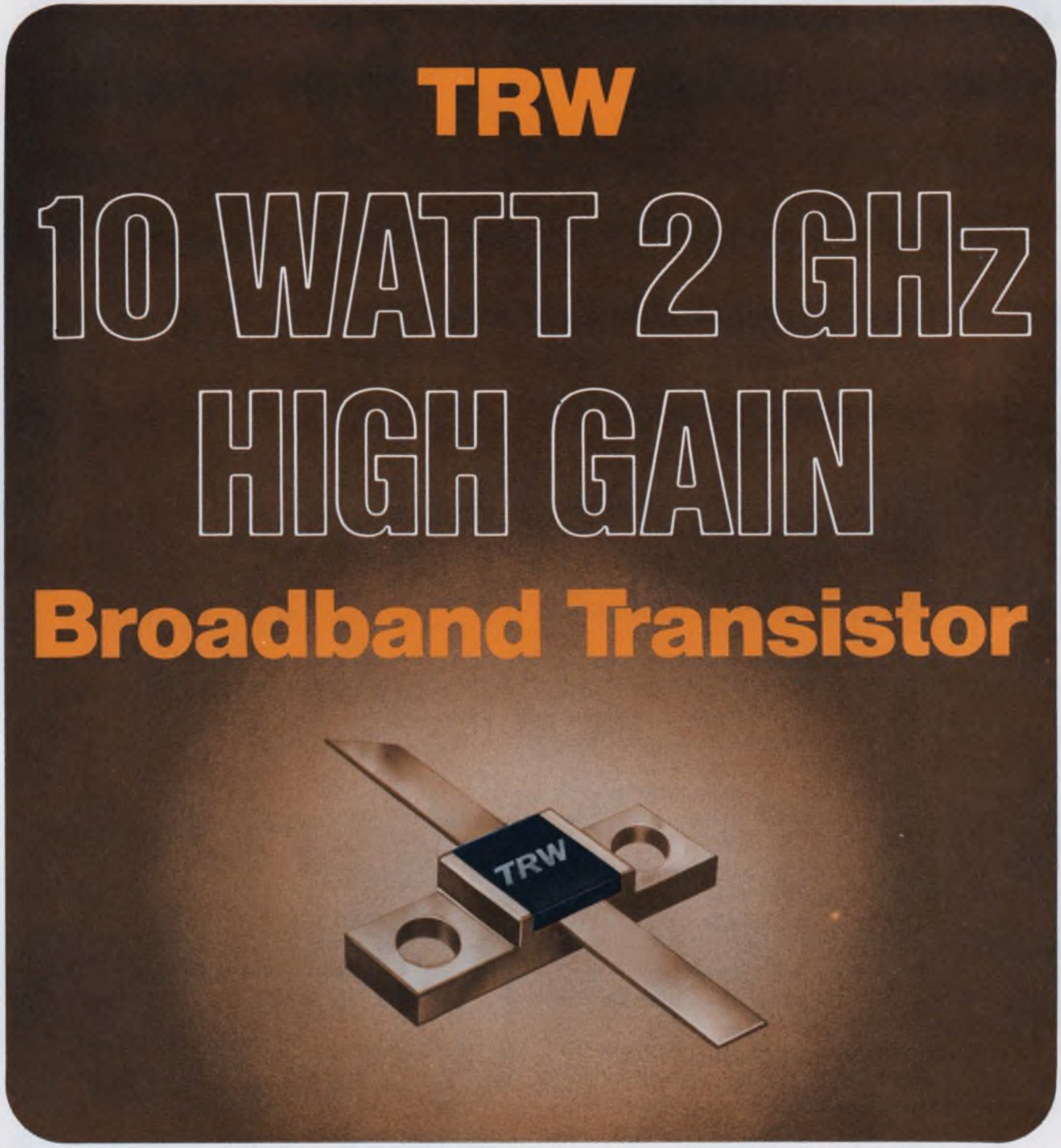
A word of caution: The salesman may go on the defensive when questioned about the customer's application. If he does, it's because he doesn't know all the answers and feels threatened. Don't pin the poor devil to the wall. Simply explain what data you need and why. He will then realize that you are trying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



. . . higher power for telemetry, ECM, NAVAIDS, Radar

TRW has added still another member to its Gigahertz family. PT8610 provides 10 watts output power at 2 GHz, with 7dB gain and 15% bandwidth. It is a single-chip device in a new low parasitic MIC package.

The broadband capability of the device provides circuit design simplicity and insures repeatable system-to-system performance with a minimum of circuit tuning elements.

Designed for use in common-base circuits, PT8610 can be cascaded with other TRW broadband devices to extend reliable solid state power at 2 GHz. Companion transistors are the 5 watt 2N5768, 2.5 watt 2N5767 and the 1 Watt 2N5766.

For further information contact any TRW distributor or TRW Semiconductor Division, 14520 Aviation Boulevard, Lawndale, California 90260. Phone (213) 679-4561. TWX: 910-325-6206.

Actual Size

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INFORMATION RETREIVAL 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, $-R_2/R_3E$, 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.

$$E_o(s) = \frac{R_2+R_3}{R_3} V_c(s) - \frac{R_2}{R_3}\frac{E}{S}, \text{ neglecting R6}$$

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

$$R'_1 = R_1 + aR_5,\ R'_4 = R_4 + (1-a)R_5$$

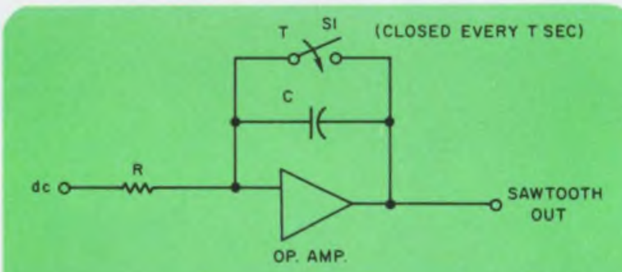
$$\text{Then: } E_o(s) = \frac{-R'_1R_2R'_4\, E\, C\, S - R_2\, E\, R'_1 - R_2R'_4\, E}{S\left(S + \dfrac{R'_1\, R_3 - R_2R'_4}{R'_1R_3R'_4C}\right) R'_1R_3R'_4C}$$

If $R'_1R_3 - R_2R'_4 = 0$ or $R'_1/R'_4 = R_2/R_3$

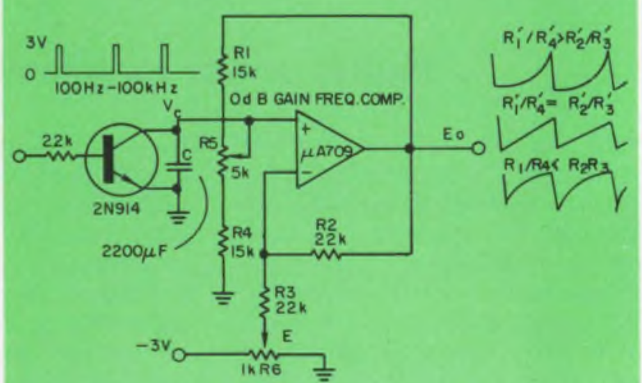
$$E_o(s) = \frac{-R_2E}{R_3S} - \frac{R_2(R'_1+R'_4)E}{R'_1R_3R'_4CS^2}$$

$$E_o(t) = \frac{-R_2E}{R_3} - \frac{R_2(R'_1+R'_4)\ (E)t}{R'_1R_3R'_4C},\ 0<t<T$$

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



1. **Classical integrator** has capacitor that floats between input and output.



2. **Improved sawtooth generator** has capacitor that is referenced to ground potential.

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Frequency Range	Filter Model*	Function BP	BR	HP	LP	Add Feature	Freq. Acc %	Attenuation Slope db/octave	Hum and Noise (RMS)	Max Attenuation	Output Volt/Amps (RMS)	3 db Points	Approx. Shipping Weight lbs/kgs	Price U.S.A. Only
.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	330B	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
10Hz – 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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OSCILLATORS / FILTERS / AC POWER SUPPLIES / AMPLIFIERS 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 +3V 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 ± 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

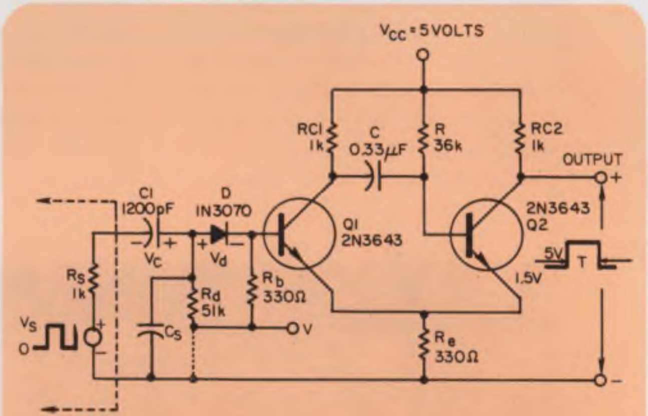
$$V_t = [R_d/(R_d+R_s)]\,V_s$$

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

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:

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



Improved voltage-variable-delay circuit uses no additional components and requires no change in any circuit values.

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

GaAsLITE Update

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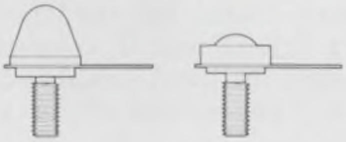
Compatibility: directly interfaces with off-the-shelf IC decoder/drivers

Price: ~~1-9, $18; 1,000 or more, $25~~ contact distributors for new prices!



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ME 2A, 5A: 1-9, $14.75; 1,000, $8.00

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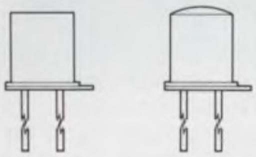
Price: 1-9, $2.30; 1,000, $1.50



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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/cm² (min) (.9 microns, $V_R = 20$ volts)
MD 2 3.0 μA/mW cm² (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

INFORMATION RETRIEVAL NUMBER 43

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

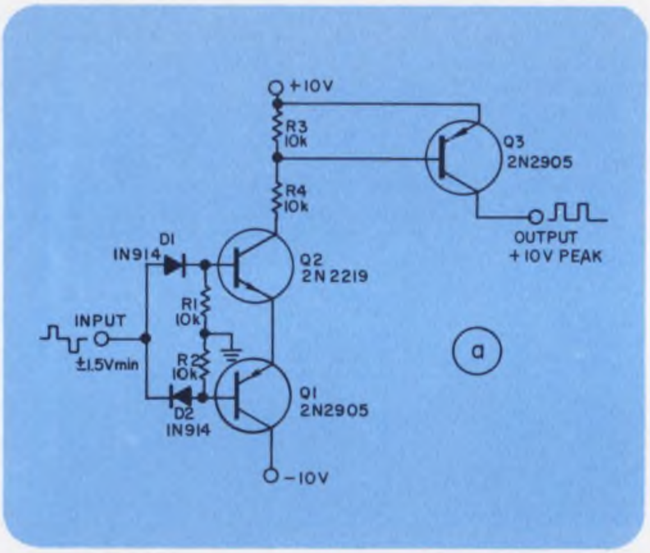
Many applications require that bipolar pulses be counted, without regard to their polarity. A circuit that modifies such pulses so that their absolute number can be determined is shown in the illustration.

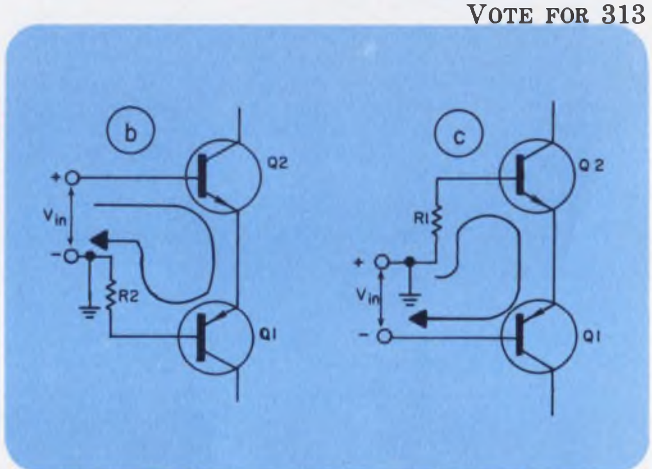
If the input signal is positive, D_1 conducts. D_2 is reverse-biased, and the input current path is shown in (b). Q_1 and Q_2 also conduct, biasing Q_3. This makes the output of Q_3 positive.

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 alterting 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.

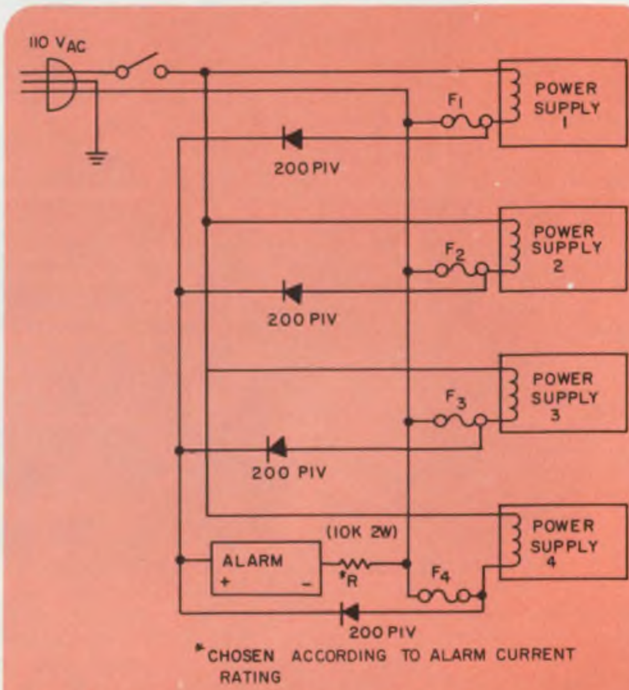
An audible alarm wired across all system fuses, as shown in the figure, will be activated whenever a fuse blows. The alarm can be one of the small panel-mounting piezoelectric units now available through electronic distributors, or an inexpensive doorbell buzzer. Diodes are required for isolation when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

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



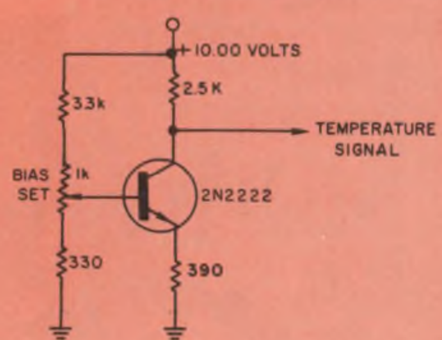
Audible fuse alarm system indicates an open circuit and alerts repair personnel.

Linear temperature sensor uses only a single transistor

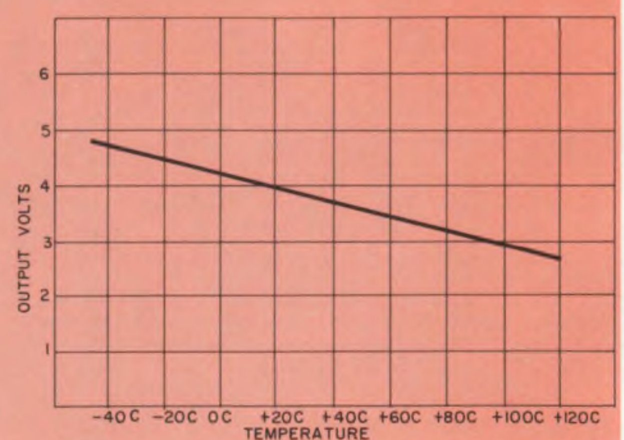
Variation in the base-emitter voltage of a transistor can be used to sense temperature and, through transistor action, provide a high level output. Linearity is approximately ±1% over a temperature range of −40%°C to +125°C.

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 ±1% between −40°C to +125°C.

of emitter to collector resistor. Bias point is controlled by the bias-set potentiomenter. 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

Varacator diode is the key to a simple frequency divider

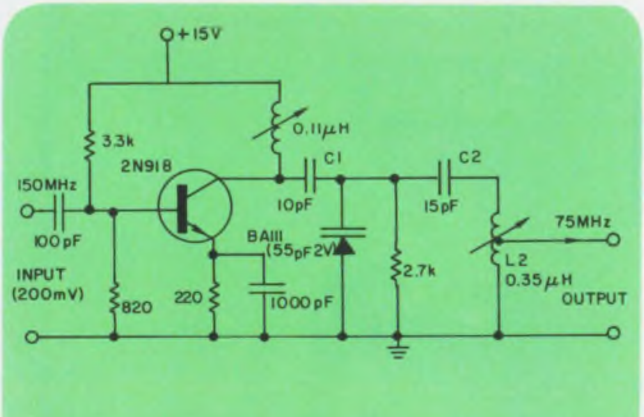
In a parametric amplifier the pump frequency is twice the frequency of the signal to be amplified. Increasing the gain of the amplifier will eventually turn it into an oscillator producing an output signal exactly half the frequency of the pump frequency. This effect can be exploited to create a frequency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

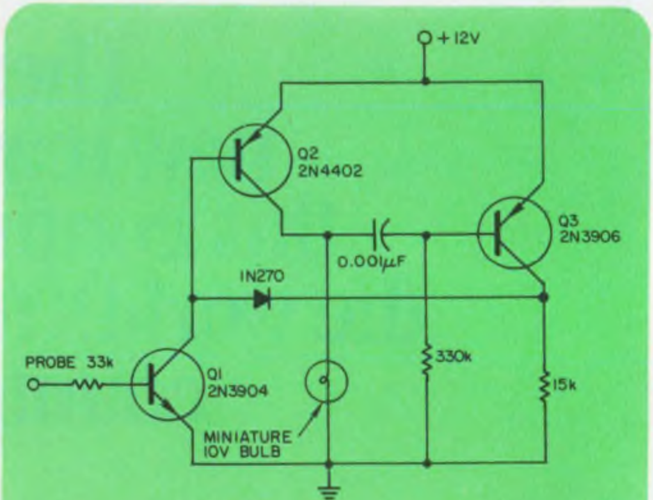
The simple probe shown in the figure lights up when a pulse or dc level above 0.7 V is found, and minimizes eye and head movements. The input impedance is high enough to protect most digital circuits from loading.

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 multivribrator 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

```
NSE-1      8:14   S2 FRI 08/29/69

100 PRINT"             VOLTS IN                          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
```

ⓐ

```
NSE-1      8:08   S2 FRI 08/29/69
```

DBRN	VOLTS IN 600 OHMS	DBM	DBRN	VOLTS IN 600 OHMS	DBM
0	.0000245	-90	46	.0048874	-44
1	.0000275	-89	47	.0054837	-43
2	.0000308	-88	48	.0061528	-42
3	.0000346	-87	49	.0069036	-41
4	.0000388	-86	50	.0077460	-40
5	.0000436	-85	51	.0086911	-39

ⓑ

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
```

ⓐ

```
RTRF       7:59   S2 FRI 08/29/69

THIS TABLE IS BASED ON PURELY RESISTIVE IMPEDANCES.
```

Z(1):Z(2)	RETURN LOSS	REFLECTION LOSS
1.25:1	19.08DB	.05DB
1.50:1	13.98DB	.18DB
1.75:1	11.29DB	.34DB
2.00:1	9.54DB	.51DB
2.25:1	8.30DB	.70DB

ⓑ

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 and zener protectors. Under normal supply voltage, Q_1 is ON and Q_2 is OFF provided that:

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

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

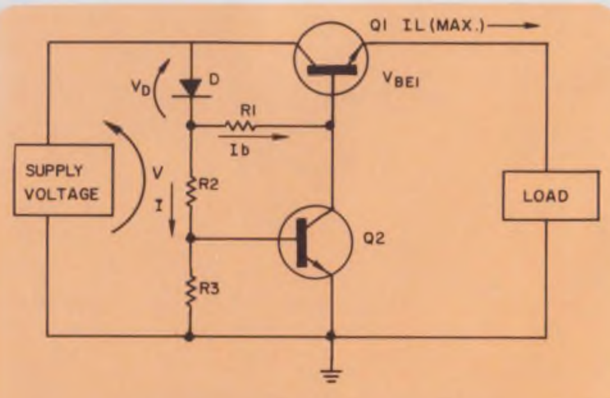
$$R_3 \leq V_{BE2} / I$$

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

In case the supply voltage exceeds V, Q_2 turns ON, diverting the base current I_b to ground thus turning Q_1 OFF. In the case of wrong polarity, Q_1 never turns on due to the absence of base current I_b 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.

For multilayer or precision double sided boards with plated-thru holes,—in volume—the place to go is Cinch-Graphik—the world's largest independent producer of precision circuits.

For information on the capabilities and automated facilities of Cinch-Graphik, contact your local Cinch Electronics Group District office or Cinch-Graphik, 200 South Turnbull Canyon Road, City of Industry, California, 91744.
Phone (213) 333-1201.

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CG-1006

INFORMATION RETRIEVAL NUMBER 47

July - December 1969

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.

Departments key

ART Technical Article

IFD Idea for Design

PF Product Feature

SR Special Report

Subject Listing

Avionics
Circuits & Circuit Theory
Communications
Components
Computer-Aided Design
Computers & Data Processing
Consumer Electronics
Displays
General Industry
Industrial Electronics
Management
Materials & Packaging
Medical Electronics
Microelectronics
Microwaves & Lasers
Military & Aerospace
Product Source Directories
Semiconductors
Systems
Test & Measuring

Communications

Components

Industrial Electronics

Management

Materials & Packaging

Medical Electronics

Microelectronics

Microwaves & Lasers

Military & Aerospace

Product Source Directories

Semiconductors

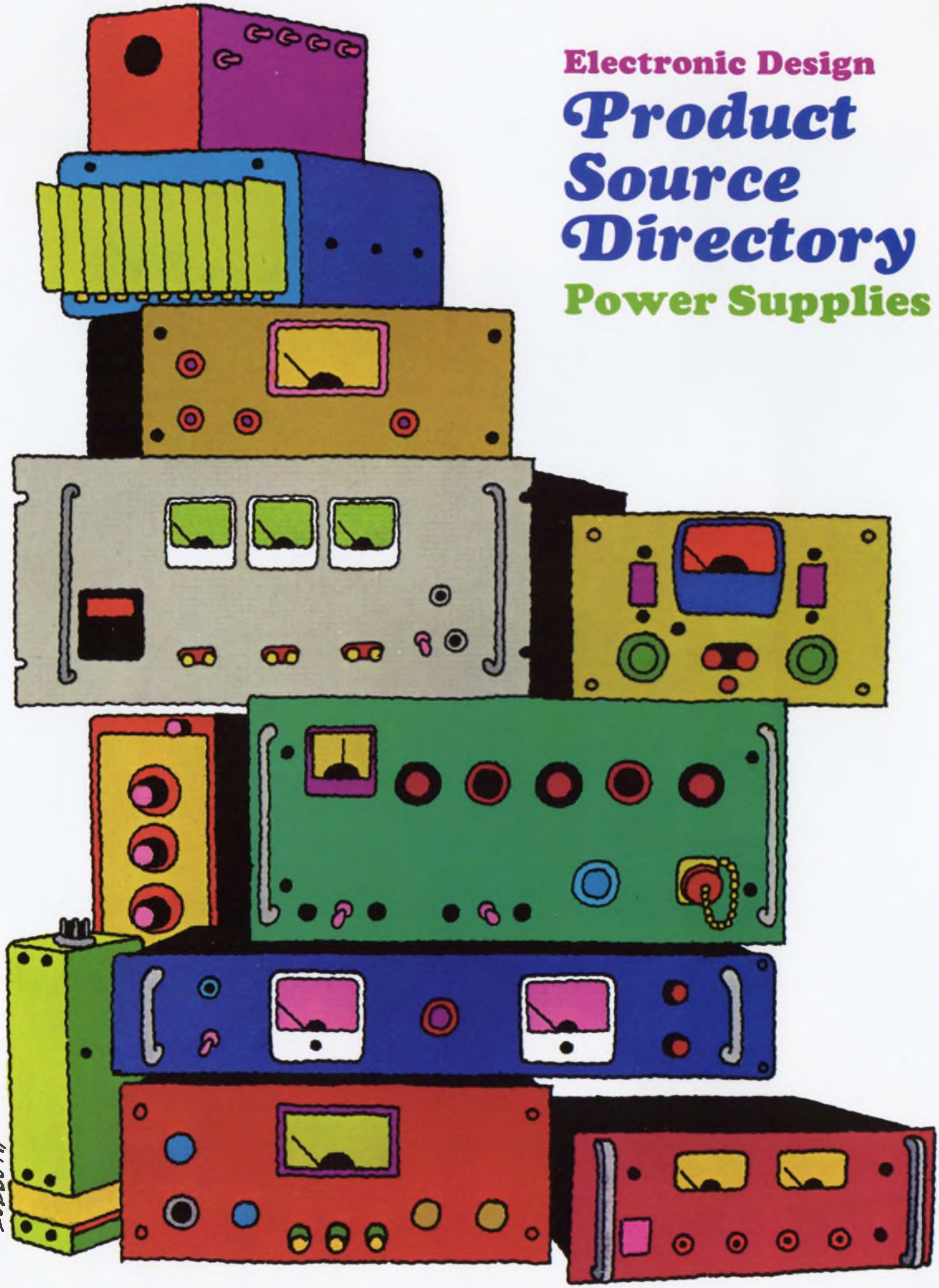
Systems

Test & Measuring

Electronic Design

Product Source Directory

Power Supplies

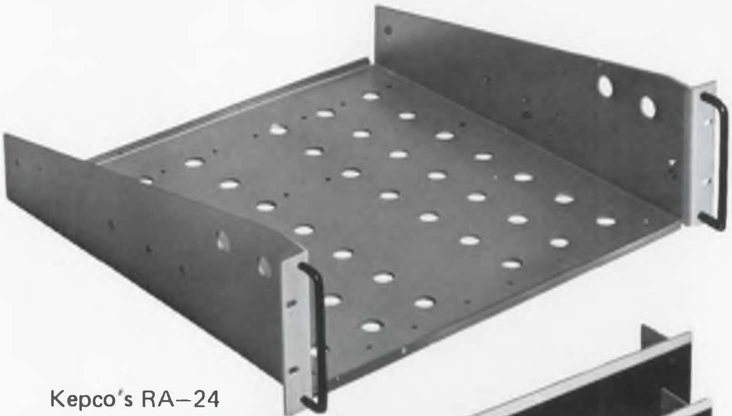


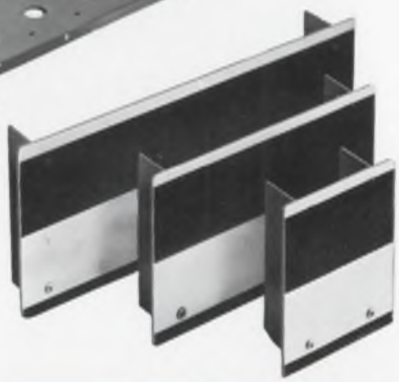
KEPCO

4-in-a-RACK

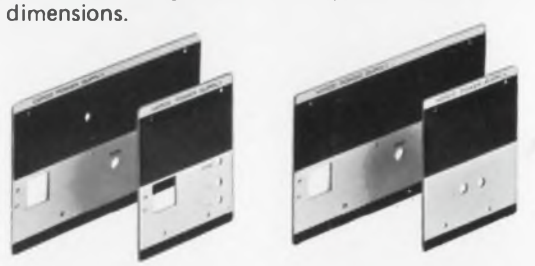
POWER SUPPLY MOUNTING SYSTEM

The Kepco 4-in-a-rack hardware system offers a flexible means for combining various sized power units in standard rack dimensions.

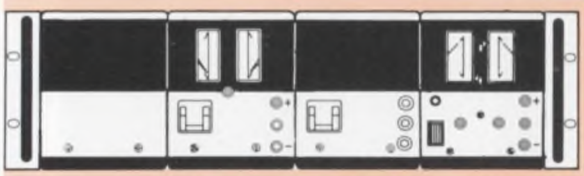




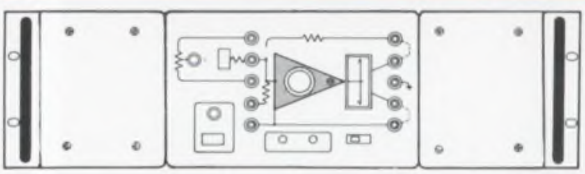
Kepco's RA–24 houses lots of different power regulators in the popular quarter-rack and half-rack sizes.



Panel adapters make easy the assembly of power modules into custom multioutput combinations.

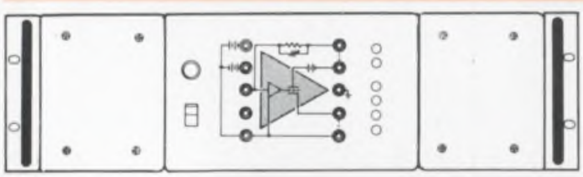


CPS/JQE Kepco's extensive JQE and CPS inventory provides 36 different voltage regulating power supplies in models from 6 volts to 100 volts, 1 ampere to 90 amperes, in quarter-rack, half-rack and full-rack sizes. A precision I-C regulating amplifier delivers 0.0005% line, 0.005% load regulation. All models are fully programmable and are available in fast-programming models also.



BOP The unique Bipolar Operational Power Amplifier/Power Supply provides four quadrant operation with outputs of + to –36 volts and + to –72 volts at ±1.5 amperes and ±5 amperes. The BOP's will deliver full output modulated from d-c to 20 kHz. The front panel of the metered models is a complete operational patch board with summing inputs and adjustable feedback.

PVS This low-cost, 4½ digit calibrator features 0.02% absolute display accuracy with 0.0005% line and 0.001% load regulation (0–1 ampere). The readout is a clear, easy-to-read digital display from 0.0000 volts to 100.00 volts in three factor-of-ten ranges.



OPS (Hybrid) Three of the highest voltage op-amps going! 0–500 volts/40 mA, 0–1000V/20 mA, 0–2000V/10 mA. All feature Kepco's operational patch panel making input and feedback connections easy. Gain $>0.5 \times 10^6$ V/V; slewing rate >1V/μsec.

DPD/DPR A digital programming system offering a 3½ digit, 4½ digit or 5½ digit computer interface for any of the JQE, CPS, BOP, OPS and many other Kepco supplies. Serial or parallel input formats with keyboard input too.

NOW YOU CAN RACK UP POWER AND SUPPORT EQUIPMENT SIMPLY AND EASILY IN A FLEXIBLE MOUNTING SYSTEM. FOR SPECIFICATIONS AND APPLICATIONS NOTES – WRITE DEPARTMENT DG–05

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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.

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.


Dipped Mica by the Millions!
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From the inventor of the Mica Capacitor.
CDE
CORNELL-DUBILIER

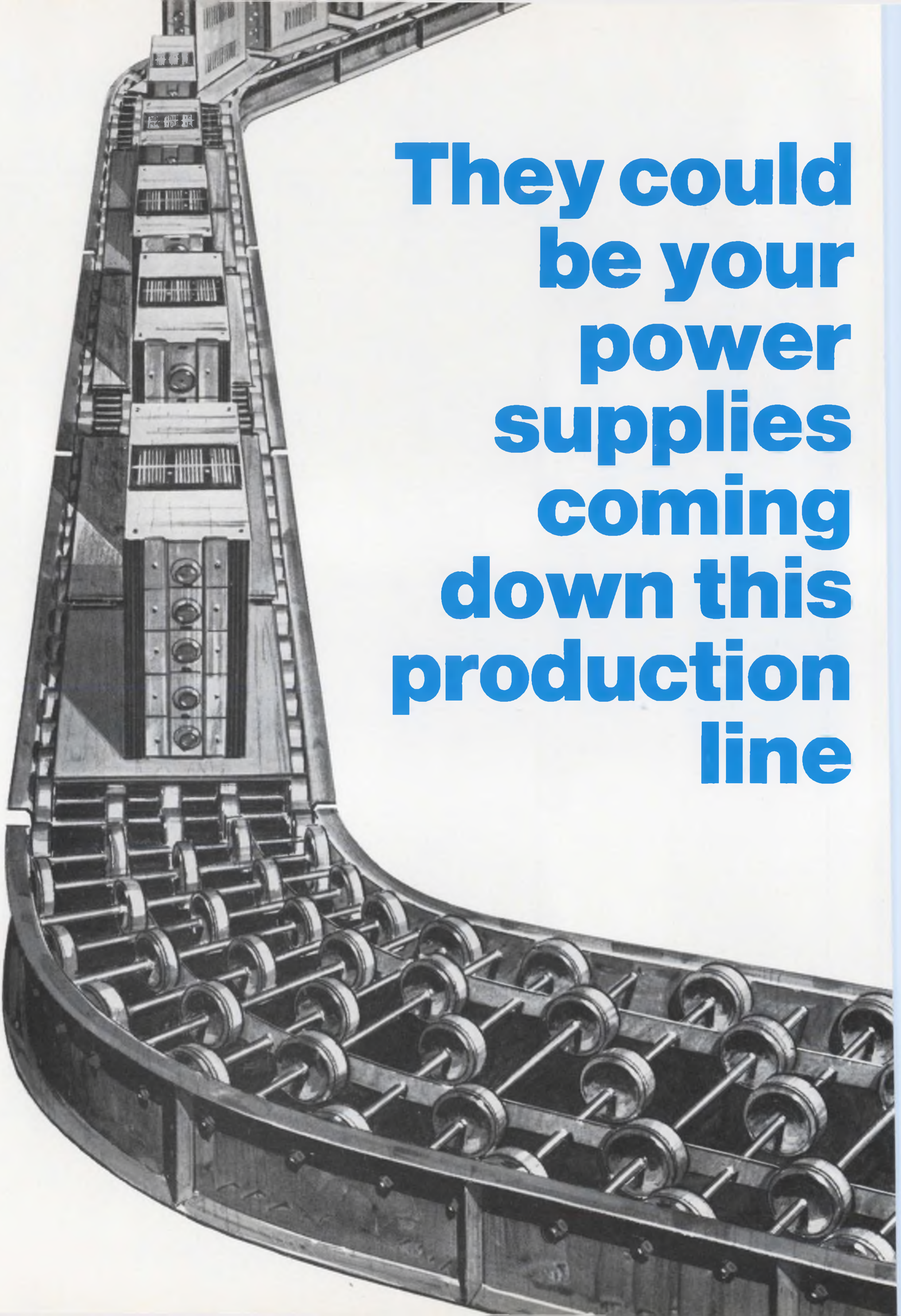
Master Cross Index

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

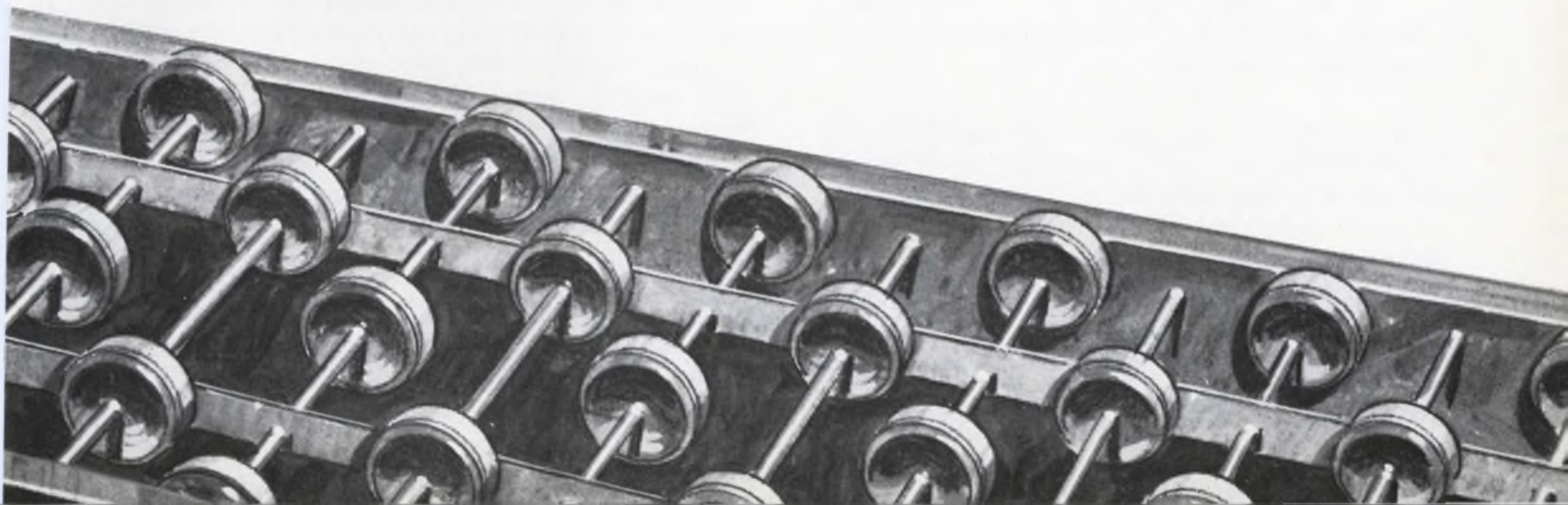
Abbrev.	Company	Reader Service No.
CEA	CEA Division Berkleonics Inc. 1221 S. Shamrock Monrovia, Calif. 91016 (213) 359-9261	363
Chalco	Chalco Engineering 15126 S. Broadway Gardena, Calif. 90247 (213) FA 1-0121	364
Christie	Christie Electric Corp. 3410 W. 67th St. Los Angeles, Calif. 90043 (213) 750-1151	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
Kepco	Kepco 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
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
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



They could be your power supplies coming down this production line



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-

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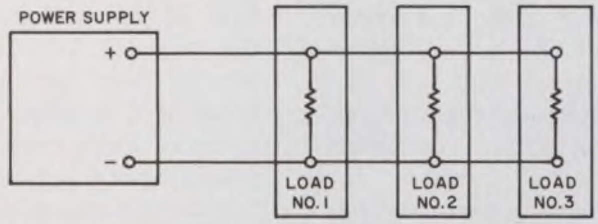
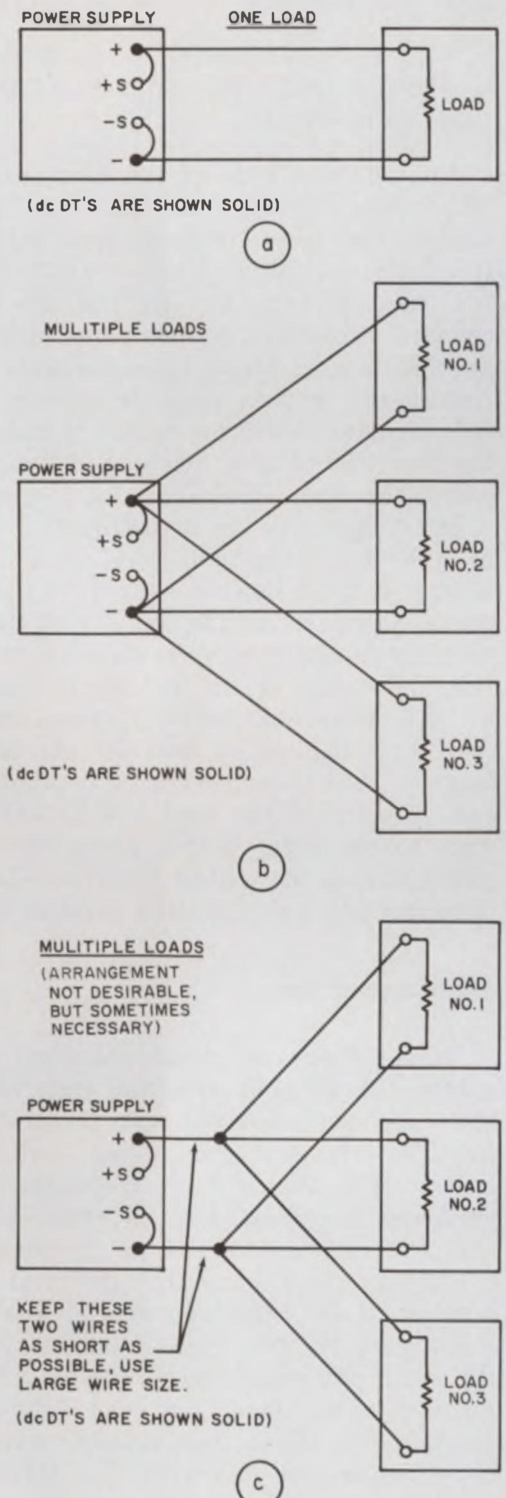
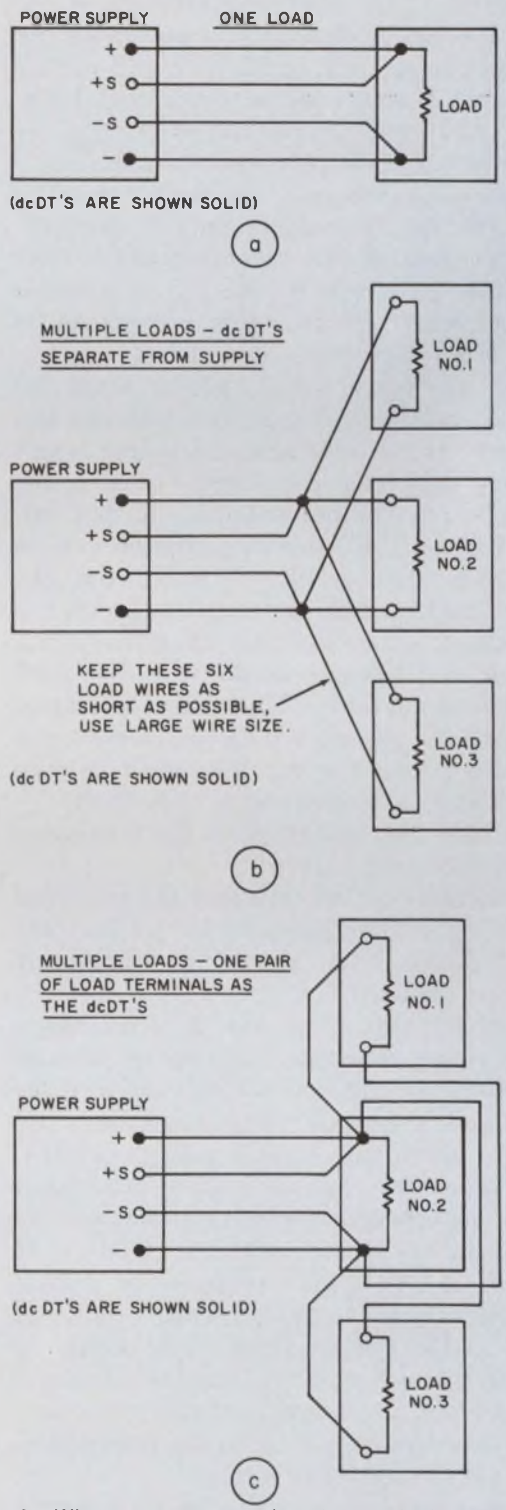


1. **A common example of improper load wiring** results in time-varying interaction among the loads.



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 mΩ, 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 μH—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_0, L_1, L_2 . . . . and R_0, 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 $2R_0$ with R_S, and $2L_0$ with L_S. The total impedance seen by the load is $Z_T = (R_S+2R_0) + j\omega\ (L_S+2L_0)$, 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 $e_L = L_T di/dt$ where $L_T = L_S + 2L_0$, 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—$(R_S+2R_0) + j\omega\ (L_S+2L_0)$—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_0 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_0 seen by the load, since L_0 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).

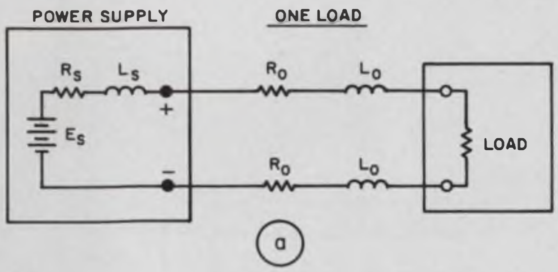
To be effective, the high-frequency impedance of local decoupling capacitors, C_0, C_1, C_2, and C_3 of Fig. 5, must be lower than the impedance of wires connected to the same load. Thus a decoupling capacitor must be chosen with care, with full knowledge of its inductance and effective series resistance, 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.

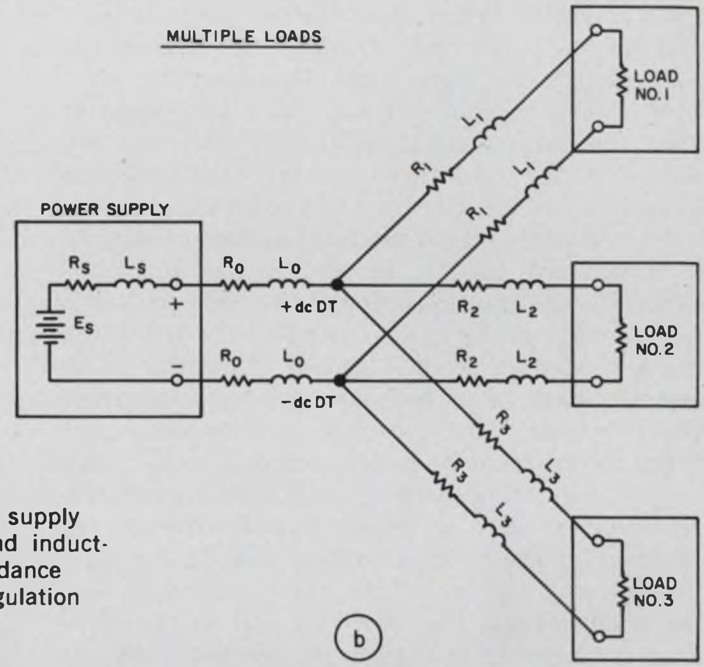
Avoid ground loops

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.

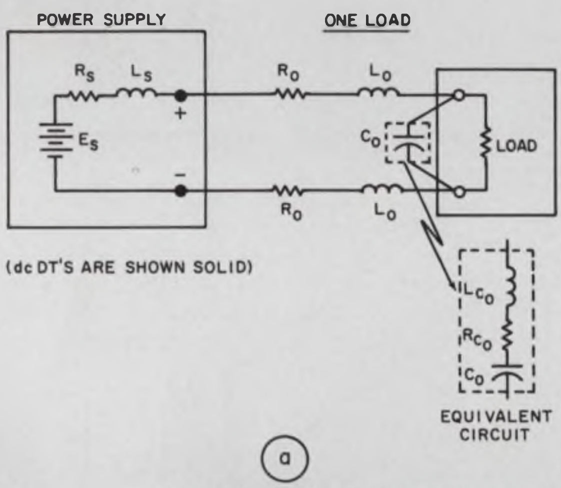
Start by recognizing that the ideal concept of a single "quiet" ground potential is a snare and a delusion. No two ground points have exactly the same potential. The potential differences in many cases are small, but even a difference of a fraction of a volt in two "ground" potentials will cause amperes of current to flow through a complete ground loop.

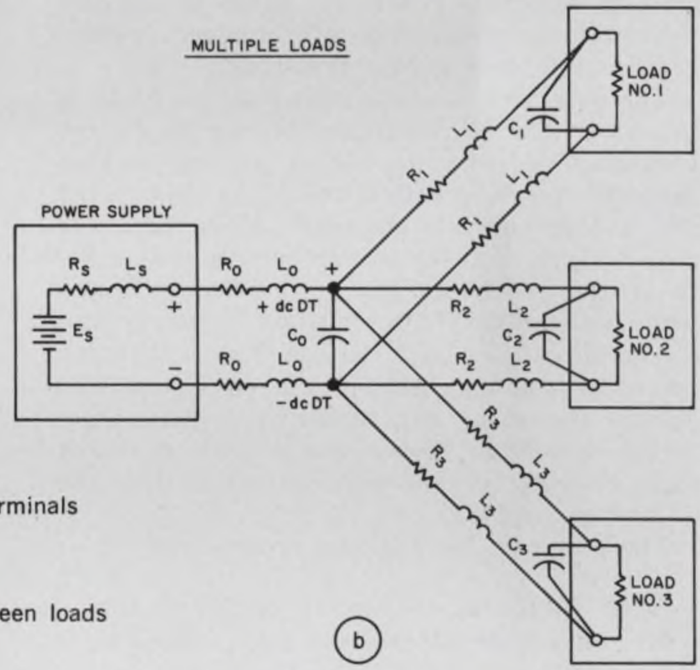
To avoid ground-loop problems, it is necessary to have only one ground return point in a power-



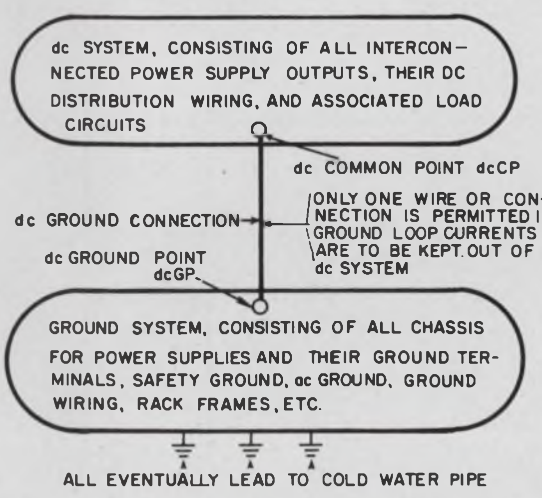


4. **A more exact circuit model** for a power supply includes an equivalent source resistance and inductance. R_S is the power-supply output impedance at dc and is found by dividing the load regulation by the current rating.





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 tis 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.

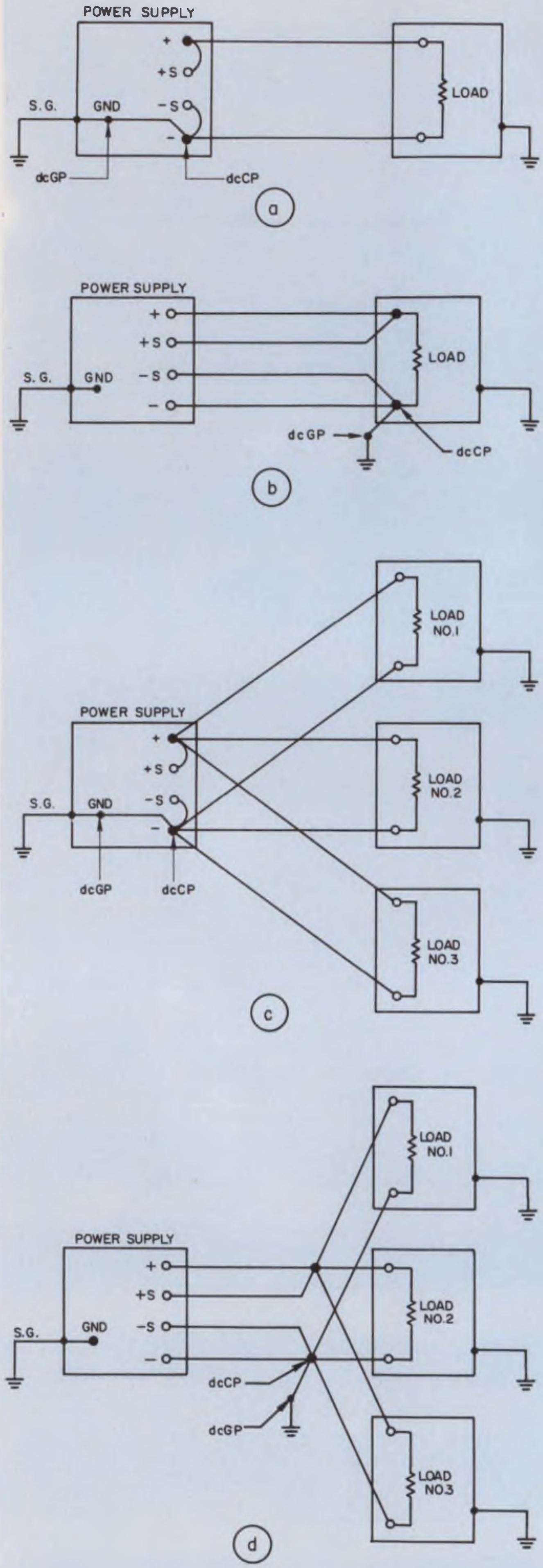
The only way to avoid such common paths is to connect the dc distribution system to ground with only one wire. In Fig. 6, dc (and signal) currents circulate within the upper box, while ground-loop currents circulate within the lower box. So long as there is only one connection between the two boxes, 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.

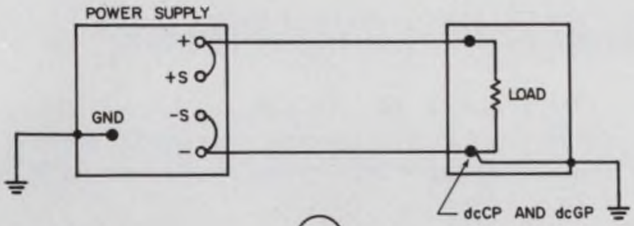
The first rule for avoiding ground-loop is:

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





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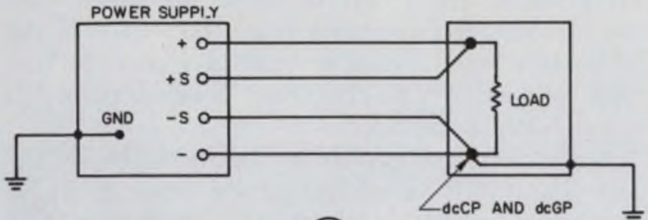

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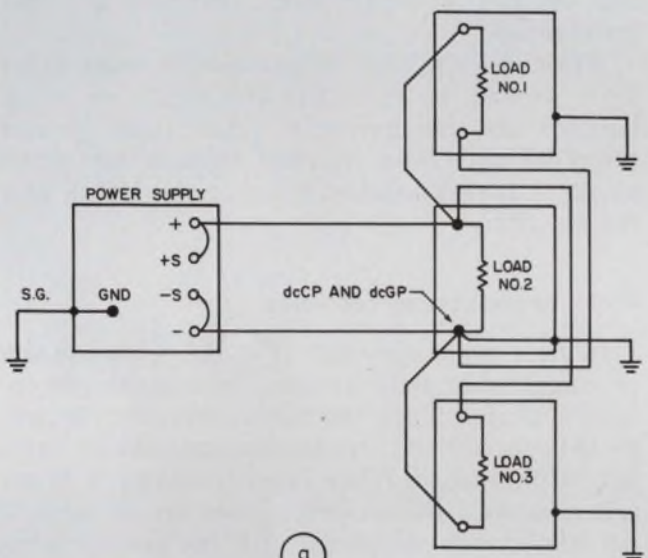

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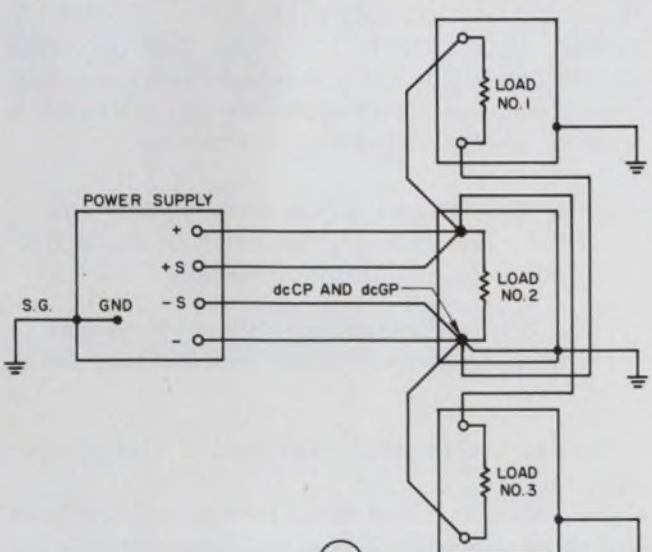

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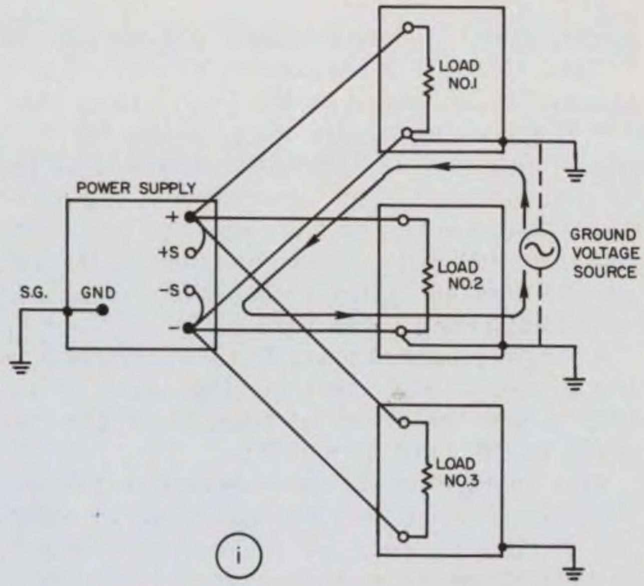

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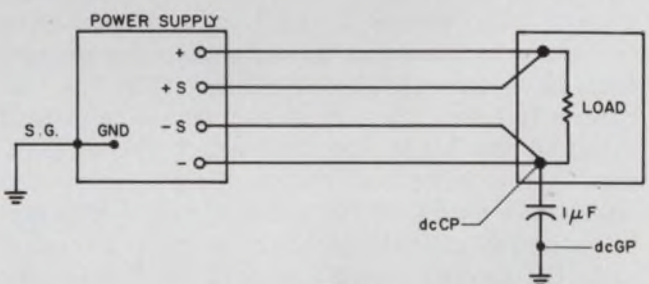


j

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 μF 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 expressly 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

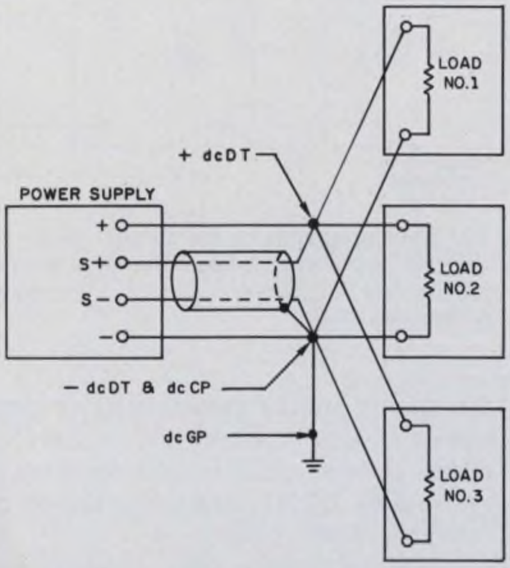
In using remote sensing (Fig. 8), some amount of compromise with respect to normal power-supply performance characteristics can be expected, particularly transient performance and output impedance. When remote sensing is properly employed, these compromises are of secondary importance compared with the 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.

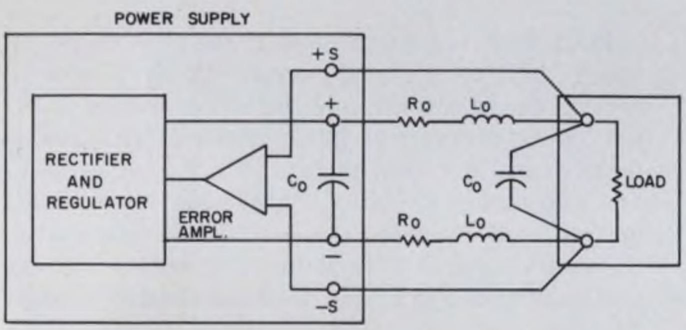
C2. Using shielded two-wire cable, connect the power-supply sensing terminals to the DCDTs.

Do not use the shield as one of the sensing conductors.

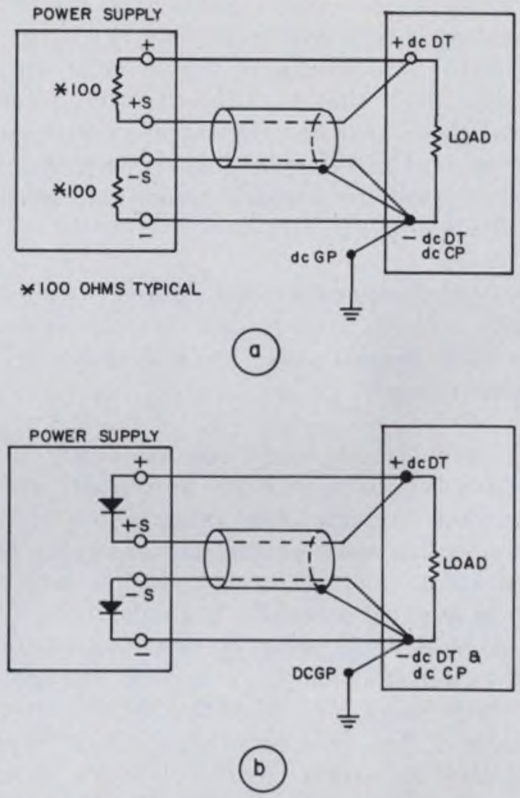
To ensure that the temperature coefficient of the copper sensing leads will not significantly affect the power-supply temperature coefficient



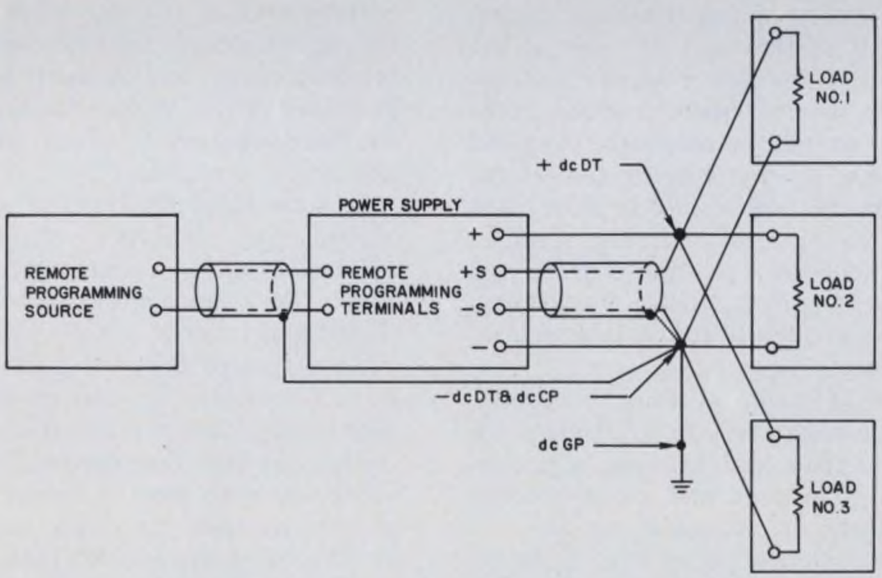
8. **Remote sensing leads and shields** are shown properly connected.



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.



9. **Sensing protection** using resistor configuration is shown in (a) using diode configuration in (b).



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.

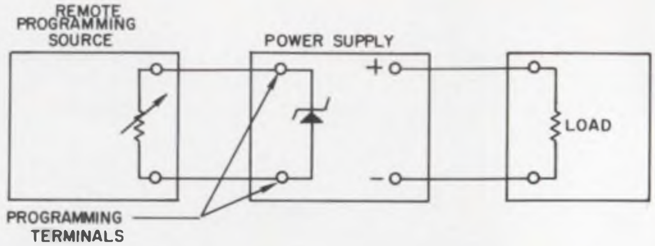
Such open-circuit conditions are likely if the remote-sensing path includes any relay, switch, or connector contacts. Any interruption of hard wire connection between the power-supply sensing terminals and the dc distribution terminals should be avoided wherever possible.

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 correponding 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 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.



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.

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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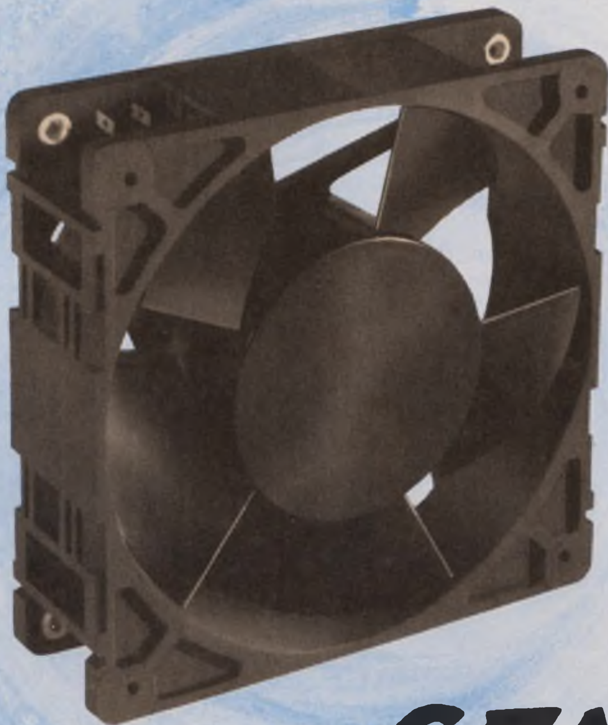

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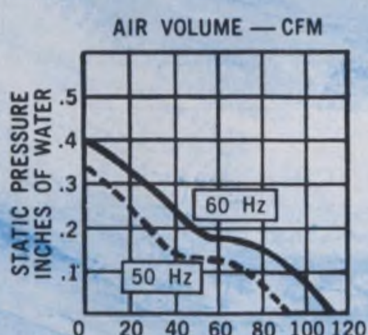

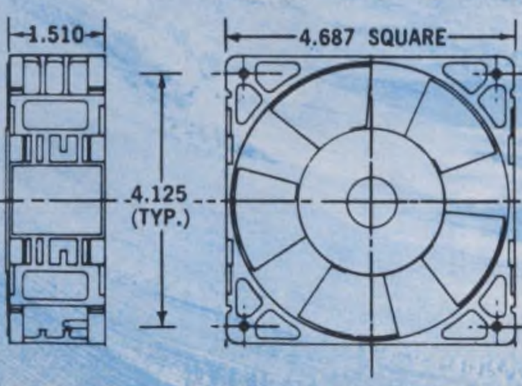

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Make sure you pick the right power supply

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 electolytic 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 xformer	SI	C, LC	none	1	3-10	25	1/W	same as input	75	ext	int	conv
Narrow range (slot)	xformer	SI	C	± 5 - 20	0.03	0.03	25	1/W	transistor (silicon)	40	ext	int	conv
Wide range	xformer	SI	C	100	0.01	0.01	0.1	2/W	transistor (silicon)	30	ext	int	conv
High wattage:													
>500 W	xformer	SI	C, LC	100	0.1	0.1	1	0.50/W	SCR	75	ext	int	blower
Low ripple	xformer	SI	C, LC	limited	0.1	0.1	1	0.60/W	SCR & transistor filter	70	ext	int	blower
Good regulation	xformer	SI	C	100	0.01	0.01	0.1	0.70/W	SCR, transistor switch & pass	50	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

High Current Power Supplies

	Mfr	Model	OUTPUT Range Volts	Max Amps	REGULATION Line %	Load %	Ripple mV	Notes	Price $
	Int Cont	CPS500-1	2	25	0.05	0.05	5	t	995
	*Trygon	LH54-14	2.5	14	0.01	0.01	1		229
	*ERA	SR0218	1-3	15	±0.01	0.05	0.8	abd	430
HC 1	*ERA	SR0225	1-3	25	±0.01	0.05	0.8	abd	515
	Chalco	T0458F5	2-3.5	58	0.005	0.005	0.01%	abdj	510
	Chalco	T0497F7	2-3.5	97	0.005	0.005	0.01%	abdj	655
	Beco	301	0-4	7.2	0.01	0.1	0.2	dep	reg
	*H-P	6463A	0-4	2000	50mV	50mV	280	abcdey	3500
	*Trygon	L3R-4-40	2.5-4.5	40	±0.005	0.005	0.5		470
	*Trygon	L5R4-70	2.5-4.5	70	±0.005	0.005	0.5		575
	*ERA	SR054	0-5	4	±0.01	0.05	0.8	abd	325
	*ERA	CP55	5	6.5	0.05	0.03	1	abd	145
	Wanless	PSS1-5	5	7.5	±0.005	±0.01	0.75	w	275
	*ERA	SR058	0-5	8	±0.01	0.05	0.8	abd	390
HC 2	*ERA	CP510	5	13	0.05	0.03	1	abd	185
	Wanless	PSS2-5	5	15	±0.005	±0.01	0.75	w	325
	*ERA	CP517	5	22	0.05	0.03	1	abd	230
	*ERA	CP525	5	32	0.05	0.03	1	abd	310
	Hyp	HY-S1-5-50	0-5	50	0.01	0.01	2	abcdej	499
	*ERA	CP550	5	65	0.05	0.03	1	abd	495
	Plastic	LV5-250	4.9-5.1	2.5	0.05	0.05	3	abdfghj	122
	Plastic	LV5-750	4.9-5.1	7.5	0.05	0.05	3	abdfghj	161
	*Trygon	LQS4-3.8	2.5-5.5	3.8	0.01	0.01	0.5		135
	*H-P	6384A	4-5.5	8	1mV	1mV	1	cde	220
HC 3	*Trygon	LQS4-8.4	2.5-5.5	8.4	0.01	0.01	0.5		174
	*Kepco	CPS6-10M	0-6	10	0.0005	0.005	0.2	abcde	366
	*Kepco	JQE6-10M	0-6	10	0.0005	0.005	0.2	abcde	289
	*Kepco	JQE6-22M	0-6	22	0.0005	0.005	0.2	abcde	520
	*Kepco	CPS6-22M	0-6	22	0.0005	0.005	0.2	abcde	585
	*Kepco	JQE6-45M	0-6	45	0.0005	0.005	0.2	abcde	625
	*Kepco	CPS6-45M	0-6	45	0.0005	0.005	0.2	abcde	660
	*Kepco	JQE6-90M	0-6	90	0.0005	0.005	0.2	abcde	977
	*Kepco	CPS6-90M	0-6	90	0.0005	0.005	0.2	abcde	995
	Wanless	SSS1-1	3-6.5	15	±0.03	±0.03	0.5	bv	250
	Wanless	SSS2-1	3-6.5	25	±0.03	±0.03	0.5	bv	315
HC 4	*Trygon	HH7-40V	0-7	4	0.01	0.01	0.5		189
	*ERA	MS074	0-7	4	±0.01	0.05	0.8	abdk	455
	Wanless	LAB1	0-7	5	±0.05	±0.05	0.75	de	125
	Power Des	6050	0-7	5	0.01	0.01	1	abcd	195
	*ERA	MS078	0-7	8	±0.01	0.05	0.8	abdk	595
	Chalco	H0739F5	2-7	38.5	0.005	0.005	0.01%	abdj	510
	Chalco	H0744F5	3.5-7	44	0.005	0.005	0.01	abdj	510
	Chalco	T0749F5	4.5-7	49.2	0.005	0.005	0.01%	abdj	510
	Chalco	H0764F7	2-7	64	0.005	0.005	0.01	abdj	665
HC 5	Chalco	H0774F7	3.5-7	73.5	0.005	0.005	0.01%	abdj	665
	Chalco	T0782F7	4.5-7	82	0.005	0.005	0.01%	abdj	655
	*H-P	6281A	0-7.5	5	0.01	5mV	0.2	abcde	210
	*Sorensen	QRE7.5-10	0-7.5	10	±0.01	±0.01	0.3	abcdej	345
	*Sorensen	QRE7.5-20	0-7.5	20	±0.01	±0.01	0.3	abcdej	495
	*Sorensen	QRE7.5-50	0-7.5	50	±0.01	±0.01	0.3	abcdej	645
	*Trygon	LQS6-3.3	4.5-7.8	3.3	0.01	0.01	0.5		135
	*Trygon	LQS6-7.7	4.5-7.8	7.7	0.01	0.01	0.5		179
	*Trygon	LH56-13.5	4.5-7.8	13	0.01	0.01	1		229
	*Trygon	LH56-24	4.5-7.8	24	0.01	0.01	1		320
	*Trygon	L3R6-40	4.5-7.8	40	±0.005	0.005	0.5		470
HC 6	*Trygon	L5R6-70	4.5-7.8	70	±0.005	0.005	0.5		595
	Beco	302	0-8	3.6	0.01	0.1	0.2	dep	reg
	*Power/Mate	BP-8D	0-8	4	0.01	0.01	0.25	abcdej	129
	*Power/Mate	BP-8E	0-8	6.5	0.01	0.01	0.25	abcdej	210
	*Power/Mate	BP-8F	0-8	9	0.01	0.01	0.25	abcdej	235
	*Power/Mate	BP-8G	0-8	12	0.01	0.01	0.25	abcdej	290
	*Kepco	KS8-15M	0-8	15	0.005	0.01	1	abcde	657
	*Power/Mate	BP-8H	0-8	15	0.01	0.01	0.25	abcdej	345
HC 7	*Kepco	KS8-25M	0-8	25	0.005	0.01	1	abcde	798
	*Trygon	M3P8-250V	0-8	25	±0.005	0.005	1		575
	*Kepco	KS8-50M	0-8	50	0.005	0.01	1	abcde	1103
	*Trygon	M5P8-500V	0-8	50	±0.005	0.005	1		750
	*Trygon	M7C8-100-0V	0-8	100	±0.005	0.005	1		995
	*Kepco	KS8-100M	0-8	100	0.005	0.01	1	abcde	1523
	*H-P	6464A	0-8	1000	25mV	25mV	80	abcdey	3300

Mfr	Model	OUTPUT Range Volts	Max Amps	REGULATION Line %	Load %	Ripple mV	Notes	Price $
*Sorensen	QSB6-4	5-9	4.4	±0.015	±0.015	0.25	abcdej	115
*Sorensen	QSB6-8	5-9	8.8	±0.015	±0.015	0.25	abcdej	170
*Sorensen	QSB6-15	5-9	16.5	±0.015	±0.015	0.25	abcdej	300
*Sorensen	QSB6-30	5-9	33	±0.015	±0.015	0.25	abcdej	400
*NJE	PVC-10-4	0-10	4	0.01	0.01	0.25	abcde	195
*NJE	LVCII-10-4	0-10	4	0.01	0.01	0.25	abcde	171
*Hyp	HY-VS-10-4	0-10	4	0.01	0.01	0.5	abcdej	199
*NJE	PVC-10-8	0-10	8	0.01	0.01	0.25	abcde	295
*H-P	6282A	0-10	10	0.01	0.01	0.5	abcde	350
Holt	275	0-10	10	0.1	0.05	0.02	cd	2060
Prec Stan	104	0-10	10	0.005	0.01	0.1	abcdef	269
*Techi	LA10-12M	0-10	12	±0.1	±0.15	0.2%	abcde	370
Hyp	HY-S1-10-12.5	0-10	12.5	0.01	0.01	0.5	abcdej	299
Prec Stan	109	0-10	15	0.005	0.01	0.1	abcdef	370
*Mid-East	HW20-15	0-10	15	0.01	0.01	1	abcde	310
*H-P	6256B	0-10	20	0.01	0.01	0.2	abcde	450
Hyp	HY-S1-10-25	0-10	25	0.01	0.01	0.5	abcdej	499
*Techni	LA10-25M	0-10	25	±0.01	±0.15	0.2%	abcde	410
*H-P	6259B	0-10	50	0.01	0.01	0.5	abcde	650
*H-P	6260B	0-10	100	0.01	0.01	0.5	abcde	825
Hyp	HY-S1-10-100	0-10	100	0.01	0.01	0.5	abcdej	1240
EMC	SCR10-250	0-10	250	0.1	0.1	5	abcde	1300
EMC	SCR10-500	0-10	500	0.1	0.1	5	abcde	1700
*Trygon	LQS8-3.1	6.5-10.5	3.1	0.01	0.01	0.5		139
*Trygon	LQS8-6.5	6.5-10.5	6.5	0.01	0.01	0.5		189
*Trygon	LH58-11.5	6.5-10.5	11.5	0.01	0.01	1		239
*Trygon	LH58-21	6.5-10.5	21	±0.005	0.005	1		320
*Trygon	L3R8-25	6.5-10.5	25	±0.005	0.005	0.5		470
*Trygon	L5R8-50	6.5-10.5	50	±0.005	0.005	0.5		595
Dynage	KHC10/10	9-11	4	±0.05	±0.05	2	abdfg	325
*Trygon	LQS10-6.5	8.5-11.5	6.5	0.1	0.01	0.5		189
*Trygon	LHS10-11.5	8.5-11.5	11.5	0.01	0.01	1		239
*Trygon	LHS10-21	8.5-11.5	21	±0.005	0.005	1		320
*Trygon	L3R10-25	8.5-11.5	25	±0.005	0.005	0.5		505
*Trygon	L5R10-50	8.5-11.5	50	±0.005	0.005	0.5		620
*ERA	MS124	11-12	4	0.01	0.05	0.8	abdk	455
Wanless	PSS1-12	12	5	±0.005	±0.01	0.75	w	275
*ERA	MS128	11-12	8	0.01	0.01	0,05	abdk	595
Wanless	PSS2-12	12	10	±0.005	±0.01	0.75	w	325
Power Des	1210S	0-12	10	0.01	0.01	1.5	abcd	329
Atlas	P3070	12	30	0.5	1	5	dj	880
*Kepco	K012-100M	0-12	100	1	1	30	abcde	1095
Plastic	LV12-400	11.75-12.25	4	0.05	0.05	3	abdfghj	139
Plastic	LV12-600	11.75-12.25	6	0.05	0.05	3	abdfghj	161
Plastic	LV12-800	11.75-12.25	8	0.05	0.05	3	abdfghj	178
Dynage	KHC12/12	11-13	3.6	±0.05	±0.05	2	abdfg	325
*Kepco	SM14-7AM	0-14	7	0.01	0.05	1	bcde	427
*Kepco	SM14-15AM	0-14	15	0.01	0.05	1	bcde	552
*NJE	TC-14-15M	5-14	15	0.5	0.5	1000	abcd	365
*NJE	TC-14-30M	5-14	30	0.5	0.5	1000	abcd	500
*Kepco	SM14-30AM	0-14	30	0.01	0.05	1	bcde	762
*NJE	TC-14-200M	5-14	200	0.5	0.5	1000	abcd	1550
*Trygon	LQS12-5.7	11-15	5.7	0.01	0.01	0.5		174
*Kepco	CPS15-6M	0-15	6	0.0005	0.005	0.2	abcde	366
*Kepco	JQE15-6M	0-15	6	0.0005	0.005	0.2	abcde	289
Hyp	HY-S1-15-10	0-15	10	0.01	0.01	0.5	abcdej	299
*Kepco	PR15-10M	0-7.5-15	10	±1	2	2%	cde	378
*Trygon	LHS12-10	11-15	10	0.01	0.01	0.5		229
*Kepco	CPS15-12M	0-15	12	0.0005	0.005	0.2	abcde	585
*Kepco	JQE15-12M	0-15	12	0.0005	0.005	0.2	abcde	520
*Trygon	LHS12-18	11-15	18	0.01	0.01	0.5		320

Reader service numbers for literature and application notes, see page D6

POWER SUPPLY with DIGITAL 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 Voltage	Ratings Current	Price(1)	Model No.	Ratings Voltage	Ratings Current	Price(1)
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 a subsidiary of CONDEC Corporation
Electronic Development and Manufacture
Kenilworth, New Jersey 07033 / (201) 272-6000 / TELEFAX: FFP • TWX: (710) 996-5967

INFORMATION RETRIEVAL NUMBER 605

	Mfr	Model	Output: Range Volts	Output: Max Amps	Regulation: Line %	Regulation: Load %	Regulation: Ripple mV	Notes	Price $
HC 8	*Kepco	CPS15-25M	0-15	25	0.0005	0.005	0.2	abcde	660
	*Kepco	JQE15-25M	0-15	25	0.0005	0.005	0.2	abcde	625
	*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
	*Kepco	PR15-30M	0-15	30	±1	2	2%	cde	552
	*Kepco	CPS15-50M	0-15	50	0.0005	0.005	0.2	abcde	995
	*Trygon	M5C15-50	0-15	50	±0.005	0.005	1		845
	*Kepco	JQE15-50M	0-15	50	0.0005	0.005	0.2	abcde	977
	*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
HC 9	Christie	SC015-100-12S	2-15	100	0.2	0.2	0.2	abcde	1025
	*H-P	6453A	0-15	200	0.2%	0.2%	150	abcdey	1375
	Dynage	KHC15/15	14-16	3.2	20.05	20.05	2	abdfg	325
	Wanless	MP-16	0-16	4	±0.01	±0.01	0.25	dev	225
	Wanless	PCD-16	0-16	4	±0.005	±0.005	0.5		375
	Chalco	H1636F5	8-16	25.5	0.005	0.005	0.01%	abdj	510
	Chalco	T1631F5	11-16	30.6	0.005	0.005	0.01%	abdj	510
	Chalco	H1643F7	8-16	42.8	0.005	0.005	0.01	abdj	665
	Chalco	T1651F7	11-16	51	0.005	0.005	0.01%	abdj	655
	*Power/Mate	BP-18E	0-18	3.5	0.01	0.01	0.25	abcdej	210
HC 10	*ERA	MS184	17-18	4	0.01	0.05	0.8	abdk	455
	*Sorensen	QSB12-4	9-18	4.4	±0.005	±0.005	0.25	abcdej	170
	*Power/Mate	BP-18F	0-18	5	0.01	0.01	0.25	abcdej	235
	*Power/Mate	BP-18G	0-18	6.5	0.01	0.01	0.25	abcdej	290
	*ERA	MS188	17-18	8	0.01	0.05	0.8	abdk	595
	*Sorensen	QSB12-8	9-18	8.8	±0.005	±0.005	0.25	abcdej	225
	*Power/Mate	BP-18H	0-18	9	0.01	0.01	0.25	abcdej	345
	*Kepco	KS18-10M	0-18	10	0.005	0.01	1	abcde	604
	*Kepco	KS18-15M	0-18	15	0.005	0.01	1	abcde	762
	*Sorensen	QSB12-15	9-18	16.5	±0.005	±0.005	0.25	abcdej	325
HC 11	*Ratelco	PS-9	1-18	20	1	1	10		450
	*Kepco	KS18-25M	0-18	25	0.005	0.01	1	abcde	1018
	*Sorensen	QSB12-30	9-18	33	±0.005	±0.005	0.5	abcdej	550
	*Kepco	KS18-50M	0-18	50	0.005	0.01	1	abcde	1428
	*H-P	6466A	0-16-18	500, 600	0.2	0.2	180	abcdey	2600
	*NJE	PVC-20-4	0-20	4	0.01	0.01	0.25	abcde	295
	*Mid-East	HW20-4	0-20	4	0.01	0.01	1		225
	*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
	*Techni	LA20-6M	0-20	6	±0.01	±0.15	0.2%	abcde	345
	*Trygon	RS20-7.5A	20	7.5	0.01	0.01	0.5		430
	Prec Stan	110	0-20	7.5	0.005	0.01	0.15	abcdef	370
	*NJE	SVC-20-7.5M	0-20	7.5	0.01	0.01	1	abcde	375
	*Sorensen	QRC20-8A	0-20	8	±0.005	±0.005	1	abcdej	425
	*H-P	6286A	0-20	10	0.01	0.01	0.5	abcde	395
	*H-P	6263B	0-20	10	0.01	0.01	0.2	abcde	435
	*Mid-East	HW20-10	0-20	10	0.01	0.01	1		310
	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
	*H-P	6427B	0-20	15	10mV	20mV	40	abcde	380
	*Trygon	RS20-15A	20	15	0.01	0.01	0.5		465
	*Sorensen	QRC20-15A	0-20	15	±0.005	±0.005	1	abcdej	525
	*NJE	SVC-20-15M	0-20	15	0.01	0.01	1	abcde	490
	*Mid-East	PR20-15	0-20	15	0.01	0.01	1	abde	495
	*Mid-East	RA20-15	0-20	15	0.01	0.01	1	abd	415
	*H-P	6264B	0-20	20	0.01	0.01	0.2	abcde	525
	Hyp	HY-S1-20-20	0-20	20	0.01	0.01	0.5	abcdej	449
	*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
	*Sorensen	QRC20-30A	0-20	30	±0.005	±0.005	1	abcdej	695
	*NJE	SVC-20-30M	0-20	30	0.01	0.01	1	abcde	690
	*Mid-East	PR20-30	0-20	30	0.01	0.01	1		670
	*H-P	6428B	0-20	45	20mV	40mV	40	abcde	550

	Mfr	Model	Output: Range Volts	Output: Max Amps	Regulation: Line %	Regulation: Load %	Regulation: Ripple mV	Notes	Price $
HC 8	*H-P	6261B	0-20	50	0.01	0.01	0.5	abcde	775
	Hyp	HY-S1-20-50	0-20	50	0.01	0.01	0.5	abcdej	1240
	EMC	SCR20-125	0-20	125	0.01	0.1	5	abcde	1150
	*Sorensen	DCR20-125	0-20	144	±0.075	±0.075	0.4%	abcdej	1150
	*Trygon	CR20-150	20	150	0.2	0.2	150		1450
	EMC	SCR20-250	0-20	250	0.1	0.1	5	abcde	1500
	*Sorensen	DCR20-250A	0-20	275	±0.1	±0.1	160	abcdej	1500
	EMC	SCR20-500	0-20	500	0.1	0.1	5	abcde	2900
HC 9	*Trygon	LQS18-4.3	13.5-20.5	4.3	0.01	0.01	0.5		174
	*Trygon	LHS18-7.5	13.5-20.5	7.5	0.01	0.01	0.5		229
	*Trygon	LHS18-13	13.5-20.5	13	0.01	0.01	0.5		320
	*Trygon	L3R18-20	13.5-20.5	20	±0.005	±0.005	0.5		505
	*Trygon	L5R18-40	13.5-20.5	40	±0.005	0.005	0.5		620
	*ERA	MS244	23-24	4	0.01	0.05	0.8	abdk	455
	Wanless	PSS2-24	24	5	±0.005	±0.01	0.75	w	325
	*ERA	MS248	23-24	8	0.01	0.05	0.8	abdk	595
	Plastic	LV24-400	23.5-24.5	4	0.05	0.05	3	abdfghj	150
	*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	*Trygon	LH54-25	25	25	0.01	0.01	1		320
	*Kepco	JQE25-36M	0-25	36	0.0005	0.005	0.2	abcde	977
	*Kepco	K025-50M	0-25	50	1	1	40	abcde	995
	*Sorensen	QSB18-3	13-26	3.3	±0.005	±0.005	0.25	abcdej	170
	*Sorensen	QSB18-6	13-26	6.6	±0.005	±0.005	0.25	abcdej	255
	*Sorensen	QSB18-12	13-26	13.2	±0.005	±0.005	0.25	abcdej	325
	*Trygon	LQS24-3.3	18.5-27.5	3.3	0.01	0.01	0.5		174
	*Trygon	LHS24-5.7	18.5-27.5	5.7	0.01	0.01	0.5		219
	*Trygon	LHS24-10	18.5-27.5	10	0.01	0.01	0.5		279
	*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	Wanless	MOS Series	5-28	2.1-5	±0.05	±0.05	0.75	du	125-325
	*ERA	MS288	27-28	8	0.01	0.05	0.8	abdk	595
	Deltron	LA	3-28	39	0.005	0.005	1	abdgj	109-299
	Plastic	LV28-400	27.4-28.6	4	0.05	0.05	3	abdfghj	150
	Plastic	LV28-500	27.4-28.6	5.0	0.05	0.05	3	abdfghj	197
	*Power/Mate	BP-30F	0-30	3.5	0.01	0.01	0.25	abcdej	235
	*Power/Mate	BP-30G	0-30	5	0.01	0.01	0.25	abcdej	290
HC 12	Prec Stan	111	0-30	5	0.005	0.01	0.18	abcdej	370
	*Power/Mate	BP-30H	0-30	6.5	0.01	0.01	0.25	abcdej	345
	R-S	NGRS30/10	0-30	10	±10	0.001	0.3	cd	470
	R-S	NGGS30/10	0-30	10	±10	0.05	0.5	cd	470
	EMC	SCR30-100	0-30	100	0.1	0.1	5	abcde	1250
	EMC	SCR30-200	0-30	200	0.1	0.1	5	abcde	1600
	*ERA	MS324	31-32	4	0.01	0.05	0.8	abdk	455
	*ERA	LC325	4-32	6.5	±0.01	0.5	0.8	abd	189
	*ERA	TR Series	5-32	to 8	0.05	0.05	2	abdg	275-330
HC 13	*NJE	TC-32-10M	10-32	10	0.5	0.5	1000	abcd	320
	*ERA	LC3210	4-32	12.5	±0.01	0.05	0.8	abd	225
	EPL	PSR-500-32	2-32	15	0.1	1.0	0.5%	c	395
	*NJE	SP32-20	10-32	20	50mV	100mV	50	bcd	525
	*NJE	TC-32-20M	10-32	20	0.5	0.5	1000	abcd	445
	*NJE	SP32-30	10-32	30	50mV	100mV	50	bcd	562
	*NJE	TC-32-30M	10-32	30	0.5	0.5	1000	abcd	585
	*NJE	SP32-50	10-32	50	50mV	100mV	50	bcd	735
	*NJE	TC-32-50M	10-32	50	0.5	0.5	1000	abcd	865
HC 14	*NJE	SP32-100	10-32	100	50mV	100mV	50	bcd	1450
	*NJE	TC-32-120M	10-32	120	0.5	0.5	1000	abcd	1570
	*ERA	WR334	1-33	4.8	±0.01	0.05	0.8	abd	255
	*Trygon	LHS28-5.5	22-33	5.5	0.01	0.01	0.5		219
	*Trygon	LHS28-9	22-33	9	0.01	0.01	0.5		279

Mallory designed this DURACELL® for Bogen

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.

Naturally they turned to Mallory, makers of DURACELL, the amazing long distance power cell. And Mallory made it. A one-ounce DURACELL mercury battery that can last up to 1000 hours and can maintain about 80% of its energy up to two years in storage.

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. (In Canada: Mallory Battery Company of Canada Limited, Sheridan Park, Ontario.)

MALLORY

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	Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
HC 15	*ERA	WR338	1-33	9.6	±0.01	0.05	0.8	abd	305
	Chalco	H3315F5	16-33	14.5	0.005	0.005	0.01%	abdj	510
	*Trygon	L3R28-15	24-33	15	±0.005	0.005	0.5		470
	Chalco	T3318F5	22-33	17.8	0.005	0.005	0.01%	abdj	510
	Chalco	H3324F7	16-33	24	0.005	0.005	0.01	abdj	665
	Chalco	T3330F7	22-33	30	0.005	0.005	0.01%	abdj	655
	*Trygon	L5R28-30	24-33	30	+0.005	0.005	0.5		565
	*ERA	SL36-4M	0-36	4	±0.01	0.05	1	abcde	290
	*Sorensen	QSB28-4	18-36	4.4	±0.005	±0.005	0.25	abcdej	255
HC 16	*NJE	RVC36-5M	0-36	5	0.01	0.01	1	abcde	375
	Power Des	3650S	0-36	5	0.01	0.01	1.5	abcd	299
	Power Des	3650R	0-36	5	0.01	0.01	0.5	abcde	350
	*Kepco	KS36-5M	0-36	5	0.005	0.01	1	abcde	552
	*Kepco	SM36-5AM	0-36	5	0.01	0.05	1	bcde	415
	*Kepco	JQE36-6M	0-36	6	0.0005	0.005	0.2	abcde	520
	*ERA	SL36-8M	0-36	8	±0.01	0.05	1	abcde	355
	*Sorensen	QSB28-8	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
	*Kepco	KS36-10M	0-36	10	0.005	0.01	1	abcde	657
	*Kepco	SM36-10AM	0-36	10	0.01	0.05	1	bcde	552
	*NJE	SY36-10M	10-36	10	0.01	0.01	1	abcd	390
	*ERA	SL-36-12M	0-36	12	±0.01	0.05	1	abcde	455
	*Kepco	JQE36-13M	0-36	13	0.0005	0.005	0.2	abcde	625
	*NJE	RVC-36-15M	0-36	15	0.01	0.01	1	abcde	545
	*Kepco	KS36-15M	0-36	15	0.005	0.01	1	abcde	767
	*Kepco	SM36-15AM	0-36	15	0.01	0.05	1	bcde	657
HC 18	*Trygon	M5P36-15	0-36	15	±0.005	0.005	1		615
	*NJE	SY-36-20M	10-36	20	0.01	0.01	1	abcd	485
	*ERA	SL36-25M	0-36	25	±0.01	0.05	1	abcde	650
	*NJE	RVC-36-25M	0-36	25	0.01	0.01	1	abcde	690
	Power Des	36250A	0-36	25	0.01	0.01	0.5	abcde	875
	*Kepco	JQE36-25M	0-36	25	0.0005	0.005	0.2	abcde	977
	*Kepco	KS36-30M	0-36	30	0.005	0.01	1	abcde	1208
	*NJE	SY-36-30M	10-36	30	0.01	0.01	1	abcd	645
	*H-P	6456B	0-36	100	0.2%	0.2%	160	abcdey	1275
HC 19	*Trygon	CR36-100	36	100	0.2	0.2	150		1350
	Hyp	HY-CR3-28-100	18-36	100	0.2	0.2	180	abcdej	1150
	*H-P	6469A	0-36	300	0.2	0.2	180	abcde	2300
	Plastic	LV36-400	35.3-36.7	4	0.05	0.05	3	abdfghj	215
	Christie	SC036-50-125	2-37	50	0.25	0.25	200	abcde	839
	*Kepco	PR38-5M	0-19-38	5	±1	2	1%	cde	357
	*Kepco	PR38-15M	0-38	15	±1	2	1%	cde	520
	*Sorensen	QRC40-4A	0-40	4	±0.005	±0.005	1	abcdej	350
	*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
	*H-P	6266B	0-40	5	0.01	0.01	0.2	abcde	435
	*H-P	6291A	0-40	5	0.01	0.01	0.5	abcde	395
	*Trygon	RS40-5A	40	5	0.01	0.01	0.5		445
	*Techni	LA40-6M	0-40	6	±0.01	±0.15	0.2%	abcde	360
	*Sorensen	QRC40-8A	0-40	8	±0.005	±0.005	1	abcdej	470
	*NJE	SVC-40-10M	0-40	10	0.01	0.01	1	abcde	475
	*Mid-East	PR-40-10	0-40	10	0.01	0.01	1		485
	*Mid-East	RA40-10	0-40	10	0.01	0.01	1		415
	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
	*Trygon	RS40-10A	40	10	0.01	0.01	0.5		475
	*Sorensen	DCR40-10A	0-40	11.5	±0.075	±0.075	0.4%	abcdej	360
	*Techni	LA40-12M	0-40	12	±0.01	±0.15	0.2%	abcde	420
	*Sorensen	QRC40-15A	0-40	15	±0.005	±0.005	1	abcdej	650
	*NJE	SVC-40-20M	0-40	20	0.01	0.01	1	abcde	670
	*Mid-East	PR40-20	0-40	20	0.01	0.01	1		675
	*Mid-East	RA40-20	0-40	20	0.01	0.01	1		440
	*Ratelco	PS-8	1-40	20	1	1	10		500
	*Sorensen	DCR40-20A	0-40	23	±0.075	±0.075	0.4%	abcdej	500

Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
*Techni	LA40-25M	0-40	25	±0.01	±0.15	0.2%	abcde	530
*H-P	6434B	0-40	25	18mV	40mV	40	abcde	550
*Trygon	M5C36-30	0-40	30	±0.005	0.005	1		690
*Sorensen	QRC40-30A	0-40	30	±0.005	±0.005	1	abcdej	775
*Mid-East	RA40-30	0-40	30	0.01	0.01	1		665
*H-P	6268B	0-40	30	0.01	0.01	1	abcde	695
*Sorensen	DCR40-35A	0-40	40	±0.075	±0.075	0.4%	abcdej	750
*Trygon	M7C40-50	0-40	50	±0.005	0.005	1		975
*H-P	6269B	0-40	50	0.01	0.01	1	abcde	875
EMC	SCR40-60	0-40	60	0.1	0.1	5	abcde	1010
*Sorensen	DCR40-60A	0-40	69	±0.075	±0.075	0.4%	abcdej	925
EMC	SCR40-125	0-40	125	0.1	0.1	5	abcde	1375
*Sorensen	DCR40-125A	0-40	138	±0.1	±0.1	160	abcdej	1375
EMC	SCR40-250	0-40	250	0.1	0.1	5	abcde	2500
*Sorensen	DCR40-250A	0-40	275	±0.1	±0.1	160	abcdej	2340
*Sorensen	DCR40-500A	0-40	550	±0.1	±0.1	0.4%	abcdej	3850
*NJE	SP41-20	10-41	20	50mV	100mV	50	bcd	800
*NJE	SP41-30	10-41	30	50mV	100mV	50	bcd	940
Chalco	H4511F5	22-45	11	0.005	0.005	0.01%	abdj	510
Chalco	T4514F5	29-45	13.8	0.005	0.005	0.01%	abdj	510
Chalco	H4518F7	22-45	18.4	0.005	0.005	0.01%	abdj	665
Chalco	T4523F7	29-45	23	0.005	0.005	0.01%	abdj	655
*Kepco	K045-30M	0-45	30	1	1	20	abcde	895
Deltron	OEM	3-48	9	0.05	0.05	1	abdgj	75-85
Deltron	N	3-48	36	0.005	0.005	0.5	abdgj	79-299
Christie	SC048-40-12S	2-48	40	0.25	0.25	20	abcde	940
R-S	NGRS50/5	0-50	5	±10	0.001	0.2	cd	670
EMC	SCR50-200	0-50	200	0.1	0.1	10	abcde	2500
*NJE	TC-52-6M	20-52	6	0.5	0.5	1000	abcd	420
*NJE	TC-52-12M	20-52	12	0.5	0.5	1000	abcd	850
*Trygon	LHS48-3.3	32-53	3.3	0.01	0.01	0.5		229
*Trygon	LHS48-5.8	32-53	5.8	0.01	0.01	0.5		295
*Trygon	L3R48-8.5	32-53	8.5	±0.005	0.005	0.5		520
*Trygon	L5R48-17	32-53	17	±0.005	0.005	0.5		640
*Kepco	JQE55-4.5M	0-55	4.5	0.0005	0.005	0.2	abcde	520
*Kepco	JQE55-9M	0-55	9	0.0005	0.005	0.2	abcde	625
EPL	PSR-500-55	2-55	10	0.1	1.0	0.5%	c	395
*Kepco	JQE55-18M	0-55	18	0.0005	0.005	0.2	abcde	977
Atlas	P3130	45-55	25	±2% max	±2% max	1% rms	d	835
*Power/Mate	BP-60H	0-60	3.25	0.01	0.01	0.25	abcdej	360
*NJE	SVC-60-3.5M	0-60	3.5	0.01	0.01	1	abcde	365
Hyp	HY-S1-60-5	0-60	5	0.01	0.01	0.5	abcdej	349
*H-P	6438B	0-60	5	30mV	60mV	120	abcde	360
*Kepco	KS60-5M	0-60	5	0.005	0.01	1	abcde	678
*NJE	SY-60-6M	10-60	6	0.01	0.01	1	abcd	420
*Mid-East	RA60-7	0-60	7	0.01	0.01	1		425
*Mid-East	PR60-7	0-60	7	0.01	0.01	1		500
*NJE	SVC-60-7M	0-60	7	0.01	0.01	1	abcde	595
*Trygon	RS60-7.5A	60	7.5	0.01	0.01	0.5		625
Hyp	HY-S1-60-7.5	0-60	7.5	0.01	0.01	1	abcdej	499
*Kepco	KS60-10M	0-60	10	0.005	0.01	1	abcde	940
*Trygon	M5P60-10	60	10	±0.005	0.005	1		660
*NJE	SY-60-12M	10-60	12	0.01	0.01	1	abcd	515
Lambda	LK-340A	0-60	13.5	0.015	0.015	0.5	abcdeg	330
*NJE	SVC-60-14M	0-60	14	0.01	0.01	1	abcde	690
*Mid-East	PR60-14	0-60	14	0.01	0.01	1		670
*Mid-East	RA60-14	0-60	14	0.01	0.01	1		510
*Trygon	M5C60-15	60	15	±0.005	0.005	1		725
*Sorensen	DCR60-13A	0-60	15	±0.075	±0.075	0.4%	abcdej	500
*H-P	6439B	0-60	15	60mV	120mV	60	abcde	550
*H-P	6274A	0-60	15	0.01	0.01	0.5	abcde	695

High Current Power Supplies

	Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
HC 22	*NJE	SY-60-18M	10-60	18	0.01	0.01	1	abcd	665
	*Kepco	KS60-20M	0-60	20	0.005	0.01	1	abcde	1418
	*Mid-East	RA60-20	0-60	20	0.01	0.01	1		675
	*Sorensen	DCR60-25A	0-60	28.8	±0.075	±0.075	0.4%	abcdej	875
	*Trygon	M7C60-30	60	30	±0.005	0.005	1		1070
	Lambda	LK-350	0-60	35	0.015	0.015	0.5	abcdeg	640
	*Sorensen	DCR60-40A	0-60	45	±0.075	±0.075	0.4%	abcdej	1090
	Lambda	LK-360-FM	0-60	66	0.015	0.015	0.5	abcdeg	950
	*H-P	6459A	0-64	50	0.2	0.2	160	abcdey	1275
	*H-P	6472A	0-64	150	0.02	0.02	160	abcdey	2600
HC 23	*Trygon	CR65-55	0-65	55	0.2	0.2	150		1350
	*Kepco	K070-20M	0-70	20	1	1	30	abcde	995
	*Kepco	SM75-5AM	0-75	5	0.01	0.05	1	bcde	552
	*Kepco	JQE75-6.5M	0-75	6.5	0.0005	0.005	0.2	abcde	625
	*Kepco	SM75-8AM	0-75	8	0.01	0.05	1	bcde	657
	*Kepco	JQE75-13M	0-75	13	0.0005	0.005	0.2	abcde	977
	*NJE	TC-80-4M	25-80	4	0.5	0.5	1000	abcd	320
	*Sorensen	DCR80-5A	0-80	5.75	±0.075	±0.075	0.4%	abcdej	380
	*Techni	LA80-6M	0-80	6	±0.01	±0.15	0.2%	abcde	430
	*NJE	TC-80-8	25-80	8	0.5	0.5	1000	abcd	545
HC 24	*Sorensen	DCR80-10A	0-80	11.5	±0.075	±0.075	0.4%	abcdej	600
	*Kepco	PR80-8M	0-80	8	±1	2	0.7%	cde	499
	*Techni	LA80-12M	0-80	12	±0.01	±0.15	0.2%	abcde	535
	*NJE	TC-80-20	25-80	20	0.5	0.5	1000	abcd	850
	*Sorensen	DCR80-18A	0-80	20.7	±0.075	±0.075	0.4%	abcdej	850
	*Techni	LA80-25M	0-80	25	±0.01	±0.15	0.2%	abcde	660
	*Sorensen	DCR80-30A	0-80	34.5	±0.075	±0.075	0.4%	abcdej	900
	*Trygon	L3R65-6	50-83	6	±0.005	0.005	0.5		530
	*Trygon	L5R65-12	50-83	12	±0.005	0.005	0.5		650
	*Kepco	JQE100-5M	0-100	5	0.0005	0.005	0.2	abcde	625
HC 25	*NJE	TC-100-6	40-100	6	0.5	0.5	1000	abcd	625
	R-S	NGR100/10	0-100	10	±10	0.001	0.5	cd	750
	*Kepco	JQE100-10M	0-100	10	0.0005	0.005	0.2	abcde	977
	Deltron	SP	0-100	50	0.005	0.005	0.5	abcdej	220-920
	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

Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
EPL	PSR-500-125	2-125	5	0.1	1.0	0.5%		425
*Mid-East	RA125-6.5	0-125	6.5	0.01	0.01	1		560
*NJE	SVC-125-6.5M	0-125	6.5	0.01	0.01	1	abcde	1110
*Mid-East	PR125-6.5	0-125	6.5	0.01	0.01	1		875
*Trygon	L3R100-4	80-126	4	±0.005	0.005	0.5		530
*Trygon	L5R100-8	80-126	8	±0.005	0.005	0.5		680
*Sorensen	DCR150-5A	0-150	5.75	±0.075	±0.075	0.4%	abcdej	600
*Sorensen	DCR150-10A	0-150	11.5	±0.075	±0.075	0.4%	abcdej	850
*Sorensen	DCR150-15A	0-150	17.3	±0.075	±0.075	0.4%	abcdej	900
*Sorensen	DCR150-35A	0-150	38.5	±0.1	±0.1	500	abcdej	1500
*Sorensen	DCR150-70A	0-150	77	±0.1	±0.1	500	abcdej	2495
*Kepco	PR1556-4M	0-155	4	±1	2	0.6%	cde	473
*Kepco	SM160-4AM	0-160	4	0.01	0.05	1	bcde	657
*Trygon	M5C160-5	160	5	±0.005	0.005	1		995
*Trygon	M7C160-15	160	5	±0.005	0.005	1		1550
*Techni	LA160-6M	0-160	6	±0.01	±0.15	0.2%	abcde	565
*Trygon	M7C160-8	160	8	±0.005	0.005	1		1250
*Techni	LA160-12M	0-160	12	±0.01	±0.15	0.2%	abcde	680
EMC	SCR160-30	0-160	30	0.1	0.1	10	abcde	1500
*Trygon	L5R150-6	115-161	6	±0.005	0.005	0.5		690
Deltron	L	0.5-200	72	0.005	0.005	0.5	abdgj	190-924
*H-P	6477A	0-220	50	0.2	0.2	330	abcdey	2600
Deltron	C	3-250	36	0.003	0.003	0.5	abdgj	75-470
*Sorensen	DCR300-5A	0-300	5.75	±0.075	±0.075	0.4%	abcdej	850
*Sorensen	DCR300-8A	0-300	9.2	±0.075	±0.075	0.4%	abcdej	925
*Sorensen	DCR300-18A	0-300	19.8	±0.1	±0.1	0.4%	abcdej	1500
*Sorensen	DCR300-35A	0-300	38.5	±0.1	±0.1	0.4%	abcdej	2495
*H-P	6479A	0-300	35	0.2	0.2	300	abcdey	2600
Lambda	LB-700	0-300	300	0.05	0.1	10	abcdeg	1100
EMC	SCR500-5	0-500	5	0.1	0.1	10	abcde	1300
EMC	SCR500-10	0-500	10	0.1	0.1	10	abcde	1700
*H-P	6483B	0-440, 0-500, 0-600	25, 20, 15	0.5	0.5	600	abcdey	2600

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.
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

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ment Div.	SCR20-250	HC8
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	SCR30-200	HC12
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	SCR40-125	HC16
	SCR40-250	HC16
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	SCR100-100	HC25
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	SVC-60-6M	HC20
	SVC-60-7M	HC20
	SVC-60-14M	HC21
	SVC-125-3.2M	HC26
	SVC-125-6.5M	HC22
	SY-36-10M	HC17
	SY-36-20M	HC18
	SY-36-30M	HC18
	SY-60-6M	HC20
	SY-60-12M	HC21

Name	Model	Code
	SY-60-18M	HC22
	TC-14-15M	HC6
	TC-14-30M	HC6
	TC-14-200M	HC7
	TC-32-10M	HC13
	TC-32-20M	HC13
	TC-32-30M	HC13
	TC-32-50M	HC13
	TC-32-120M	HC14
	TC-52-6M	HC18
	TC-52-12M	HC18
	TC-80-4M	HC23
	TC-80-8	HC23
	TC-80-20	HC24
	TC-100-6	HC25
Plastic	LV5-250	HC3
Plastic	LV5-750	HC3
Capacitors,	LV12-400	HC5
Inc.	LV12-600	HC6
	LV12-800	HC6
	LV24-400	HC9
	LV28-400	HC11
	LV28-500	HC11
	LV36-400	HC19
Power Des	12105	HC5
Power	3650R	HC16
Designs,	3650S	HC16
Inc.	6050	HC4
	36100R	HC17
	36250A	HC18
Power/Mate	BP-8D	HC6
Power/Mate	BP-8E	HC6
Corp.	BP-8F	HC6
	BP-8G	HC7
	BP-8H	HC7
	BP-18E	HC9
	BP-18F	HC10
	BP-18G	HC10
	BP-18H	HC10
	BP-30F	HC11
	BP-30G	HC11
	BP-30H	HC12
	BP-60H	HC19
Prec Stan	104	HC2
Precision	105	HC11
Standards	109	HC2
Corp.	110	HC12
	111	HC12
Ratelco	PS-8	HC21
Ratelco, Inc.	PS-9	HC11
R-S	NGGS30/10	HC12
Rhode &	NGR100/10	HC25
Schwarz	NGRS30/10	HC12
Sales Corp.	NGRS50/5	HC18
Sorensen	DCR20-125	HC8
Sorensen	DCR20-250A	HC8
Operation,	DCR40-10A	HC21
Raytheon	DCR40-20A	HC21
Co.	DCR40-35A	HC15
	DCR40-60A	HC16
	DCR40-125A	HC16
	DCR40-250A	HC16
	DCR40-500A	HC16
	DCR60-13A	HC21
	DCR60-25A	HC22
	DCR60-40A	HC22
	DCR80-5A	HC23
	DCR80-10A	HC24
	DCR80-18A	HC24
	DCR80-30A	HC24
	DCR150-5A	HC22
	DCR150-10A	HC23
	DCR150-15A	HC23
	DCR150-35A	HC23

Index by Model Number (continued)

Model SP601 shown actual size.

We make it possible by harnessing the space-saving advantages of the switching regulator—but have pulled its RFI fangs (input and output meet MIL-I-6181).

When you read our data sheet carefully, you'll also find it full of hidden features that other manufacturers would loudly acclaim.

Such as an IC regulating amplifier, automatic overvoltage crowbar, self-resetting automatic overload and short circuit protection, and even 30 ms full-load storage after the input voltage disappears.

Efficiency is so high that the very hottest spot on the heat sink has a rise of only 25°C.

You can actually hold our unit after hours of full-load bench operation without smelling burning flesh!

And is there any other unit you've heard about that will continue to deliver full-load at 71°C.—without derating, heat sinking or forced air cooling.

Single, dual, or triple outputs at voltage levels of 3V to 30V can be provided to your specific needs.

By the way, if you think our $400 price is high, try adding the "optional extras" to anybody else's standard you had in mind.

Trio Laboratories, Inc., 80 Dupont Street, Plainview, L. I., N.Y. 11803. Tel.: (516) 681-0400.
TWX: (510) 221-1861.

triolab®

Now you can squeeze your 5V/20A power supply down to fit your microcircuitry.

INFORMATION RETRIEVAL NUMBER 610

Constant Current Power Supplies

	Mfr	Model	Output Min mA	Output Max Amps	Output Max Volts	Regulation Line %	Regulation Load %	Regulation Ripple mV	Notes	Price $
CC 1	North Hills	CS-120	0.0001	0.001	2000	0.07	0.07	0.15%		995
	* Kepco	ABC2500M	0	0.002	2500	0.1	0.1	0.1	abcde	383
	North Hills	CS-151	0.1	0.01	±10	0.0005	0.0005	0.0002%	bdj	2995
	* Kepco	ABC1500M	0	0.01	1500	0.1	0.1	0.1	abcde	309
	* Kepco	ABC1000M	0	0.02	1000	0.1	0.1	0.1	abcde	309
	* Kepco	ABC425M	0	0.05	425	0.1	0.1	0.1	abcde	220
	* Kepco	ABC200M	0	0.1	200	0.1	0.1	0.1	abcde	220
	* H-P	6186B	0	0.1	300	25ppm	25ppm	0.005	abcde	475
	* Trygon	HR40-750	0	0.75	40	0.01	0.05	0.15	abcde	169
	* Kepco	CK40-0.8M	1	0.8	40	0.01	0.01	0.05%	abcde	281
	* Kepco	HB8AM	0	0.8	325	0.01	0.01	0.01%	abcde	435
	* Kepco	ABC2-1M	0	1	2	0.1	0.5	0.1%	abcde	131
	* Kepco	ABC15-1M	0	1	15	0.1	0.5	0.1%	abcde	175
	* Trygon	SHR20-3A	0	1	20	0.01	0.01	0.5	abcde	239
	* Trygon	DL40-1	0	1	20	0.01	0.01	0.25	abcdef	249
	* Kepco	CC21-1M	0	1	21	0.0005	0.005	0.02%		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
	Keithley	225	$1x10^{-7}$	0.1	±100	±0.005	±0.005	0.01%	dej	550
	North Hills	CS-11	0.001	0.1	100	0.001	0.001	0.02%	d	1295
	EMC	C612AM	0.001	0.1	260	0.15	0.10	0.0005	abc	320
	* Kepco	PAX100-0.1HS	1	0.1	100	0.1	0.1	1		104
	Int.Cont.	CC200	30	0.1	100	0.05	0.05	1		190
	North Hills	CS-152	0.1	0.15	±25	0.0005	0.0005	0.0002%	bdj	3495
	* Trygon	SHR60-1A	0	1	60	0.01	0.01	0.05	abcdef	239
	* Kepco	JQE100-1M	0	1	100	0.005	0.01	0.02%	abcde	300
	* Kepco	KS120-1M	0	1	120	0.01	0.01	0.1%	abcde	578
	* Kepco	HB250M	0	1	250	0.01	0.01	0.01%	abcde	595
	North Hills	CS-12	0.001	1	12.5	0.001	0.001	0.02%	d	1495
	EMC	C630CM	0.01	1	280	0.15	0.10	0.004	abc	962
	* 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
	* Kepco	PAX72-.15HS	1	0.15	72	0.1	0.1	1		104
	* Kepco	CC100-0.2M	0	0.2	100	0.0005	0.0005	0.02%		195
	* Kepco	ABC100-0.2M	0	0.2	100	0.1	0.5	0.1%	abcde	197
	* Kepco	HB2AM	0	0.2	325	0.01	0.01	0.01%	abcde	325
	* Kepco	BHK1000-0.2M	0	0.2	1000	100μA	100μA	0.1	abcde	825
	* Trygon	HH32-1.5	0	1.5	32	0.01	0.01	0.5	abcde	165
	* Trygon	HR20-1.5	0	1.5	20	0.01	0.05	0.15	abcde	169
	* Kepco	CK36-1.5M	1	1.5	36	0.01	0.01	0.05%	abcde	321
	* Trygon	SHR40-1.5A	0	1.5	40	0.01	0.01	0.5	abcde	239
	* Kepco	JQE75-1.5M	0	1.5	75	0.005	0.01	0.02%	abcde	300
	* Kepco	CC7-2M	0	2	7	0.0005	0.005	0.02%		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	cdj	595
	EMC	C633CM	0.0022	0.22	730	0.15	0.10	0.001	abc	700
	* H-P	6181B	0	0.25	100	25ppm	25ppm	0.02	abcde	425
	* Kepco	ABC30-0.3M	0	0.3	30	0.1	0.5	0.1%	abcde	131
	* Kepco	CC72-0.3M	0	0.3	72	0.0005	0.005	0.02%		195
	EMC	C633CM	.0022	0.3	420	0.15	0.10	0.0005	abc	500
	* Kepco	PAX36-0.3HS	1	0.3	36	0.1	0.1	1		104
	* Kepco	BHK500-0.419	0	0.4	500	100μA	100μA	0.1	abcde	825
	* Kepco	JQE55-2M	0	2	55	0.005	0.01	0.02%	abcde	300
	* Kepco	KS60-2M	0	2	60	0.01	0.01	0.1%	abcde	552
	Deltron	CA/CD	0	2	100	0.05	0.05	0.25	abdegj	99-119
	* Trygon	HR160-2B	0	2	160	0.01	0.01	0.5	abcde	510
	* Trygon	HR60-2.5B	0	2.5	60	0.01	0.01	0.5	abcde	355
	* Kepco	JQE-100-2.5M	0	2.5	100	0.005	0.01	0.02%	abcde	520
	* 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	HB 4AM	0	0.4	325	0.01	0.01	0.01%	abcde	365
	* Kepco	CC40-0.5M	0	0.5	40	0.0005	0.005	0.02%		195
	* Kepco	ABC40-0.5M	0	0.5	40	0.1	0.5	0.1%	abcde	175
	* H-P	6177B	0	0.5	50	25ppm	25ppm	0.04	abcde	425
	* Trygon	SHR160-500B	0	0.5	160	0.01	0.01	0.5	abcde	329
	* Trygon	DL40-1	0	0.5	40	0.01	0.01	0.25	abcdef	249
	* Kepco	ABC18-0.5M	0	0.5	18	0.1	0.5	0.1%	abcde	131
	* Sorensen	DCR150-2.5A	0	2.88	150	±0.075	±0.075	0.4%	abcdej	360
	* Sorensen	DCR300-2.5	0	2.88	300	±0.075	±0.075	0.4%	abcdej	600
	* Trygon	HH15-3	0	3	15	0.01	0.01	0.5	abcde	169
	* Kepco	JQE36-3M	0	3	36	0.005	0.01	0.02%	abcde	289
	* Trygon	HR40-3B	0	3	40	0.01	0.01	0.5	abcde	325
	* Kepco	JQE75-3M	0	3	75	0.005	0.01	0.02%	abcde	520
	Deltron	RP	0	3	100	.005	.005	0.25	abcdej	159-205
CC 6	* Kepco	HB525M	0	0.5	525	0.01	0.01	0.01%	abcde	550
	North Hills	CS-111	0.001	0.5	250	0.0025	0.0025	0.03%	d	1795
	* Kepco	PAX21-0.5HS	1	0.5	21	0.1	0.1	1		104
	* Kepco	CK60-0.5M	1	0.5	60	0.01	0.01	0.05%	abcde	321
	* Kepco	HB6AM	0	0.6	325	0.01	0.01	0.01%	abcde	395
	* Kepco	ABC10-.75M	0	0.75	10	0.1	0.5	0.1%	abcde	131
	* Kepco	PAX15-.75HS	1	0.75	15	0.1	0.1	1		104
	* Kepco	CK18-3M	1	3	18	0.01	0.01	0.05%	abcde	321
	Plastic	LVC48-300	500	3	47-49	0.05	0.05	3	abdfghj	225
	Plastic	LVC36-300	500	3	35.3-36.7	0.05	0.05	3	abdfghj	160
	* Trygon	HH7-40V	0	4	7	0.01	0.01	0.5	abcde	189
	* Kepco	JQE25-4M	0	4	25	0.005	0.01	0.02%	abcde	289
	* Sorensen	QRC40-4A	0	4	40	±0.005	±0.005	0.2	abcdej	350
	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 multimeter 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 thermoplastic 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 ±.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 $379.50 complete.

Constant Current Power Supplies

	Mfr	Model	OUTPUT Min mA	OUTPUT Max Amps	OUTPUT Max Volts	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
CC 7	* Kepco	JQE55-4.5M	0	4.5	55	0.005	0.01	0.02%	abcde	520
	* Trygon	HR20-5B	0	5	20	0.01	0.01	0.5	abcde	329
	* Trygon	HR40-5B	0	5	30	0.01	0.01	0.5	abcde	325
	* Kepco	KS36-5M	0	5	36	0.01	0.01	0.1%	abcde	552
	Power Des	3650R	0	5	36	0.01	0.01	0.5	abcde	350
	* Trygon	RS40-5A	0	5	40	0.01	0.01	0.5	abcde	445
	* Trygon	HR60-5B	0	5	60	0.01	0.01	0.5	abcde	375
	* Kepco	KS60-5M	0	5	60	0.01	0.01	0.1%	abcde	678
	* Trygon	DL40-1	0	5	80	0.01	0.01	0.25	abcdef	249
CC 8	* Kepco	JQE100-5M	0	5	100	0.005	0.01	0.02	abcde	625
	* Kepco	KS120-5M	0	5	120	0.01	0.01	0.1%	abcde	1019
	* Trygon	M5C160-5	0	5	160	±0.005	0.005	1	abcde	995
	* Kepco	CK8-5M	1	5	8	0.01	0.01	0.05%	abcde	363
	Plastic	LVC28-500	500	5	28.6	0.05	0.05	3	abdfghj	207
	* Sorensen	DCR80-5A	0	5.75	80	±0.075	±0.075	0.4%	abcdej	380
	* Sorensen	DCR150-5A	0	5.75	150	±0.075	±0.075	0.4%	abcdej	600
	* Sorensen	DCR300-5A	0	5.75	300	±0.075	±0.075	0.4%	abcdej	850
	* Kepco	JQE15-6M	0	6	15	0.005	0.01	0.02%	abcde	289
CC 9	* Kepco	JQE36-6M	0	6	36	0.005	0.01	0.02%	abcde	520
	Plastic	LVC12-600	500	6	12.25	0.05	0.05	3	abdfghj	171
	* Kepco	JQE75-6.5M	0	6.5	75	0.005	0.01	0.02%	abcde	625
	* Trygon	RS20-7.5A	0	7.5	20	0.01	0.01	0.5	abcde	430
	* Trygon	HR40-7.5B	0	7.5	40	0.01	0.01	0.5	abcde	395
	* Trygon	RS60-7.5A	0	7.5	60	0.01	0.01	0.5	abcde	625
	Plastic	LVC5-750	500	7.5	5.1	0.05	0.05	3	abdfghj	171
	* Sorensen	QRC20-8A	0	8	20	±0.005	±0.005	0.2	abcdej	425
	* Sorensen	QRC40-8A	0	8	40	±0.005	±0.005	0.2	abcdej	470
CC 10	* Trygon	M7C160-8	0	8	160	±0.005	0.005	1	abcde	1250
	* Kepco	CK2-8M	1	8	2	0.01	0.01	0.05%	abcde	363
	Plastic	LVC12-800	500	8	12.25	0.05	0.05	3	abdfghj	189
	* Kepco	JQE25-9M	0	9	25	0.005	0.01	0.02%	abcde	520
	* Kepco	JQE55-9M	0	9	55	0.005	0.01	0.02%	abcde	625
	* Sorensen	DCR300-8A	0	9.2	300	±0.075	±0.075	0.4%	abcdej	925
	* Kepco	JQE6-10M	0	10	6	0.005	0.01	0.02%	abcde	289
	* Kepco	KS18-10M	0	10	18	0.01	0.01	0.1%	abcde	762
	* Trygon	HR20-10B	0	10	20	0.01	0.01	0.5	abcde	369
	* Kepco	KS36-10M	0	10	36	0.01	0.01	0.1%	abcde	657
CC 11	Power Des	36100R	0	10	36	0.01	0.01	0.5	abcde	463
	* Trygon	RS40-10A	0	10	40	0.01	0.01	0.5	abcde	475
	* Trygon	M5P60-10	0	10	60	±0.005	0.005	1	abcde	660
	* Kepco	KS60-10M	0	10	60	0.01	0.01	0.1%	abcde	940
	* Kepco	JQE100-10M	0	10	100	0.005	0.01	0.02%	abcde	977
	* Kepco	KS120-10M	0	10	120	0.01	0.01	0.1%	abcde	1523
	Holt	275	10	10	10	0.1	0.05	0.15, .02%	cd	2060
	* Sorensen	DCR40-10A	0	11.5	40	±0.075	±0.075	0.4%	abcdej	360
CC 12	* Sorensen	DCR80-10A	0	11.5	80	±0.075	±0.075	0.4%	abcdej	600
	* Sorensen	DCR150-10A	0	11.5	150	±0.075	±0.075	0.4%	abcdej	850
	* Kepco	JQE15-12M	0	12	15	0.005	0.01	0.02%	abcde	520
	* Kepco	JQE36-13M	0	13	36	0.005	0.01	0.02%	abcde	625
	* Kepco	JQE75-13M	0	13	75	0.005	0.01	0.02%	abcde	977
	Chalco	V5013F5	0	13	150	0.005	0.005	0.01%	abcdej	1000
	* Kepco	KS8-15M	0	15	8	0.01	0.01	0.1%	abcde	657
	* Kepco	KS18-15M	0	15	18	0.01	0.01	0.1%	abcde	1018
	* Sorensen	QRC20-15A	0	15	20	±0.005	±0.005	0.2	abcdej	525
	* Trygon	RS20-15A	0	15	20	0.01	0.01	0.5	abcde	465

Mfr	Model	OUTPUT Min mA	OUTPUT Max Amps	OUTPUT Max Volts	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
* Kepco	KS36-15M	0	15	36	0.01	0.01	0.1%	abcde	767
* Trygon	M5P36-15	0	15	36	±0.005	0.005	1	abcde	615
* Sorensen	QRC40-15A	0	15	40	±0.005	±0.005	0.2	abcdej	650
* Trygon	M5C60-15	0	15	60	±0.005	0.005	1	abcde	725
* Sorensen	DCR60-13A	0	15	60	±0.075	±0.075	0.4%	abcdej	500
* Trygon	M7C160-15	0	15	160	±0.005	0.005	1	abcde	1550
* Sorensen	DCR150-15A	0	17.3	150	±0.075	±0.075	0.4%	abcdej	900
* Kepco	JQE25-18M	0	18	25	0.005	0.01	0.02%	abcde	625
* 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%	abcdej	1000
* Sorensen	DCR300-18A	0	19.8	300	±0.1	±0.1	0.4%	abcdej	1500
* Kepco	KS60-20M	0	20	60	0.01	0.01	0.1%	abcde	1418
* Sorensen	DCR80-18A	0	20.7	80	±0.075	±0.075	0.4%	abcdej	850
* Kepco	JQE6-22M	0	22	6	0.005	0.01	0.02	abcde	520
Chalco	V5022F7	0	22	150	0.005	0.005	0.01%	abcdej	1200
* Sorensen	DCR40-20A	0	23	40	±0.075	±0.075	0.4%	abcdej	500
* Kepco	KS8-25M	0	25	8	0.01	0.01	0.1%	abcde	798
* Trygon	M3P8-250V	0	25	8	±0.005	0.005	1	abcde	575
* Kepco	JQE15-25M	0	25	12	0.005	0.01	0.02%	abcde	625
* Kepco	KS18-25M	0	25	18	0.01	0.01	0.1%	abcde	1428
Power Des	36250A	0	25	36	0.01	0.01	0.5	abcde	875
* Kepco	JQE36-25M	0	25	36	0.005	0.01	0.02%	abcde	977
* Spectro	6030	200	28	75	0.005	0.005	2	acd	2290
* Sorensen	DCR60-25A	0	28.8	60	±0.075	±0.075	0.4%	abcdej	875
* Trygon	M5P15-30	0	30	15	±0.005	0.005	1	abcde	660
* Sorensen	QRC20-30A	0	30	20	±0.005	±0.005	0.2	abcdej	695
* Trygon	M5C36-30	0	30	36	±0.005	0.005	1	abcde	690
* 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	abcdej	775
Chalco	F6030F5	0	30	60	0.005	0.005	0.01%	abcdej	950
* Trygon	M7C60-30	0	30	60	±0.005	0.005	1	abcde	1070
* Trygon	CR110-30	0	30	110	0.2	0.2	550	cey	1450
Spectro	6021	100	30	30	0.005	0.005	5	acd	1180
Spectro	6121	-300	+30	30	0.005	0.005	5	acdj	1240
Chalco	V0032F7	0	32	100	0.005	0.005	0.01%	abcdej	1200
Spectro	6010	1000	33	300	0.005	0.005	10	cdf	12,850
Spectro	6009	1000	33	300	0.005	0.005	10	cd	7780
* Sorensen	DCR80-30A	0	34.5	80	±0.075	±0.075	0.4%	abcdej	900
* Kepco	JQE25-36M	0	36	25	0.005	0.01	0.02%	abcde	977
Chalco	F4538F5	0	38	45	0.005	0.005	0.01%	abcdej	900
* Sorensen	DCR150-35A	0	38.5	150	±0.1	±0.1	500	abcdej	1500
* Sorensen	DCR300-35A	0	38.5	300	±0.1	±0.1	0.4%	abcdej	2495
* Sorensen	DCR40-35A	0	40	40	±0.075	±0.075	0.4%	abcdej	750
Christie	SC048-40-12S	2000	42	48	0.25	0.25	200	abcde	940
* Kepco	JQE6-45M	0	45	6	0.005	0.01	0.02%	abcde	625
* Sorensen	DCR60-40A	0	45	60	±0.075	±0.075	0.4%	abcdej	1090
Chalco	F3348F5	0	48	33	0.005	0.005	0.01%	abcdej	900
* Kepco	KS8-50M	0	50	8	0.01	0.01	0.1%	abcde	1103
* Trygon	M5P8-500V	0	50	8	±0.005	0.005	1	abcde	750
* Kepco	JQE15-50M	0	50	15	0.005	0.01	0.02%	abcde	977
* Trygon	M5C15-50	0	50	15	±0.005	0.005	1	abcde	845
* Kepco	KS18-50M	0	50	18	0.01	0.01	0.1%	abcde	1428
* Trygon	M7C40-50	0	50	40	±0.005	0.005	1	abcde	975
Chalco	F6050F7	0	50	60	0.005	0.005	0.01%	abcdej	1100
Deltron	SP	0	50	100	0.005	0.005	0.5	abcdej	195-925

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.
j. 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.

Constant Current Power Supplies 45

			OUTPUT			REGULATION				
	Mfr	Model	Min mA	Max Amps	Max Volts	Line %	Load %	Ripple mV	Notes	Price $
CC 13	*Trygon	CR65-55	0	55	65	0.2	0.2	0.15	cey	1350
	Christie	SC015-50-12S	2500	55	37	0.25	0.25	200	abcde	839
	Chalco	F4563F7	0	63	45	0.005	0.005	0.01%	abcdej	1000
	*Sorensen	DCR40-60A	0	69	40	±0.075	±0.075	0.4%	abcdej	925
	Chalco	F1675F5	0	75	16	0.005	0.005	0.01%	abcdej	900
	*Sorensen	DCR150-70A	0	77	150	±0.1	±0.1	500	abcdej	2495
	*Trygon	M7C15-80	0	80	15	±0.005	0.005	1	abcde	1250
	*Sorensen	DCR40-125A	0	138	40	±0.1	±0.1	160	abcdej	1375
	*Sorensen	DCR20-125A	0	144	20	0.075	0.075	0.4%	abcdej	1150
	*Trygon	CR20-150	0	150	20	0.2	0.2	0.15	cey	1450
	Spectro	6004	-1000	+155	56	0.0005	0.0005	3	acdj	5990
	Spectro	6020	-1.5A	262	94	0.0005	0.0005	6	acdj	9600
	Sorensen	DCR20-250A	0	275	20	±0.1	±0.1	160	abcdej	1500
CC 14	Chalco	F3380F7	0	80	33	0.005	0.005	0.01%	abcdej	1000
	*Kepco	JQE6-90M	0	90	6	0.005	0.01	0.02%	abcde	977
	*Kepco	KS8-100M	0	100	8	0.01	0.01	0.1%	abcde	1523
	*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	SC015-100-12S	5000	110	15	0.2	0.2	50	abcde	1025
	Chalco	A1625F7	0	125	16	0.005	0.005	0.01%	abcdej	1000
	*Sorensen	DCR40-250A	0	275	40	±0.1	±0.1	15	abcdej	2340
	*Sorensen	DCR40-500A	0	500	550	±0.1	±0.1	0.4%	abcdej	3850
	*Sorensen	DCR20-1000	0	1100	20	±0.1	±0.1	160	abcdej	4200

Index by Model Number

Index by Model Number (continued)

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

High Voltage Power Supplies

	Mfr	Model	OUTPUT Min Volts	OUTPUT Max kV	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
HV 1	*Kepco	1520B	0	1.5	0.5	0.05	0.1	3		788
	*Sorensen	DCR1500-1A	15	1.5	1.15	±0.075	±0.075	±0.4%	abcdej	995
	*Kepco	ABC1500M	0	1.5	0.01	0.05	0.05	1		309
	*Kepco	ABC1500M	0	1.5	0.01	0.05	0.05	1	abcde	309
	*H-P	6515A	0	1.6	0.005	0.01	0.01	2	cde	235
	Vector	PM-1K-01A	200	1.8	0.01	0.001	0.001	2		365
	Grafix	503D	1500	2	3VA	0.005	0.2	0.15%	dfgh	368
	*Kepco	BHK2000-0.1M	0	2	0.1	0.005	0.01	1	abcde	850
HV 2	*Kepco	BHK2000-0.1M	0	2	0.1	0.005	0.01	1		850
	*H-P	6522A	0	2	0.1	0.005	0.005	1	cde	750
	Power Des	2K10	1	2	0.01	0.002	0.002	1	chj	299
	*Kepco	HB2050	0	2	0.5	0.02	0.005	3		1733
	Hamner	NV-13	1	2.012	0.01	0.0025	0.0025	1 p-p	a	425
	Keithley	245	0.05	2.1	0.01	0.001	0.002	1	acdhj	425
	Fluke	412B	0	2.1	0.03	0.001	0.001	0.5		410
	Monroe	156	±1	2.11	0.0005	0.02	0.005	10	dhj	395
	ITI	IT-322	-850	2.2	0.002	1	4	4500	df	250
HV 3	*Kepco	ABC2500M	0	2.5	0.002	0.05	0.05	1		383
	*Kepco	ABC2500M	0	2.5	0.002	0.05	0.05	1	abcde	383
	Vector	PM-2K-01A	500	2.5	0.01	0.001	0.001	3		480
	*NJE	S-325	500	2.5	0.01	±0.01	±100mV	5	c	340
	*NJE	H-2.5-50	0	2.5	0.05	±1	15-25	2%	c	770
	*Kepco	HB2500	0	2.5	0.05	0.02	0.005	5		1024
	*NJE	H-2.5-100	0	2.5	0.1	±1	15-25	2%	c	825
	*NJE	S-326	500	2.5	0.5	±0.01	±100mV	5	c	380
	*NJE	HH2.5-1000	0	2.5	1	±1	10	1%	a	2400
	Grafix	503	1500	3	6VA	0.005	0.2	0.15%	dgh	276
HV 4	Fluke	415B	0	3	ina	0.0005	0.0005	0.1		525
	*H-P	6110A	0	3	0.006	0.001	0.001	0.4	cde	495
	*H-P	6516A	0	3	0.006	0.01	0.01	1	cde	295
	Hamner	NV-19	0	3	0.01	0.001	0.001	ina	aj	460
	Vector	PM-3K-01A	500	3.5	0.01	0.001	0.001	4		570
	Keithley	246	0.05	3.1	0.01	0.001	0.002	1	cdhj	475
	Power Des	1544	1	3	0.02	0.001	0.001	1	chj	520
	Power Des	1547	1	3	0.04	0.001	0.001	1	chj	575
	*Sorensen	1003-200	0	3	0.2	0.2	n/a	0.01%	abcdhj	790
	*Sorensen	DCR3000-.5A	30	3	0.575	±0.075	±0.075	0.4%	abcdj	1250
HV 5	*Sorensen	2003-100	0	3	1	±0.2	n/a	0.01%	abcdij	1865
	*ERA	SAR3K/2	3000	3.1	0.002	±0.2	0.3	0.5%	dh	345
	Grafix	385	0	3.2	3VA	0.2	0.3	1%	adgh	350
	Hamner	N-4035	750	3.55	0.035	0.002	0.001	0.5	a	650
	*H-P	6525A	0	4	0.05	0.005	0.005	1	cde	750
	Grafix	266	300	5	0.0001	1	5	0.05%	adgh	358
	Hamner	N-4050	500	5	0.002	0.01	0.01	5		705
	*ERA	HV15KM	0	5	0.015	0.01	0.01	5	abcdh	435
	*ERA	HV15KM	0	5	0.015	0.01	0.01	5	a	ina
	*NJE	S327	500	5	0.01	±0.01	±100mV	5	c	490
HV 6	*Spellman	RHR5PN50	0	5	0.01	0.01	0.01	1000	acdj	525
	Vector	PM-5K-01A	500	5	0.01	0.001	0.001	5		690
	*NJE	H-5-25	0	5	0.025	±1	15-25	1	c	770
	*NJE	H-5-50	0	5	0.05	±1	15-25	2%	c	825
	*NJE	H-5-100	0	5	0.1	±1	15-25	3.5%	c	1015
	*NJE	H-5-200	0	5	0.2	±1	15-25	3.5%	c	1510
	*NJE	H-5-500	0	5	0.5	±1	15-25	1%	c	1850
	*Spellman	HP5-1000SR	0	5	1	±0.01	±0.01	1000	acj	req
	*ERA	SAR5K/2	5000	5.1	0.002	±0.2	0.3	0.5%	dh	395
	Grafix	505	3000	6	6VA	0.005	0.2	0.15%	dgh	298
HV 7	Power Des	1556A	10	6	0.02	0.001	0.001	1.0	chj	625
	Fluke	408B	0	6	0.02	0.001	0.001	1		665
	*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	314S	0	10	20VA	0.05	5	0.1%	adgh	950
	Monroe	151	±500	10	0.001	0.01	0.01	500	abcdhj	1990
	*NJE	H-10-5	0	10	0.005	±1	15-25	1%	c	830
	*Sorensen	5010-8	1000	10	0.008	±0.05	±0.05	0.003%	abcdhj	890

Mfr	Model	OUTPUT Min Volts	OUTPUT Max kV	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
*Spellman	RHR10PN100	0	10	0.01	0.01	0.01	2000	acdj	675
Fluke	410B	0	10	0.01	0.001	0.001	1		975
*Power Des	1543A	10	10	0.01	0.001	0.001	5	chj	950
*NJE	S-328	1000	10	0.01	±0.01	±150mV	15	c	1530
*NJE	H-10-25	0	10	0.025	±1	15-25	1%	c	910
*NJE	H-10-50	0	10	0.05	±1	15-25	2%	c	1065
*NJE	H-10-100	0	10	0.1	±1	15-25	3.5%	c	1585
*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
*Sorensen	1012-50	0	12	0.05	0.2	n/a	0.01%	abcdhj	815
*Sorensen	2012-250	0	12	0.25	±0.2	n/a	0.01%	abcdil	1865
*Hipo	815PL	0	15	0.002	l	6.6	2.5%	cdh	600
*NJE	S-330	5000	15	0.002	±0.01	±0.01	15		1980
*Spellman	RHR15PN120	0	15	0.006	0.01	0.01	3000	acdl	770
*NJE	H-15-10	0	15	0.01	±1	15-25	0.5%	c	925
*NJE	H-15-20	0	15	0.02	±1	15-25	1%	c	1115
Grafix	515	12000	16	20VA	0.005	0.2	0.03%	dgh	498
*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%		950
*NJE	H-20-20	0	20	0.02	±1	15-25	1%	a	1240
*Sorensen	1020-30	0	20	0.03	±0.2	n/a	0.01%	abcdhj	865
*NJE	H-20-50	0	20	0.05	±1	15-25	2%	c	1585
*Sorensen	2020-150	0	20	0.15	±0.2	n/a	0.01%	abcdij	2080
*Spellman	HP20-200SR	0	20	0.2	±0.01	±0.01	4000	acl	req
Grafix	520	16000	22	20VA	0.005	0.2	0.03%	dgh	557
*NJE	HH-25-100	0	25	0.1	±0.5	10	1%	c	2850
*Spellman	RHR30PN120	0	30	0.004	0.01	0.01	6000	acdl	950
*Sorensen	5030-4	5000	30	0.004	±0.005	±0.025	0.015	abcdhj	1085
*NJE	H-30-5	0	30	0.005	±1	15-25	0.5%	c	975
*NJE	H-30-10	0	30	0.01	±1	15-25	1%	c	1140
*Sorensen	1030-20	0	30	0.02	±0.2	n/a	0.01%	abcdhj	895
*NJE	H-30-35	0	30	0.035	±1	15-25	2%	c	1760
*Spellman	RHR40PN120	0	40	0.003	0.01	0.01	8000	acdj	1020
Plastic	HVR500-251	ina	50	250µA	0.1	0.1	100V		540
*NJE	H0-50-5	0	50	0.005	±1	15-25	2%	ci	1370
Del	LHRMSeries	0	50	0.01	0.03	0.03	0.03%	acd	615-1980
*NJE	H0-50-10	0	50	0.01	±1	15-25	3.5%	ci	1560
*NJE	HH050-50	0	50	0.015	±0.5	15-25	3.5%	ci	3090
*NJE	H0-50-15	0	50	0.015	±1	15-25	3.5%	ci	2030
*Spellman	RHR60PN120	0	60	0.002	0.01	0.01	12000	acdl	1500
*Hipo	860PL	0	60	0.002	l	6.6	2.5%	cdh	1050
*NJE	H060-10	0	60	0.01	±1	15-25	3.5%	ci	1750
*Sorensen	1061	0	60	0.01	±0.2	n/a	0.01%	abcdhj	1195
*Hipo	880PL	0	80	0.002	l	7.6	2.5%	cdh	1800
*Spellman	RHR100P120	0	100	0.001	0.01	0.01	20000	acd	1800
*Sorensen	1101	0	100	0.0015	±0.2	n/a	0.01%	abcdhj	1195
*Hipo	8120PL	0	120	0.002	l	8.3	2.5%	cdh	2500
*NJE	H0-120-5	0	120	0.005	±1	15-25	2%	ci	2010
*Sorensen	1121	0	120	0.005	±0.2	n/a	0.01%	abcdhj	1595
*Sorensen	2120-30	0	120	0.03	±0.2	n/a	0.01%	abcdij	2800
*Spellman	RHR150P300	0	150	0.002	0.01	0.01	30000	acd	req
*Sorensen	1151	0	150	0.005	±0.2	n/a	0.01%	abcdhj	1795
*NJE	H0-150-5	0	150	0.005	±1	15-25	2%	ci	2335
*NJE	H0-150-10	0	150	0.01	±0.5	15-25	4%	ci	3200
*NJE	HH0-150-20	0	150	0.02	±0.5	15-25	3.5%	ci	2790
*NJE	H0-200-5	0	200	0.005	±0.5	15-25	3.5%	ci	4290
*NJE	HH0-250-5	0	250	0.005	±1	15-25	3.5%	ci	5525
*Spellman	RHR300P300	0	300	0.001	0.01	0.01	60000	acd	req
Uni-Volt	BRE	500	600	10	0.01-0.1	0.02-0.1	0.005%-0.01%	chij	1000-75k
LATE ARRIVAL									
Bertan	602	0	2.5	5mA	0.01	0.01	0.001% p-p	ab	265
Bertan	615	10	20	500µa	0.001	0.001	5 p-p		695

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. Control section and high voltage tank are separate units.
j. Reversible polarity.
l. Line regulation optional, consult factory.

Reader service numbers for literature and application notes, see page D6.
Companies advertising in the power supply section are marked by an asterisk.

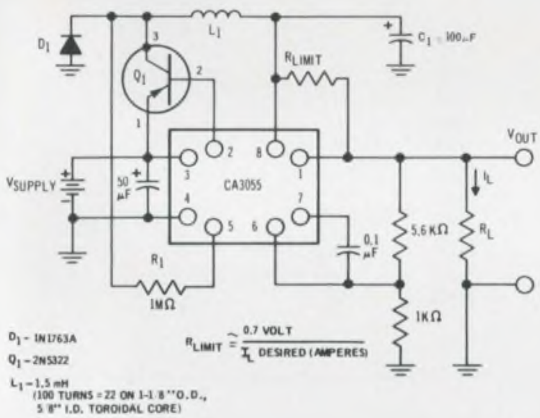
Index by Model Number

Name	Model	Code
Bertan	602	HV7
Bertan	615	HV7
Associates		
Del	LHRM series	HV4
Del Electronics		
ERA	HV15KM	HV5
Electronic	SAR3K/2	HV5
Research	SAR5K/2	HV6
Associates		
Fluke	408B	HV7
John Fluke	410B	HV1
Manufac-	412B	HV2
turing	415B	HV4
Grafix	266	HV5
Grafix, Inc.	314S	HV7
	385	HV5
	503	HV3
	503D	HV1
	505	HV6
	510	HV1
	515	HV2
	520	HV3
Hamner	N-4035	HV5
Hamner	N-4050	HV5
Electronics	NV-13	HV2
	NV-19	HV5
H-P	6110A	HV4
Hewlett	6515A	HV1
Packard	6516A	HV4
Co.	6522A	HV2
	6525A	HV5
Hipo	815P	HV2
Hipotronics,	860PL	HV5
Inc.	880PL	HV5
	8120PL	HV5
ITI	IT-322	HV2
ITI Electronics, Inc.		
Keithley	245	HV2
Keithley	246	HV4
Instruments, Inc.		
Kepco	1520B	HV1
Kepco, Inc.	ABC1500M	HV1
	ABC2500M	HV3
	BHK2000-0.1M	HV1, HV2
	HB2050	HV2
	HB2500	HV2
Monroe	151	HV7
Monroe	156	HV2
Electronics		
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
	HH-2.5-100	HV3
	HH-10-250	HV1
	HH-25-100	HV3
	HO-50-5	HV4
	HO-50-10	HV4
	HO-50-15	HV5
	HO-60-10	HV5
	HO-120-5	HV5
	HO-150-5	HV6
	HO-150-10	HV6
	HO-200-5	HV6
	HHO-50-50	HV4
	HHO-150-20	HV6
	HHO-250-5	HV6
	S-325	HV3
	S-326	HV3
	S-327	HV5
	S-328	HV1
	S-330	HV2
Plastic	HVR500-251	HV4
Plastic Capacitors		
Power Des	2K10	HV2
Power De-	1543A	HV1
signs, Inc.	1544	HV4
	1547	HV4
	1556A	HV7
Sorensen	1003-200	HV4
Sorensen	1006-100	HV7
Operation,	1012-50	HV2
Raytheon	1020-30	HV3
Co.	1030-20	HV4
	1061	HV5
	1101	HV5
	1121	HV6
	1151	HV6
	2003-100	HV5
	2006-500	HV7
	2012-250	HV2
	2020-150	HV3
	2120-30	HV6
	5010-8	HV7
	5030-4	HV3
	DCR1500-1A	HV1
	DCR3000-.5A	HV4
	DCR6000-.25A	HV7
Spellman	HP5-1000SR	HV6
Spellman	HP10-500SR	HV1
High-	HP20-200SR	HV3
Voltage	RHR5PN50	HV6
	RHR10PN100	HV1
	RHR15PN120	HV2
	RHR30PN120	HV3
	RHR40PN120	HV4
	RHR60PN120	HV5
	RHR100P120	HV5
	RHR150P300	HV6
	RHR300P300	HV6
Uni-Volt	BRE	HV7
Universal Voltronics		
Vector	PM-2K-01A	HV3
Vector Engi-	PM-3K-01A	HV4
neering, Inc.	PM-5K-01A	HV6

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_1) 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	<0.15Ω
Line Regulation	.03%
Efficiency	76.5%
Rise Time	1 µs
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 application 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_{CEO} (sus) of 225 V (max.), while 2N5805 offers V_{CEO} (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.

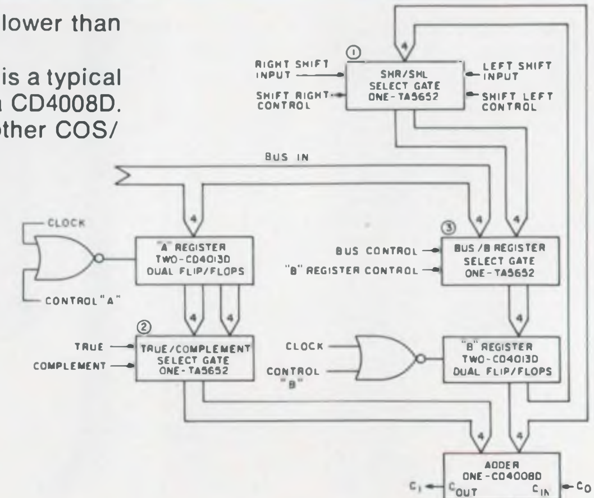
New COS/MOS 4-Bit Full Adder is significantly faster than P-MOS adders

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 µW (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.

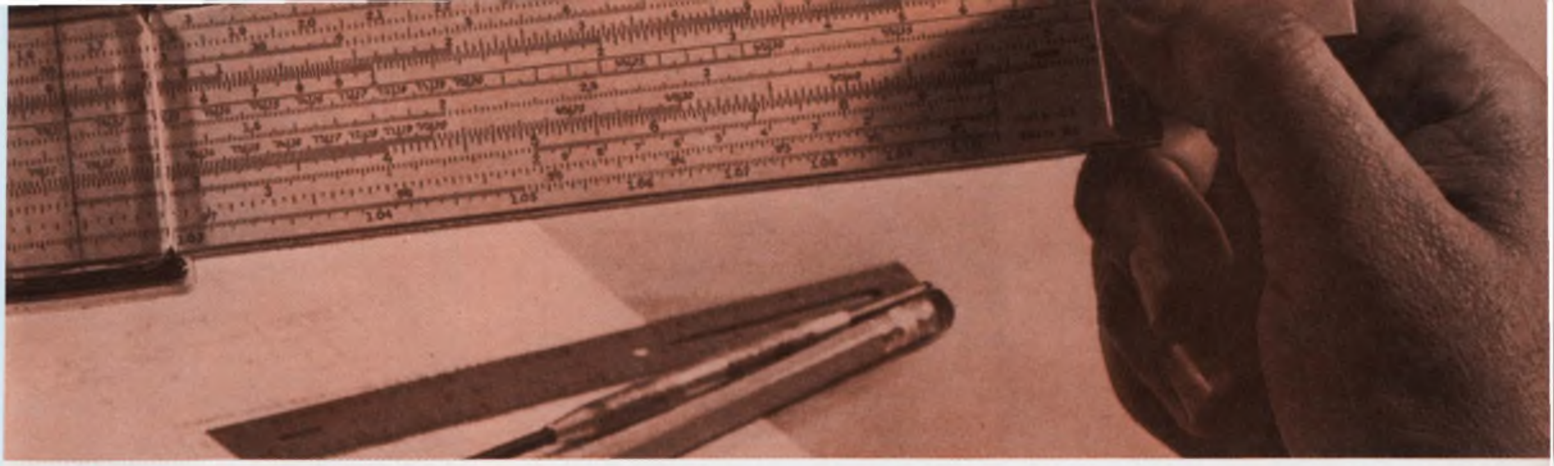
The new COS/MOS adder will operate with a single power supply over a wide voltage range—6 to 15 V—and with power consumption several orders of magnitude lower than bipolar adders.

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 1.2×10^{14} n/cm² accompanied by reactor gamma radiation ($E \backsimeq 1.0$ MeV); gamma dose 1.5×10^7 rads. Peak primary photo current (Ipp) 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, $I_E=O$	0.008 nA	0.35 nA
$V_{(BR)\ CBO}$	$I_C=1$ μA, $I_E=O$	33 V	36 V
$V_{(BR)\ CEO}$	$I_C=3$ mA, $I_E=O$	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

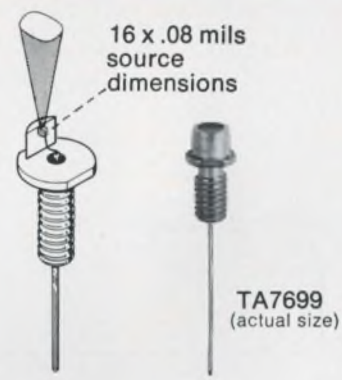
Contact your local RCA Representative who will be pleased to work with you on your high-reliability requirements.

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.

RCA

			OUTPUT		REGULATION				
	Mfr	Model	Range Volts	Max Amps	Line %	Load %	Ripple mV	Notes	Price $
LT 1	*Kepco	ABC2-1M	0-2	1	0.05	0.05	0.25	abcde	131
	Int Cont	CV100	2-6	1	0.008	0.03	1		160
	Power Des	630	0-6	3	0.01	0.01	1	abcd	150
	*H-P	6203B	0-7.5	3	3mV	5mV	0.2	abcde	169
	*Trygon	LQS6-33	4.5-7.8	1.9	0.01	0.01	0.5		135
	*Power/Mate	BP-8C	0-8	1.5	0.01	0.01	0.25	abcdej	89
	*Kepco	ABC10-0.75M	0-10	0.75	0.05	0.05	0.25	abcde	131
	*H-P	6214A	0-10	1	0.01	0.01	0.2	cde	115
	*Trygon	EAL0-10	0-10	1	0.01	0.2	0.5		99
	*H-P	6213A	0-10	1	0.01	0.01	0.2	cde	90
LT 2	*Mid-East	PMA10-1.5	0-10	1.5	±0.01	0.02	1	abcd	165
	*H-P	6113A	0-10	2	0.001	0.001	0.04	abcd	375
	*NJE	PVC-10-2	0-10	2	0.01	0.01	0.25	abcde	148
	Prec Stan	103	0-10	2	0.005	0.01	0.1	abcde	169
	*NJE	LVCII-10-2	0-10	2	0.01	0.01	0.25	abcde	124
	Int Cont	CV100	6.5-10.5	1	0.008	0.03	0.28		160
	*Trygon	LQS10-3	8.5-11.5	3	0.01	0.01	0.5		139
	P/N	PR-30	±15	±0.03	±0.05	±0.05	3 p-p		98
	Endevco	4203	1-15	0.2	0.01	0.01	0.1 p-p	bd	180
	P/N	PR-300	±15	±0.3	±0.005	±0.005	0.25		250
LT 3	*Trygon	HH15-3	0-15	0.3	0.01	0.01	0.5	c	169
	*Heath	IP-18	1-15	0.5	50mV	50mV	5	ae	22kit
	*Kepco	ABC15-1M	0-15	1	0.05	0.05	0.25	abcde	175
	*Kepco	CDT15-1.5M	0-±15	±1.5	0.005	0.01	0.25	abcden	399
	*Sorensen	QRS15-2	0-15	2.2	±0.01	±0.01	0.4	abcdej	145
	*Sorensen	QRD15-2	0-15	2.2	±0.005	±0.005	0.2	abcdej	178
	Beco	303	0-15	2.4	0.01	0.1	0.2	dep	reg
	*Trygon	LQS12-2.5	11-15	2.5	0.01	0.01	0.5		135
	Power Des	6050	0-15	3	0.01	0.01	1	abcd	195
LT 4	*Sorensen	QRD15-2-7.5-3	0-7.5-15	2.2-3.3	±0.005	±0.005	0.2	abcdefj	396
	*Sorensen	QRD15-2-7.5-3	0-7.5-15	2.2-3.3	±0.005	±0.005	0.2	abcdefj	198
	P/N	NPS-300A	12-18	±0.3	±0.05	±0.05	1		135
	Topaz	91PQ	5-18	0.5	±0.05	5mV	1		reg
	*Kepco	ABC18-0.5M	0-18	0.5	0.05	0.05	0.25	abcde	131
	*Power/Mate	BP-18C	0-18	1	0.01	0.01	0.25	abcdej	89
	Wanless	LAB11	0-18	1.25	±0.05	±0.05	0.75	def	150
	*Sorensen	QSB12-2	9-18	2.2	±0.005	±0.005	0.25	abcdej	115
	*Power/Mate	BP-18D	0-18	2.5	0.01	0.01	0.25	abcdej	129
	*Kepco	CK18-3M	0-18	3	0.005	0.01	0.5	abcde	321
LT 5	*RCA	WP703A	0-20	0.5	7mV	10mV	0.2	cd	59
	*RCA	WP-702A	0-20	0.2	30mV	50mV	0.5	cdf	87
	*RCA	WP-700A	0-20	0.2	30mV	50mV	0.5	cd	48
	*Trygon	EAL20-500	0-20	0.5	0.01	0.2	0.5	c	99
	*H-P	6823A	-20 to +20	0.5	0.02	0.02	2	z	194
	*H-P	6204B	0-20	0.6	0.01	0.01	0.2	abcde	144
	*Sorensen	QHS20-1.0	0-20	1	1ppm	5ppm	0.1	abcdej	345
	*H-P	6111A	0-20	1	0.001	0.001	0.04	abcde	375
	*NJE	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
	*NJE	PVC-20-1	0-20	1	0.01	0.01	0.25	abcde	148
	*Trygon	SHR20-3A	0-20	1	0.01	0.01	0.5	e	239
	Prec Stan	102	0-20	1	0.005	0.01	0.15	abcde	169
	*Sorensen	QHS20-1.0L	0-20	1	1ppm	5ppm	0.1	abcdej	265

		OUTPUT		REGULATION				
Mfr	Model	Range Volts	Max Amps	Line %	Load %	Ripple mV	Notes	Price $
*Trygon	HR20-1.5	0-20	1.5	0.01	0.05	0.15	e	169
*H-P	6201B	0-20	1.5	0.01	0.01	0.2	abcde	169
Power Des	2015R	0-20	1.5	0.03	0.03	0.45	abcde	175
*H-P	6200B	0-20	1.5	0.01	0.01	4	abcde	189
*Trygon	LQS24-1.5	18.5-27.5	1.5	0.01	0.01	0.5		135
*Trygon	LQS18-1.9	13.5-20.5	1.9	0.01	0.01	0.5		135
*NJE	LVCII-20-2	0-20	2	0.01	0.01	0.25	abcde	171
*NJE	PVC-20-2	0-20	2	0.01	0.01	0.25	abcde	195
*H-P	6253A	0-20	3	0.01	0.01	0.2	abcdef	445
Hyp	HY-VS-20-3	0-20	3	0.01	0.01	0.25	abcdej	199
*H-P	6284A	0-20	3	0.01	0.01	0.2	abcde	210
*Sorensen	QRD20-4	0-20	4.4	±0.005	±0.005	0.2	abcdejy	278
*Sorensen	QRS20-4	0-20	4.4	±0.01	±0.01	0.4	abcdej	255
North Hills	VS-36	21.1	0.1	0.0025	0.0025	0.02%	bd	1450
Wanless	PSS1-24	24	2.5	±0.005	±0.01	0.75	s	275
*H-P	6224B	0-24	3	0.01	0.01	0.2	abcde	325
*H-P	6215A	0-25	0.4	0.01	0.01	0.2	cde	90
*H-P	6216A	0-25	0.4	0.01	0.01	0.2	cde	115
EPL	PSR-12-25	0-25	0.5	0.01	0.01	100	c	110
*H-P	6220B	0-25	1	0.01	0.01	0.2	abcdef	250
*H-P	6227B	0-25	2	1mV	0.01	0.25	abcde	450
Power Des	6050	0-25	2	0.01	0.01	1	abcd	195
*Sorensen	QSB18-1.5	13-26	1.6	±0.005	±0.005	0.25	abcdej	115
Rosemont	SPS-2089-L-A	1-28	0.5	25mV	25mV	1		98
Endevco	4204	1-30	0.1	0.01	0.01	0.1pp	bd	180
*H-P	721A	0-30	0.15	15mV	30mV	150	cde	145
*Acopian	K55	1.25-30	0.3	10mV	±0.5	1	cdj	98
*Kepco	ABC30-0.3M	0-30	0.3	0.05	0.05	0.25	abcde	131
AUL	RS-30A	1-30	0.5	20mV	20mV	3		45
Topaz	151	0-30	0.5	±0.02	5mV	1		reg
Prec Stan	113	0-30	0.7	0.005	0.01	0.18	abcde	169
AUL	PS-30	0-30	1	0.01	0.01	1		63
*H-P	6206B	0-30	1	0.01	0.01	0.2	abcde	169
AUL	PSS-30	0-30	1	0.01	0.01	1	n	120
*Heath	IP-28	1-30	1	25mV	50mV	5	abcde	48kit
*Sorensen	QRS30-1	0-30	1.1	±0.01	±0.01	0.4	abcdej	145
Sorensen	QRD30-1	0-30	1.1	±0.005	±0.005	0.2	abcdej	178
Beco	304	0-30	1.2	0.01	0.1	0.2	dep	reg
*Power/Mate	BP-30E	0-30	2.5	0.01	0.01	0.25	abcdej	210
R-S	NGN	0-30	2.5	-15-+10	±0.5	2.5	cfj	610
Prec Stan	114	0-30	3	0.005	0.01	0.18	abcde	269
*Trygon	HH32-1.5	0-32	1.5	0.01	0.01	0.5	c	165
*Trygon	LQS28-1.4	22-33	1.4	0.01	0.01	0.5		135
*Power/Mate	BP-89	0-34	0.5	0.01	0.01	0.25	abcde	89
*Power/Mate	BP-34C	0-34	0.5	0.01	0.01	0.25	abcdej	89
*Power/Mate	BP-118	0-34	1.5	0.01	0.01	0.25	abcde	118
*Power/Mate	BP-34D	0-34	1.5	0.01	0.01	0.25	abcdej	129
*Sorensen	QSB28-1	18-36	1.1	±0.005	±0.005	0.25	abcdej	115
*Kepco	CK36-1.5M	0-36	1.5	0.005	0.01	0.5	abcde	321
*Kepco	BOP36-1.5M	±36	±1.5	0.1mV	1mV	3	acdz	525
*ERA	SL36-2/2M	0-36	2	±0.01	±0.01	1	abcdef	465
*ERA	SL36-2M	0-36	2	±0.01	±0.01	1	abcde	235
*Sorensen	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 $345.00

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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.

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Circle 200 on Inquiry Card

Laboratory Type Power Supplies

	Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
LT 7	Plastic	LV36-300	35.3-36.7	3	0.05	0.05	3	abdfghj	150
	Int Conf	CPS400-1	0.1-38	1	0.05	0.05	5	t	395
	*RCA	WP704A	0-40	0.25	7mV	20mV	0.5	cd	59
	*H-P	6204B	0-40	0.3	0.01	0.01	0.2	abcde	144
	*Mid-East	PMA40-.5	0-40	0.5	±0.01	0.02	1	abcd	175
	*Kepco	ABC40-0.5M	0-40	0.5	0.05	0.05	0.25	abcde	175
	*H-P	6112A	0-40	0.5	0.001	0.001	0.04	abcde	375
	*Sorensen	QHS40-.75	0-40	0.5	1ppm	5ppm	0.1	abcdej	345
	*Kepco	CDT40-0.5M	0-±40	±0.5	0.005	0.01	0.25	abcden	399
	*Sorensen	QHS40-.5L	0-40	0.5	1ppm	5ppm	0.1	abcdej	265
LT 8	*H-P	6102A	0-40	0.5	0.001	0.001	0.04	abcde	265
	*ERA	TR040M	0-40	0.5	±0.15	0.03	0.8	abcdeg	130
	*H-P	6205B	0-20-40	0.3-0.6	0.01	0.01	0.2	abcdef	235
	*H-P	6202B	0-40	0.75	0.01	0.01	0.2	abcde	169
	*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
	*Sorensen	QRD40-.75	0-40	0.825	±0.005	±0.005	0.2	abcdej	178
	*Sorensen	QRS40-.75	0-40	0.825	±0.01	±0.01	0.4	abcdej	145
LT 9	*H-P	6255A	0-40	1.5	0.01	0.01	0.2	abcdef	445
	*Sorensen	QRD40-.75-20-1.5	0-20-40	0.75-1.5	±0.005	±0.005	0.2	abcdefj	396
	*Trygon	SHR40-1.5A	0-40	1.5	0.01	0.01	0.5	e	239
	*H-P	6289A	0-40	1.5	0.01	0.01	0.2	abcde	210
	Wanless	MP-40	0-40	1.6	±0.01	±0.01	0.25	dev	225
	Wanless	PDC-40	0-40	1.6	±0.005	±0.005	0.5		375
	*Sorensen	QRD40-.75-20-1.5	0-20-40	0.825-1.65	±0.005	±0.005	0.2	abcdefj	198
	*Trygon	DL40-1	0-20-40	0.5-2	0.01	0.01	0.25	f	249
	*Mid-East	HW40-2	0-40	2	0.01	0.01	1	abcde	225
	*Sorensen	QRD40-2	0-40	2.2	±0.005	±0.005	0.2	abcdej	278
LT 10	*Sorensen	QRS40-2	0-40	2.2	±0.01	±0.01	0.4	abcdej	255
	*H-P	6265B	0-40	3	0.01	0.01	0.2	abcde	350
	*Techni	LA40-3M	0-40	3	±0.01	±0.15	0.2%	abcde	320
	*Trygon	HR40-3B	0-40	3	0.01	0.01	0.5	e	325
	*H-P	6290A	0-40	3	0.01	0.01	0.5	abcde	350
	*Sorensen	QRD40-2-20-4	0-20-40	2.2-4.4	±0.005	±0.005	0.2	abcdefj	298
	Plastic	LV48-300	47-49	3	0.05	0.05	3	abdfghj	215
	*H-P	6217A	0-50	0.2	0.01	0.01	0.2	cde	90
	*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
	*EPL	PSR-12-50	0-50	0.25	0.01	0.01	100	c	110
	Prec Stan	101	0-50	0.4	0.005	0.01	0.2	abcde	169
	*NJE	LVCII-50-.5	0-50	0.5	0.01	0.01	0.25	abcde	124
	*H-P	6220B	0-50	0.5	0.01	0.01	0.2	abcdef	250
	*NJE	PVC-50-.5	0-50	0.5	0.01	0.01	0.25	abcde	148
	Power Des	5005S	0-50	0.5	0.005	0.005	1	abcd	150
	*NJE	LVCII-50-1	0-50	1	0.01	0.01	0.25	abcde	171
	*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	a	150
	*NJE	PVC-50-1	0-50	1	0.01	0.01	0.25	abcde	195
	*H-P	6824A	-50 to +50	1	0.02	0.02	10	z	350
	*Heath	IP-27	0.5-50	1.5	0.05	15mV	0.25	cde	80kit
	*H-P	6226B	0-50	1.5	0.01	0.01	0.2	abcde	325

Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
Power Des	5015T	0-50	1.5	0.01	0.01	0.75	abcd	235
*Kepco	JQE55-2M	0-55	2	0.0005	0.005	0.2	abcde	300
*NJE	PVC-50-2	0-50	2	0.01	0.01	0.25	abcde	295
*Trygon	T50-2	0-50	2	0.05	0.05	0.5	e	249
Prec Stan	106	0-50	2	0.005	0.01	0.2	abcde	269
Prec Stan	112	0-50	3	0.001	0.01	0.2	abcde	370
*Trygon	LQS48-.67	32-53	0.67	0.01	0.01	0.5		139
*Trygon	LQS48-1.9	32-53	1.9	0.01	0.01	0.5		185
*Mid-East	PMA60-.35	0-60	0.35	±0.01	0.02	1	abcd	175
*Kepco	CK60-0.5M	0-60	0.5	0.005	0.01	0.5	abcde	321
Power Des	6050	0-60	0.5	0.01	0.01	1	abcd	195
*H-P	6206B	0-60	0.5	0.01	0.01	0.2	abcde	169
AUL	RSD-30A	2-60	0.5	20mV	20mV	3	f	85
*Sorensen	QRD60-.5	0-60	0.55	±0.005	±0.005	0.2	abcdej	185
*Sorensen	QRS60-.5	0-60	0.55	±0.01	±0.01	0.4	abcdej	155
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
*Power/Mate	BP-60E	0-60	1.25	0.01	0.01	0.25	abcdej	220
*ERA	SL601-2M	0-60	1	±0.01	±0.05	1	abcde	440
*Trygon	SHR60-1A	0-60	1	0.01	0.01	0.5	e	239
*Sorensen	QRD60-.5-30-1	0-30-60	0.5-1	±0.005	±0.005	0.2	abcdefj	205
*H-P	6294A	0-60	1	0.01	0.01	0.2	abcde	210
*ERA	SL60-1M	0-60	1	±0.01	±0.05	1	abcde	220
AUL	PSD-30	0-60	1	0.01	0.01	1	f	120
*ERA	LC Series	4-60	1-12.5	±0.01	0.05	0.8	abdegj	95-225
Prec Stan	116	0-60	1.5	0.005	0.01	0.24	abcde	269
*Sorensen	QRD60-1.5-30-3	0-30-60	1.65-3.3	±0.005	±0.005	0.2	abcdefj	305
*Sorensen	QRD60-1.5	0-60	1.65	±0.005	±0.005	0.2	abcdej	285
*Mid-East	HW60-1.5	0-60	1.5	0.01	0.01	1		225
*Sorensen	QRS60-1.5	0-60	1.65	±0.01	±0.01	0.4	abcdej	265
*Power/Mate	BP-60F	0-60	1.75	0.01	0.01	0.25	abcdej	245
*Kepco	KS60-2M	0-60	2	0.005	0.01	1	abcde	552
North Hills	TC-602CR	60	2	0.0001	0.0001	0.05	abcd	1750
*Trygon	HR60-2.5B	0-60	2.5	0.01	0.01	0.5	e	355
Prec Stan	118	0-60	2.5	0.005	0.01	0.24	abcde	370
*Power/Mate	BP-60G	0-60	2.5	0.01	0.01	0.25	abcdej	300
*H-P	6296A	0-60	3	0.01	0.01	0.5	abcde	395
*Mid-East	HW60-3	0-60	3	0.01	0.01	1		310
*H-P	6271B	0-60	3	0.01	0.01	0.2	abcde	435
*Kepco	BOP721.5M	±72	±1.5	0.1mV	1mV	3	acdz	1125
*Kepco	JQE75-1.5M	0-75	1.5	0.0005	0.005	0.2	abcde	300
*Kepco	SM75-2M	0-75	2	0.01	0.05	1	bcde	447
*Kepco	ABC7.5-2M	0.75	2	0.05	0.05	0.25	abcde	175
*Kepco	JQE75-3M	0-75	3	0.0005	0.005	0.2	abcde	520
*Techni	LA80-1.5M	0-80	1.5	±0.01	±0.15	0.2%	abcde	325
*Kepco	PR80-2.5	0-80	2.5	±1	2	0.7%	cde	357
*Techni	LA80-3M	0-80	3	±0.01	±0.15	0.2%	abcde	355
*Trygon	LQS65-1.3	50-83	1.3	0.01	0.01	0.5		199
AUL	RST-30A	3-90	0.5	20mV	20mV	3	m	125
*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
	JQE75-							

	Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
LT 13	*Mid-East	PMA100-.2	0-100	0.2	±0.01	0.2	1	abcd	190
	North Hills	TC-100.2BR	100	0.2	0.0001	0.0001	0.04	abcd	2200
	*Kepco	ABC100-0.2M	0-100	0.2	0.05	0.05	0.25	abcde	197
	*Kepco	CDT100-0.2M	0-±100	±0.2	0.005	0.01	0.25	abcden	399
	Prec Stan	117	0-100	0.2	0.005	0.01	0.4	abcde	185
	*H-P	6116A	0-100	0.2	0.001	0.001	0.04	abcde	375
	*Sorensen	QHS100-.2	0-100	0.2	1ppm	5ppm	0.1	abcdej	345
	*Sorensen	QHS100-.2L	0-100	0.2	1ppm	5ppm	0.1	abcdej	265
	*H-P	6131B	0-100	0.5	2mV	2mV	5	o	1500
	*H-P	6299A	0-100	0.75	0.01	0.01	0.2	abcde	225
LT 14	*Kepco	JQE100-1M	0-100	1	0.0005	0.005	0.2	abcde	300
	Prec Stan	115	0-100	1	0.005	0.01	0.4	abcde	269
	*Kepco	PVS100-1M	0-100	1	0.0005	0.001	0.1	abcde	875
	*Mid-East	HW100-2	0-100	2	0.01	0.01	1		360
	*Kepco	JQE100-2.5	0-100	2.5	0.0005	0.005	0.2	abcde	520
	Deltron	RP	0-100	3	0.005	0.005	0.2	abcdej	159-205
	Deltron	SP	0-100	50	0.005	0.005	0.5	abcdej	195-925
	*ERA	SR Series	5-110	0.1-0.2	±0.1	±0.1	0.01%	abdegj	95-125
	North Hills	VS-35	111.1	0.1	0.0025	0.0025	0.02%	bd	1250
	Lambda	LL-900	0-120	1	0.01	0.01	1	cdg	75
LT 15	*Kepco	KS120-1M	0-120	1	0.005	0.01	1	abcde	578
	*Kepco	KS120-2.5M	0-120	2.5	0.005	0.01	1	abcde	730
	*H-P	6443B	0-120	2.5	60mV	120mV	240	abcde	360
	Lambda	LH	0-120	9	0.015	0.015	1	abcdeg	170
	*NJE	SVC-125-1.6M	0-125	1.6	0.01	0.01	1	abcde	515
	*Sorensen	DCR150-2.5A	0-150	2.88	±0.075	±0.075	0.4%	abcdej	360
	*Kepco	PR155-1M	0-155	1	±1	2	0.6%	cde	357
	*H-P	6207B	0-160	0.2	0.02	0.02	0.5	abcde	235
	*Trygon	SHR160-500B	0-160	0.5	0.01	0.01	0.5	e	329
	*Techni	LA160-0.75M	0-160	0.75	±0.01	±0.15	0.2%	abcde	335
LT 16	*Kepco	SM160-1AM	0-160	1	0.01	0.05	1	bcde	447
	*Trygon	RS160-1A	0-160	1	0.01	0.01	0.5	e	550
	*Techni	LA160-1.5M	0-160	1.5	±0.01	±0.15	0.2%	abcde	365
	*Kepco	SM160-2AM	0-160	2	0.01	0.05	1	bcde	552
	*Trygon	HR160-2B	0-160	2	0.01	0.01	0.5	e	510
	*Techni	LA160-3M	0-160	3	±0.01	±0.15	0.2%	abcde	440
	*Trygon	RS160-3A	0-160	3	0.01	0.01	0.5	e	685
	*Trygon	LQS158-67	115-161	0.67	0.01	0.01	0.5		199
	*Trygon	LHS150-1.9	115-161	1.9	0.01	0.01	0.5		320
	*Trygon	L3R150-3	115-161	3	±0.005	0.005	0.5		530
LT 17	*Kepco	ABC200M	0-200	0.1	0.05	0.05	0.5	abcde	220
	Assoc Spec	13	75-200	0.1	1	1	5	c	89.50
	*Mid-East	HW-200-1	0-200	1	0.01	0.01	1		395
	*Kepco	PR220-3M	0-220	3	±1	2	0.5%	cde	473

Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
*Kepco	HB250M	0-250	1	0.01	0.01	1	abcde	595
Lambda	LPD-400	0-±250	1.7, 3.4	0.01	0.01	1.5	abcdefg	290
Lambda	LR-600	0-250	1.8	0.0005	0.0005	0.1	abcdeg	265
Lambda	LP-400	0-250	2	0.01	0.01	1.5	abcdeg	140
Lambda	LS-500	0-250	2.8	0.0005	0.0005	0.1	abcdeg	430
R-S	NGU	0-300	0.1	±10	±0.1	0.2		195
*Trygon	FT300-500	300	0.5	±1	10	700		125
*Sorensen	DCR300-1.25A	0-300	1.44	±0.075	±0.075	0.4%	abcdej	400
*Sorensen	DCR300-2.5A	0-300	2.88	±0.075	±0.075	0.4%	abcdej	600
*Kepco	PR310-0.6M	0-310	0.6	±1	2	0.5%	cde	378
*Kepco	PR310-2M	0-310	2	±1	2	0.5%	cde	473
*H-P	6209B	0-320	0.1	0.02	0.02	1	abcde	235
*H-P	890A	0-320	0.6	0.007	0.007	1	abcde	445
*H-P	895A	0-320	1.5	0.007	0.007	1	abcde	625
*Trygon	RS320-1.5B	0-320	1.5	0.01	0.01	0.5	e	625
Assoc Spec	3	200-325	0.1	1	1	10	c	80
*Kepco	HB2AM	0-325	0.2	0.01	0.01	1	abcde	325
*Kepco	HB4AM	0-325	0.4	0.01	0.01	1	abcde	365
*Kepco	SM325-0.5AM	0-325	0.5	0.01	0.05	1	bcde	462
*Kepco	HB6AM	0-325	0.6	0.01	0.01	1	abcde	395
*Kepco	HB8AM	0-325	0.8	0.01	0.01	1	abcde	435
*Kepco	SM325-1AM	0-325	1	0.01	0.05	1	bcde	583
*Kepco	SM325-2AM	0-325	2	0.01	0.05	1	bcde	709
*Mid-East	HV350-1	0-350	1	0.005	0.01	1	abd	605
*Mid-East	HV350-2	0-350	2	0.005	0.01	1		725
*Mid-East	HV350-3	0-350	3	0.005	0.01	1		905
*Heath	IP-17	0-400	0.1	1	1	10	c	62 kit
*Kepco	400B	0-400	0.15	0.1	0.025	3		310
*Kepco	ABC425M	0-425	0.05	0.05	0.05	0.5	abcde	220
*Kepco	BHK500-0.4M	0-500	0.4	0.005	0.01	1	abcde	825
*Kepco	HB525M	0-525	0.5	0.01	0.01	1	abcde	550
*Kepco	615B	0-600	0.5	0.1	0.02	3		394
*Kepco	605	0-600	0.5	0.1	0.02	3		473
*H-P	6448B	1-600	1.5	600mV	600 mV	600	abcde	550
*Kepco	2400B	0-800	.005-0.3	0.1	0.025	1-6	t	625
*Kepco	430D	0-900	0.3-0.6	0.1	0.025	3-6	t	762
*Kepco	ABC1000M	0-1000	0.01	0.05	0.05	1	abcde	309
Keithley	241	0-1000	0.02	±0.005	±0.005	1	hj	885
*H-P	6521A	0-1000	0.2	0.005	0.005	1	cde	750
Buchler	3-1014A	1000	0.2	±1	±1	1%	cdj	595
*Kepco	BHK1000-0.2M	0-1000	0.2	0.005	0.01	1	abcde	825
*Kepco	1250B	0-1000	0.5	0.05	0.01	3		730
Fluke	341A	0-1100	0.025	0.0005	0.0005	0.1		1195
Fluke	343A	0-1100	0.025	0.0005	0.0005	0.05		1695
Fluke	335A	0-1100	0.05	0.0002	0.0002	0.04		2485
Fluke	332B	0-1100	0.05	0.0002	0.0002	0.04		2295
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	t	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.

Index by Model Number

Name	Model	Code
Acopian	K55	LT3
Acopian Corp.		
Assoc Spec	3	LT14
Associated Specialties Co.	13	LT17
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	304	LT4
State Systems	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	SL36-2/2M	LT6
Research	SL60-1M	LT9
Associates	SL601-2M	LT9
	TR040M	LT8
Endevco	4204	LT3
Fluke	332B	LT17
John Fluke	335A	LT17
Manufactur-	341A	LT17
ing Co.	343A	LT17
	3330A	LT17
H-P	721A	LT3
Hewlett-	890A	LT13
Packard Co.	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

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		
Kepco	ABC2-1M	LT1
Kepco, Inc.	ABC2-1M	LT1
	ABC10-0.75M	LT1
	ABC15-1M	LT3
	ABC30-0.3M	LT3
	ABC40-0.5M	LT7
	ABC100-0.2M	LT13
	ABC200M	LT17
	ABC425M	LT15
	ABC1000M	LT16
	BHK500-0.4M	LT15
	BHK1000-0.2M	LT16
	BOP36-1.5M	LT6
	BOP72-1.5M	LT11
	CDT15-1M	LT3
	CDT40-0.5M	LT7
	CDT100-0.2M	LT13
	CK18-3M	LT4
	CK36-1.5M	LT6
	CK40-0.8M	LT8
	CK60-0.5M	LT7
	HB2AM	LT14
	HB4AM	LT14
	HB6AM	LT14
	HB8AM	LT14
	HB250M	LT13
	HB525M	LT15
	JQE36-3M	LT6
	JQE55-12M	LT7
	JQE75-1.5M	LT11
	JQE75-3M	LT11
	JQE100-1M	LT14
	JQE100-2.5M	LT14
	KS60-2M	LT10
	KS120-1M	LT15
	KS120-2.5M	LT15
	PR80-2.5M	LT11
	PR155-1M	LT15
	PR220-3M	LT17
	PR310-0.6M	LT13
	PR310-2M	LT13
	PV5100-1M	LT14
	SM75-2M	LT11
	SM160-1AM	LT16
	SM160-2AM	LT16
	SM325-0.5AM	LT14
	SM325-1AM	LT14
	SM325-2AM	LT14
	400B	LT15
	430D	LT16
	605	LT15
	615B	LT15
	800B	LT17
	1250B	LT16
	2400B	LT15
Lambda	LH	LT15
Lambda	LL-900	LT14
Electronics	LP-400	LT13
	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
Techni	LA40-3M	LT10
Technipower,	LA80-1.5M	LT11
Inc.	LA80-3M	LT12
	LA160-0.75M	LT15
	LA160-1.5M	LT16
	LA160-3M	LT16
Topaz	91PQ	LT4
Topaz, Inc.	151	LT3
Trygon	DL40-1	LT9
Trygon	EALO-10	LT1
Electronics	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
Wanlass	LAB11	LT4
Wanlass	MP-40	LT9
Electric Co.	PDC-40	LT9
	PSSS1-24	LT2

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 ±0.005% or 1MV for line and load. All other units better than ±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°C to +71°C ambient.

STORAGE TEMPERATURE — –55°C to +85°C.

OUTPUT CURRENT vs. TEMPERATURE — Unit is rated for full current output at temperatures between –20°C and +45°C and is linearly derated from +45°C to 70% of the full output at +71°C.

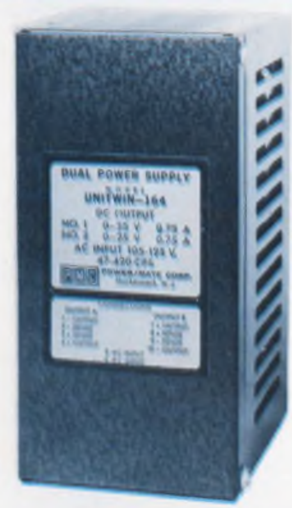
REMOTE-LOCAL SENSING — Provision is included to permit remote sensing of the output voltage directly at the load for improved over-all regulation. Unit may be connected for local sensing if desired.

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 ±0.005% or 1 Mv for line and load.

$76.00

3⁵⁄₁₆"W x 3⅞"H x 5⅛"D

WEIGHT: Net 3¾ lbs., Shipping 4¾ lbs.

UNI-88 0-34 volts, 1.5 amps over entire voltage range. Regulation: Better than ±0.005% or 1 Mv for line and load.

$99.00

3⁵⁄₁₆"W x 3⅞"H x 6⅞"D

WEIGHT: Net 5¼ lbs., Shipping 6¾ lbs.

UniTwin-164 **DUAL OUTPUT** 0-25 volts, 0.75 amps over entire voltage range. Regulation: Better than ±0.005% or 1 Mv for line and load.

$164.00

3⁵⁄₁₆"W x 4³⁄₁₆"H x 6⅞"D

WEIGHT: Net 5¾ lbs., Shipping 7½ lbs.

PMC

POWER/MATE CORP.
514 S. River Street, Hackensack, N. J. 07601
Phone: (201) 343-6294 / TWX: 710-990-5023

SAME DAY SHIPMENT

Modular dc Power Supplies

	Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
M 1	Dynage	D Series	0.5-1.2	0.2-1	±0.025	±0.025	1	abdgu	90-101
	*Acopian	1J10	0.75-1.25	0.1	±0.05	±0.25	0.5	abdj	70
	Dynage	D Series	1.2-1.8	0.2-1	±0.025	±0.025	1	abdgu	90-101
	*Acopian	1.5J Series	1-2	0.2-0.75	±0.05	±0.4-±0.7	1	abdfj	70-85
	Dynage	D Series	1.8-2.3	0.2-1	±0.025	±0.025	1	abdgu	90-101
	Dynage	D Series	2.3-2.7	0.2-1	±0.025	±0.025	1	abdgu	90-101
M 2	Valor	CG2 Series	1.75-3	8, 15	5mV	0.05	0.5	abdg	165, 197
	*Acopian	2.5J Series	2-3	0.2-0.75	±0.05	±0.4-0.7	1	abdfj	70-85
	Dynage	H Series	0.5-3.1	11.3-46	±0.025	±0.025	1	abdgu	195-435
	Dynage	D Series	2.7-3.1	0.2-1	±0.025	±0.025	1	abdgu	90-101
	Dynage	H Series	0.5-3.5	3.3-6.4	±0.025	±0.025	1	abdgu	124-147
M 3	*Acopian	3J Series	2.5-3.5	0.2-4.0	±0.05	±0.3-0.7	1	abdfj	70-165
	Elasco	MS3	2.8-3.5	0.1-0.5	0.05	0.05	0.01%	dsu	70-90
	Dynage	D Series	3.1-3.5	0.2-1	±0.025	±0.025	1	abdgu	90-101
	Dynage	D Series	3.5-3.9	0.2-1	±0.025	±0.025	1	abdgu	90-101
	SCI	1.4.100	4	0.1	0.01	0.05	1	bd	38
	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		205
	*Acopian	4J Series	3-4	0.2-4	±0.05	±0.2-0.5	1	abdfj	70-165
	Valor	CG3 Series	2.75-4	8, 15	5mV	0.05	0.5	abdg	165, 197
	Dynage	D Series	3.9-4.3	0.2-1	±0.025	±0.025	1	abdgu	90-101
	Elasco	MS4	3.5-4.5	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
	Dynage	D Series	4.3-4.7	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
	CP	PM703	5	0.5	±0.5	±0.5	1	s	44.90
	P/N	2205	5	0.5	±0.1 max	±0.1 max	2 max		48
	CP	PM707	5	1	±0.5	±0.5	1	s	49.90
	CP	PM709	5	1	0.05	0.05	1	s	54.90
	Elasco	LIC5-1A	5	1	0.5	0.5	10	v	29
	SCI	1.5.1000	5	1	0.05	0.1	2	bd	35
	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
	Arnold	PHU-5	5	5	0.1	1	10	d	220
	Wanlass	111-OEM5-5	5	5	±0.1	±0.1	1	abdg	90
	Atlas	P3310	5	7	±5	±5	50	d	323
	Elasco	LIC5-7A	5	7	±25mV	±25mV	10	v	55
	Wanlass	P60HP-7.51C-5	5	7.5	±0.01	1mV	0.1	abdg	220
	Wanlass	P60-7.51C-5	5	7.5	±0.02	±0.02	0.3	abdg	195
M 7	Arnold	PHU-5WW	5	8	0.1	1	10	d	290
	*ACDC	IC5N9.5	5	9.5	0.05	0.05	2	abd	134
	*ACDC	IC5N13.5	5	13.5	0.05	0.05	2	abd	186
	Wanlass	P120-151C-5	5	15	±0.02	±0.02	0.3	abdg	240
	Wanlass	P120HP-151C-5	5	15	±0.01	1mV	0.1	abdg	265
	*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

Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
Valor	CG4 Series	3.5-5	8, 15	5mV	0.05	0.5	abdg	165, 197
Dynage	D Series	4.7-5.2	0.2-1	±0.025	±0.025	1	abdgu	90-101
Dynage	H Series	3.1-5.3	11.3-46	±0.025	±0.025	1	abdgu	195-435
*Techni	HFT-5-100	2.5-5.3	100	±0.1	±0.3	30		1095
*Nucor	NPS Series	4.7-5.3	0.375-1.5	0.05	0.05	2	dju	req
*Nucor	NPS Series	4.7-5.3	3-12	0.05	0.05	3	dju	reg
Elasco	MS 5	4.5-5.5	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
*Acopian	5L200	4.5-5.5	2	±0.5	±0.5	5	abdj	140
Abbott	R5T20	4.5-5.5	20	±0.05	±0.05	5	bdgj	462
*Techni	HF80 Series	2.8-5.5	3-50	±0.05	±0.05	0.2%	u	150-480
Dynage	D Series	5.2-5.8	0.2-1	±0.025	±0.025	1	abdgu	90-101
SCI	2.6.100	±6	±0.05	0.01	0.05	1	bdf	49
SCI	2.6.50	±6	±0.05	0.01	0.05	1	bdf	39
SCI	P2.6.25	±6	0.025	0.2	0.2	2	bdf	20
SCI	2.6.200	±6	±0.05	0.01	0.05	1	bdf	59
SCI	1.6.100	6	0.1	0.01	0.05	1	bd	38
Acme	PS-65424	6	10	±1	±2	1%		ina
Acme	PS-65426	6	15	±1	±2	1%		ina
Acme	PS-65500	6	30	±1	±2	1%		ina
ACDC	JR5k10	3-6	10	0.1	0.1	3	abd	250
Acopian	5J Series	4-6	0.2-5	±0.05	±0.2-0.7	1	abdfj	70-180
Valor	CG5 Series	4.75-6	7, 8, 14	5mV	0.05	0.5	abdgu	165, 197
Power Des	UPM-16	5, 6	5	0.01	0.01	1	abd	169
Power Des	UPMD-56	5, 6	10	0.01	0.01	1	abd	225
Power Des	UPMD-6	3, 4, 5, 6	10	0.01	0.01	1	abd	245
CP	PM728	4.8-6.3	3	±0.05	±0.05	1	s	99.60
Dynage	D Series	5.8-6.4	0.2-1	±0.025	±0.025	1	abdgu	90-101
Dynage	H Series	3.5-6.4	2.9-6.4	±0.025	±0.025	1	abdgu	124-147
Rose-mount	SPS-2055	1-6.5	0.3	15mV	15mV	1.5	bd	68
Rose-mount	SPS-2062P	1-6.5	0.6	15mV	10mV	1.5	bd	72
*Sorensen	QSA5-14.6	3-6.5	17.6	±0.01	±0.01	0.3	abdegj	209
*Sorensen	QSA18-2	3-6.5	20.5	±0.01	±0.01	0.3	abdegj	249
Wanlass	30-OEM-1	3-6.9	2.5	±1	±1	0.1%		46
Valor	CS7-1.0	0-7	1	2mV	0.05	0.05	abdg	60
*Kepco	PAX7-1	0-7	1	0.05	0.05	0.25		94
*Kepco	PCX7-2	0-7	2	0.0005	0.005	0.1		111
*Kepco	PAT7-2	0-7	2	0.0005	0.005	0.1		121
Valor	CS7-3.0	0-7	3	2mV	0.05	0.5	abdg	98
Lambda	LM-F	0-7	25	0.01	0.02	0.5	abdg	450
Lambda	LM-G	0-7	35	0.01	0.02	0.5	abdg	575
Lambda	LM-H	0-7	52	0.01	0.02	0.5	abdg	875
*Power/Mate	RD-5	3-7	1	0.6	1.4	8	abdj	55
*Power/Mate	RC-5	3-7	1	0.3	0.7	4	abdj	65
*Sorensen	QSA5-6.4	3-7	7	±0.01	±0.01	0.3	abdegj	149
Elasco	MS6	5-7	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
*Acopian	6L Series	5-7	2	±0.5	±0.5	5	abdj	50-140
*Acopian	6J Series	5-7	5	±0.05	±0.05-0.7	1	abdfj	60-180

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.

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	Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
M 8	Valor	CG6Series	5.75-7	7, 14	5mV	0.05	0.5	abdg	165, 197
	Dynage	D Series	6.4-7	0.2-1	±0.025	±0.025	1	abdgu	90-101
	*Kepco	PAR-7	7	10	0.005	0.01	0.25		205
	SCI	372	0.7-5	2	0.01	0.01	1	cd	100
	Dynage	D Series	7-7.7	0.15-1	±0.025	±0.025	1	abdgu	90-101
	Litton	541430	3-8	15	±0.25	±0.25	75		reg
	*Techni	HF80Series	4-8	2-30	±0.05	±0.05	0.2%	u	145-460
	*Acopian	7L Series	6-8	2	±0.5	±0.5	5	abdfj	45-140
	*Acopian	7L Series	6-8	3	±0.5	±0.05-0.5	1	abdfj	60-165
	Valor	CG7Series	6.75-8	7, 14	5mV	0.05	0.5	abdg	165, 197
M 9	Dynage	H Series	5.3-8.5	9-40	±0.025	±0.025	1	abdgu	195-435
	Dynage	D Series	7.7-8.5	0.15-1	±0.025	±0.025	1	abdgu	90-101
	Wanlass	60-OEM-1	3.6-9	5	±1	±1	0.1%		58
	Wanlass	120-OEM-1	3.6-9	10	±1	±1	0.1%		86
	Rose-mount	SPS-2056P	5-9	0.25	15mV	5mV	1.5	bd	68
	Rose-mount	SPS-2063P	5-9	0.45	15mV	10mV	1.5	bd	72
	Elasco	MS8	7-9	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
	*Acopian	8L Series	7-9	2	±0.5	±0.5	5	abdfj	45-150
	*Acopian	8J Series	7-9	3	±0.05	±0.05-0.25	0.5-1.0	abdfj	60-170
	Valor	CG8Series	7.75-9	7, 13	5mV	0.05	0.5	abdg	165, 197
M 10	SCI	1.9.100	9	0.1	0.01	0.05	1	bd	38
	Rose-mount	SPS-2017P	9	0.175	4mV	9mV	1	bd	51
	Atlas	P2764	±9	0.75	0.1	0.2	5	def	429
	Dynage	D Series	8.5-9.4	0.15-1	±0.025	±0.025	1	abdgu	90-101
	CEA	CEA6DX 101R	3.5-9.9	0.1	0.0001	0.0004	0.0003%	rs	215
	CEA	CEA6CX 101R	3.5-9.9	0.1	0.0005	0.002	0.0005%	rs	145
	CEA	CEA6BX101	3.5-9.9	0.1	0.002	0.008	0.001%	rs	95
	CEA	CEA6AX101	3.5-9.9	0.1	0.01	0.04	0.01%	rs	85
	CEA	CEA6AX252	3.5-9.9	2.5	0.01	0.04	0.01%	rs	150
	CEA	CEA6BX252	3.5-9.9	2.5	0.002	0.008	0.001%	rs	160
M 11	CEA	CEA6CX 252R	3.5-9.9	2.5	0.0005	0.002	0.0005%	rs	210
	CEA	CEA6CX 502R	3.5-9.9	5	0.0005	0.002	0.0005%	r	235
	CEA	CEA6BX502	3.5-9.9	5	0.002	0.008	0.001%	r	185
	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
	CEA	CEA6BX253	3.5-9.9	25	0.002	0.008	0.001%	r	370
	*Sorensen	QSA10-1.4	0-10	1.5	±0.005	±0.005	0.3	abdegj	89
	*Sorensen	QSA10-2.2	0-10	2.4	±0.005	±0.005	0.3	abdegj	109
	*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
	Elasco	VS Series	3-10	0.1-0.75	0.05	0.05	0.01%	dsu	80-100
	*Techni	SCR10.0-50	5-10	50	±0.5	±0.5	1%		475
	*Acopian	9L Series	8-10	2	±0.5	±0.5	5	abdfj	45-150
	*Acopian	9J Series	8-10	3	±0.05	±0.05-0.3	0.5-1.0	abdfj	60-170
	Valor	CG9Series	8.75-10	6, 7, 13	5mV	0.05	0.5	abdgu	165, 197
	SCI	P2.10.50J	±10	0.05	0.01	0.05	1	df	53
	SCI	P1.10.100J	10	0.1	0.01	0.05±	1	d	43
	SCI	1.10.100	10	0.1	0.01	0.05	1	bd	38
	SCI	P2.10.100J	±10	0.1	0.01	0.05	1	df	58

Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
Atlas	P2763	±10	0.6	±0.1	±0.2	5	def	429
Acme	PS-47509	10	4	±1	±2	1%		ina
Arnold	PHU-10	10	4	0.1	1	20	d	398
GE	9T66Y8	10	16	±1	5	1%	d	173
*Techni	P80Series	0.5-10.3	0.2-25	±0.5	±0.5	5	su	65-475
*Techni	PM95Series	0.5-10.3	0.2-25	±0.5	±0.5	5	su	100-620
*Techni	PL80Series	2.8-10.3	0.2-6	±0.5	±0.5	1	su	60-190
*Techni	F115Series	2.8-10.3	0.375-25	±0.05	±0.05	1	su	150-1725
*Techni	MCS65 Series	2.8-10.3	0.5-30	±0.5	±0.5	5	su	70-445
*Nucor	NPS Series	9.3-10.3	0.2-1.5	0.05	0.05	2	djv	reg
*Nucor	NPS Series	9.3-10.3	3-12	0.05	0.05	3	dju	reg
Dynage	D Series	9.4-10.3	0.15-0.75	±0.025	±0.025	1	abdgu	90-101
*Techni	HFT10-50	4.5-10.5	50	±0.1	±0.3	30		995
*Techni	HFT10-100	4.5-10.5	100	±0.1	±0.3	30		1250
*Techni	HF80Series	5-11	2-30	±0.05	±0.1	0.2%	su	140-440
*Techni	HF80Series	5.5-11	2-30	±0.05	±0.05	0.2%	su	140-440
*Power/Mate	RC 9	7-11	1	0.1	0.3	4	abdj	65
*Power/Mate	RD-9	7-11	1	0.2	0.6	8	abdj	55
Dynage	K-10/10	9-11	0.175-0.6	±0.05	±0.05	2	abdfg	117-155
Elasco	MS10	9-11	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
*Acopian	10L Series	9-11	2	±0.5	±0.5	5	abdfj	45-150
*Acopian	10J Series	9-11	3	0.05	0.05-0.25	0.5-0.1	abdfj	60-170
Dynage	KH 10/10	9-11	2-4	±0.05	±0.05	2	abdfg	225-325
Dynage	H Series	6.4-11.4	2.1-5.5	±0.025	±0.025	1	abdgu	124-152
Dynage	D Series	10.3-11.4	0.1-0.75	±0.025	±0.025	1	abdgu	90-101
*Acopian	11L200	10.5-11.5	2	±0.5	±0.5	5	abdfj	150
Valor	CG10Series	10-11.5	6, 13	5mV	0.05	0.5	abdg	165-197
SCI	P2.12.50/6.50	-6, +12	0.05	0.01	0.05	1	df	65
SCI	2.12.50/6.50	-6, +12	0.05	0.01	0.05	1	bdf	39
SCI	2.12.100/6.100	-6, +12	0.1	0.01	0.05	1	bdf	49
SCI	P2.12.100/6.100	-6, +12	0.1	0.01	0.05	1	df	75
Valor	CG11Series	10.5-12	6, 12	5mV	0.05	0.5	abdg	165, 197
*Acopian	11JSeries	10-12	3	±0.05	±0.05-0.25	0.5-0.1	abdfj	60-170
SCI	P2.12.25	±12	0.025	0.2	0.2	2	bdf	20
SCI	2.12.50J	±12	0.05	0.01	0.05	1	bdf	35
SCI	P2.12.50J	±12	0.05	0.01	0.05	1	df	55
SCI	2.12.50	±12	0.05	0.01	0.05	1	bdf	30
Rose-mount	SPS-2073D-P	±12	0.075	3mV	6mV	1	bdf	83
SCI	P2.12.100	±12	0.1	0.01	0.05	1	df	60
SCI	2.12.100J	±12	0.1	0.01	0.05	1	bdf	53
SCI	2.12.100	±12	0.1	0.01	0.05	1	bdf	48
SCI	1.12.100	12	0.1	0.01	0.05	1	bd	38
Rose-mount	SPS-2120P	±12	0.175	5mV	10mV	1.5	bdf	102
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

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	Mfr	Model	OUTPUT Range Volts	Max Amps	REGULATION Line %	Load %	Ripple mV	Notes	Price $
M 13	SCI	2.12.200J	±12	0.2	0.01	0.05	1	bdf	70
	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
	SCI	C2.12.200	±12	0.3	0.05	0.1	1	bdf	98
	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
	Atlas	P2762	±12	0.5	±0.1	±0.2	5	df	429
	SCI	P2.12.60	±12	0.06	0.01	0.05	1	df	50
	SCI	C1.12.600	12	0.6	0.05	0.1	1	bd	70
	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
	SCI	E2.12.1000	±12	1	0.01	0.01	1	bdf	148
	Acme	PS47623	12	3	±1	±2	1%		ina
	Arnold	PHU-12	12	3.3	0.1	1	20	d	235
	Wanlass	111-OEM12-5	12	5	±0.1	±0.1	1	abdg	90
	Wanlass	P60HP-51C-12	12	5	±0.01	1mV	0.1	abdg	220
	GE	9T66Y51	12	5	±1	5	1%	d	147
	Wanlass	P60-51C-12	12	5	±0.02	±0.02	0.3	abdg	195
	Acme	PS-65428	12	5	±1	±2	1%		ina
	*Kepco	PAR-12	12	7	0.005	0.01	0.25		205
M 15	Wanlass	P120HP101C-12	12	10	±0.01	1mV	0.1	abdg	265.
	Wanlass	P120-10C-12	12	10	±0.02	±0.02	0.3	abdg	240
	Acme	PS65430	12	10	±1	±2	1%		ina
	GE	9T66Y53	12	15	±1	5	1%	d	178
	Acme	PS65432	12	15	±1	±2	1%		ina
	GE	9T66Y978	12	20	±1	5	1%	d	194
	Lambda	LM-H	12	150	0.01	0.02	0.5	abdg	995
	*Nucor	NPSSeries	11.4-12.5	0.1-1.5	0.05	0.05	2	dju	reg
	*Nucor	NPSSeries	11.4-12.5	3-12	0.05	0.05	3	dju	reg
	Dynage	D Series	11.4-12-6	0.1-0.75	±0.025	±0.025	1	abdgu	76-105
M 16	*Power/Mate	RC-12	11-13	1	0.075	0.1	4	abdj	65
	*Power/Mate	RD-12	11-13	1	0.15	0.2	8	agdj	55
	Rose-mount	SPS-2077P	9-13	0.05	3mV	6mV	1.5	bd	48
	Rose-mount	SPS-2057P	9-13	0.2	2mV	5mV	0.5	bd	61
	Rose-mount	SPS-2064P	9-13	0.35	5mV	10mV	0.5	bd	68
	*Acopian	12L Series	11-13	2	±0.5	±0.5	5	abdfj	45-150
	*Acopian	12J Series	11-13	3	±0.05	±0.05-0.25	1	abdfj	60-170
	Dynage	KH 12/12	11-13	1.8-3.6	±0.05	±0.05	2	abdfg	225-325
	Dynage	K-12/12	11-13	0.15-0.5	±0.05	±0.05	2	abdfg	117-155
	Elasco	MS12	11-13	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
M 17	Valor	CG12Series	11.5-13	6, 12	5mV	0.05	0.5	abdg	165, 197
	Abbott	T12D-12.3A	11.6-13	9.72	±0.2	±0.5	0.2%	dgj	285
	Dynage	H Series	8.5-13.9	7-32.8	±0.025	±0.025	1	abdgu	195-435
	*Sorensen	QSA12-1.3	8-14	1.4	±0.005	±0.005	0.3	abdegj	89
	*Sorensen	QSA12-2.1	8-14	2.3	±0.005	±0.005	0.3	abdegj	109
	*Sorensen	QSA12-3.8	8-14	4.2	±0.005	±0.005	0.3	abdegj	129
	*Sorensen	QSA12-9.3	8-14	11	±0.005	±0.005	0.3	abdegj	199
	*Sorensen	QSA12-13	8-14	15.4	±0.005	±0.005	0.3	abdegj	249
	*Acopian	13LSeries	12-14	2	±0.5	±0.5	5	abdfj	45-150
	*Acopian	13JSeries	12-14	3	±0.05	±0.05-0.25	0.5-0.1	abdfj	65-170

Mfr	Model	Range Volts	Max Amps	Line %	Load %	Ripple mV	Notes	Price $
Valor	CG13Series	12.5-14	6, 12	5mV	0.05	0.5	abdg	165, 197
Valor	CS15-0.4	0-15	0.4	2mV	0.05	0.05	abdg	60
Deltron	OS/PS	0-15	0-0.6	0.02	0.02	0.5	dfg	49-89
*Kepco	PAX15-0.75	0-15	0.75	0.05	0.05	0.25		94
*Kepco	PAT15-1.5	0-15	1.5	0.0005	0.005	0.1		121
Valor	CS15-2.0	0-15	2	2mV	0.05	0.5	abdg	98
R-S	NGG15/15	0.3-15	15	±10	0.01	1	cd	380
*ERA	DVSeries	4-15	0.06-1	0.05	0.05	0.8	bdef	105-189
Litton	541400	3-15	6	±0.25	±0.25	50	reg	
*Techni	HF80	7.5-15	1.5-25	±0.05	±0.1	0.2%	su 420	140-420
Elasco	MS14	13-15	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
*Acopian	14LSeries	13-15	2	±0.5	±0.5	5	abdfj	45-150
*Acopian	14JSeries	13-15	3	±0.05	±0.05-0.25	1	abdfj	65-170
Valor	CG14Series	13.5-15	6, 11	5mV	0.05	0.5		165, 197
SCI	P2.15.25	±15	0.025	0.02	0.2	2	bdf	20
	PR-30C	±15	±0.03	±0.05	±0.5	3p-p		98
P/N	2204	±15	±0.05	±0.03	±0.015	1		46
SCI	2.15.50J	±15	0.05	0.01	0.05	1	bdf	35
SCI	P2.15.50J	±15	0.05	0.01	0.05	1	df	55
SCI	2.15.50	±15	0.05	0.01	0.05	1	bdf	30
Burr-Brown	527	±15	0.05	±0.2	±0.2	1	df	39
SCI	P2.15.60	±15	0.06	0.01	0.05	1	df	50
Rose-mount	SPS-2074D-S	±15	0.065	3mV	6mV	1	bdf	83
P/N	2203	±15	±0.1	±0.03	±0.03	1		57
SCI	P2.15.100	±15	0.1	0.01	0.05	1	df	60
SCI	2.15.100J	±15	0.1	0.01	0.05	1	bdf	53
SCI	2.15.100	±15	0,1	0.01	0.05	1	bdf	48
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
Rose-mount	SPS-2018P	15	0.125	6mv	12mV	1	bd	51
Rose-mount	SPS-2121P	±15	0.15	5mV	10mV	1.5	bdf	102
SCI	C2.15.200	±15	0.2	0.05	0.1	1	bdf	80
SCI	2.15.200J	±15	0.2	0.01	0.05	1	bdf	70
SCI	2.15.200	±15	0.2	0.01	0.05	1	bdf	65
SCI	1.15.200	15	0.2	0.01	0.05	1	bd	49
Elasco	2Q15-250PC	15	0.25	0.1	0.1	2	df	47
P/N	PR-300C	±15	±0.3	±0.005	±0.005	0.25		200
SCI	C2.15.300	±15	0.3	0.05	0.1	1	bdf	98
SCI	C1.15.300	15	0.3	0.05	0.1	1	bd	65
CP	PM731	15	0.3	±0.1	±0.1	1	s	32
CP	PM733	15	0.3	±0.02	±0.02	1	s	37
SCI	C2.15.500	±15	0.5	0.05	0.1	1	bdf	119
CP	PM743	15	0.5	±0.02	±0.02	1	s	41
Burr-Brown	516	±15	0.5	±0.1	±0.1	2		75
CP	PM741	15	0.5	±0.1	±0.1	1	s	36
SCI	C1.15.600	15	0.6	0.05	0.1	1	bd	70
Power Des	UPMD-11	±15	1	0.1mV	0.15mV	0.15	abdf	275

Reader service numbers for literature and application notes, see page D6.

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			OUTPUT		REGULATION				
	Mfr	Model	Range Volts	Max Amps	Line %	Load %	Ripple mV	Notes	Price $
M 18	SCI	C1.15.1000	15	1	0.05	0.1	1	bd	85
	SCI	E2.15.1000	±15	1	0.01	0.01	1	bdf	148
	Burr-Brown	503A	±15	1	±0.1	±0.1	1		325
	Burr-Brown	506/16	±15	1	±0.1	±0.1	1	q	340
	Lambda	LCD-4-152	15±5%	1.5	0.01	0.01	1	abdg	220
	Power Des	UPMD-15	15	2	0.01	0.01	1	abdf	265
	Acme	PS47508	15	2	±1	±2	1%		ina
M 19	*Kepco	PAR-15	15	6	0.005	0.01	0.25		205
	*Nucor	NPS Series	13.7-15.2	0.1-1.5	0.05	0.05	2	dju	req
	Dynage	D Series	13.9-15.3	0.075-0.75	±0.025	±0.025	1	abdgu	76-105
	*TDI	TDMD	1-15.5	1.7-12	0.01	0.01	0.2	abdfgj	129-530
	*Nucor	NPS Series	13.7-15.6	3-12	0.05	0.05	3	dj	req
	Power Des	UPM-11	0-16	1	0.01	0.01	1	abdf	199
	SCI	402	0-16	1	0.01	0.01	1	cdf	199
M 20	SCI	371	0-16	1	0.01	0.01	1	cd	100
	Power Des	UPM-33	0-16	2	0.01	0.01	1	abd	143
	*Power/Mate	RC-15	13-16	0.5	0.075	0.1	4	abdj	65
	*Power/Mate	RD-15	13-16	0.5	0.15	0.2	8	abdj	55
	*ACDC	OA12/15D0.5	14-16	0.5	0.01	0.01	0.5	abd	119
	Dynage	K-15/15	14-16	0.15-0.5	±0.05	±0.05	2	abdfg	117-155
M 21	*ACDC	OA12/15D1.1	14-16	1.1	0.01	0.01	0.5	abd	149
	*Acopian	15L Series	14-16	2	±0.5	±0.5	5	abdfj	45-150
	*Acopian	15J Series	14-16	3	±0.01-0.05	±0.05-0.25	1	abdfj	60-170
	Dynage	KH 15/15	14-16	1.6-3.2	±0.05	±0.05	2	abdfg	225-325
	*ACDC	OA12/15D3.7	14-16	3.7	0.01	0.01	0.5	abd	195
M 22	Deltron	D	4.5-16	0.4-1.5	0.02	0.02	1	abdgj	118-179
	Valor	CG15 Series	14.5-16	5,6,11	5mV	0.05	0.5	abdgu	165, 197
	Abbott	V24D-15.7A	14.8-16.6	15.36	±0.2	±0.5	0.2%	dgj	350
	Dynage	D Series	15.3-16.9	0.075-0.75	±0.025	±0.025	1	abdgu	76-105
	Wanlass	30-OEM-2	9-17	2.5	±1	±1	0.1%		46
	Wanlass	60-OEM-2	9-17	5	±1	±1	0.1%		58
	Wanlass	120-OEM-2	9-17	10	±1	±1	0.1%		86
M 23	Rosemount	SPS-2078P	13-17	0.04	3mV	6mV	1.5	bd	48
	Rosemount	SPS-2058P	13-17	0.175	2mV	5mV	0.5	bd	61
	Rosemount	SPS-2065P	13-17	0.275	4mV	8mV	0.5	bd	68
	Elasco	MS16	15-17	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
	*Acopian	16J Series	15-17	2	±0.05	±0.05-0.2	1	abdfj	60-160
M 24	*Acopian	16L Series	15-17	2	±0.5	±0.5	1	abdfj	45-150
	Valor	CG16 Series	15.5-17	5,11	5mV	0.05	0.5	abdg	165, 197
	P/N	NPS-300	12-18	±0.3	±0.05	±0.05	1		135
	*Power/Mate	PT-99	12-18	0.4	0.05	0.05	0.25	abdfgj	99
	*ACDC	JR15k4	12-18	4	0.1	0.1	3	abd	250
	*Acopian	17L10	16-18	0.1	±0.5	±0.5	5	abdfj	50
	*Acopian	17J Series	16-18	2	±0.05	±0.05-0.2	0.5-1.0	abdfj	65-160

		OUTPUT		REGULATION				
Mfr	Model	Range Volts	Max Amps	Line %	Load %	Ripple mV	Notes	Price $
*Nucor	NPS Series	16.5-18.5	0.1-1.5	0.05	0.05	2	dju	req
*Nucor	NPS Series	16.5-18.5	3-12	0.05	0.05	3	dju	req
Valor	CG17 Series	16.5-18	5, 10	5mV	0.05	0.5	abdg	165, 197
SCI	P2.18.50	±18	0.05	0.01	0.05	1	df	65
SCI	2.18.50	±18	0.05	0.01	0.05	1	bdf	49
Rosemount	SPS-2019P	18	0.1	7mV	14mV	1	bd	51
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
GE	9T66Y61	18	5	±1	4	1%	d	134
Acme	PS-65434	18	5	±1	±2	1%		ina
Acme	PS-65436	18	10	±1	±2	1%		ina
GE	9T66Y966	18.5	6	±1	4	1%	d	139
GE	9T66Y967	18.5	12	±1	5	1%	d	166
GE	9T66Y965	18.5	24	±1	5	1%	jd	391
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
*Acopian	18L Series	17-19	2	±0.5	±0.5	5	abdfj	50-150
*Acopian	18J Series	17-19	2	±0.05	±0.05 -.02	1 6	abdfj	60-160
Valor	CG18 Series	17.5-19	5, 10	5mV	0.05	0.5	abdg	165, 197
*Techni	RA20-6	0-20	6	±0.1	±0.15	0.2%		245
*Techni	RA20-12	0-20	12	±0.1	±0.15	0.2%		275
*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
Rosemount	SPS-2100P	10-20	0.125	10mV	15mV	1	bd	62
Rosemount	SPS-2110P	10-20	0.2	15mV	15mV	1	bd	69
*Techni	SCR20.0-25	10-20	25	±0.5	±0.5	1%	u	420
*Techni	SCR20.0-50	10-20	50	±0.5	±0.5	1%		595
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	128
*Acopian	19J Series	18-20	2	±0.05	±0.05-0.2	0.5-1.0	abdfj	70-160
SCI	2.20.50	±20	0.05	0.01	0.05	1	bdf	49
SCI	1.20.100	20	0.1	0.01	0.05	1	bd	49
SCI	2.20.100	±20	0.1	0.01	0.05	1	bdf	55
Rosemount	SPS-2047P	20	0.1	6mV	12mV	1	bd	51
*Techni	PL80 Series	10.3-20.2	0.1-6	±0.5	±0.5	1	su	60-195
*Techni	P80 Series	10.3-20.2	0.1-25	±0.5	±0.5	5	su	65-470
*Techni	F115 Series	10.3-20.2	0.1-25	±0.05	±0.05	1	su	130-1355
*Techni	PM95 Series	10.3-20.2	0.2-25	±0.5	±0.5	5	su	90-635
*Techni	MCS65 Series	10.3-20.2	0.25-30	±0.5	±0.5	5	su	65-455
Dynage	H Series	11.4-20.6	1.3-3.8	±0.025	±0.025	1	abdgu	124-154
Dynage	D Series	18.7-20.6	0.075-0.75	±0.025	±0.025	1	abdgu	76-105
*Kepco	PAX21-0.5	0-21	0.5	0.05	0.05	0.25		94
*Kepco	PAT21-1	0-21	1	0.0005	0.005	0.1		121
*Kepco	PCX21-1	0-21	1	0.0005	0.05	0.1		111
*Kepco	PCX15-1.5	0-21	1.5	0.0005	0.005	0.1		111
*Power/Mate	RC-19	16-21	0.5	0.075	0.1	4	abdj	65
*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.

Modular dc Power Supplies

	Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
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	0.2	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	QSA18-1.1	14-22	1.2	±0.005	±0.005	0.3	abdegj	89
	*Sorensen	QSA18-1.9	14-22	2.1	±0.005	±0.005	0.3	abdegj	109
	*Sorensen	QSA18-3.0	14-22	3.3	±0.005	±0.005	0.3	abdegj	129
	*Sorensen	QSA18-10.1	14-22	14.0	±0.005	±0.005	0.3	abdegj	249
	*Sorensen	QSA18-6.8	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
	*Techni	HF80 Series	11.3-22.5	1-15	±0.05	±0.1	0.2%	su	140-425
	Rose-mount	SPS-2020P	22.5	0.09	4mV	12mV	1	bd	51
	Dynage	H Series	13.9-22.7	5.2-26.6	±0.025	±0.025	1	abdgu	195-435
M 28	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
	Valor	CG22 Series	21.5-23	4,9	5mV	0.05	0.5	abdg	165, 197
M 29	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	bd	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	111-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	P120-51C-24	24	5	±0.02	±0.02	0.3	abdg	240
	Wanlass	P120HP-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
	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

Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
*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
Valor	CG23 Series	22.5-24	4,8	5mV	0.05	0.5	abdg	165, 197
*Power/Mate	UNI-164	0-25	0.75	0.005	0.005	0.25	abdfgl	164
Elasco	VS Series	10-25	0.1-0.75	0.05	0.05	0.01%	dsu	80-100
Rose-mount	SPS-8000P	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	68
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
*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	abdfj	55-80
*Acopian	25J Series	24-26	2	±0.05	±0.05-0.2	0.5-1.0	abdfj	65-165
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
Acme	PS-47603	26	8	±1	±2	1%		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	80-108
*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	2-28	20	0.01	0.01	0.5	abdgk	395
Deltron	LA	3-28	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
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.

Modular dc Power Supplies

	Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
M 32	Rose-mount	SPS-2021P	28	0.08	6mV	14mV	1	bd	51
	SCI	1.28.100	28	0.1	0.01	0.05	1	bd	49
	SCI	2.28.100	±28	0.1	0.01	0.05	1	bdf	55
	Wanlass	C214-OEM	28	2.5	±2	±2	0.1		46
	*Kepco	PAR-28	28	3.7	0.005	0.01	0.25		205
	GE	9T66Y83	28	8	±1	3	1%	d	318
	GE	9T66Y85	28	20	±1	3	1%	d	472
	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
	Valor	CG28 Series	27.5-29	4,8	5mV	0.05	0.5	abdg	165, 197
	Rose-mount	SPS-2061P	27-29	0.12	6mV	15mV	1	bd	63
	*ACDC	BX28N0.3	27-29	0.3	0.01	0.01	0.5	abd	76
	*ACDC	BC28N0.3	27-29	0.3	0.5	0.5	5	abd	73
	*Elasco	MS28	27-29	0.1-0.75	0.05	0.05	0.01%	dsu	70-95
M 34	*ACDC	BX28N1.2	27-29	1.2	0.01	0.01	0.5	abd	116
	*ACDC	BC28N1.2	27-29	1.2	0.5	0.5	5	abd	111
	*Acopian	28L Series	27-29	2	±0.5	±0.5	5	abdfj	55-165
	*Acopian	28J Series	27-29	2	±0.05	±0.05-0.2	0.5-1.0	abdfj	65-175
	*ACDC	BC28N2.5	27-29	2.5	0.5	0.5	5	abd	132
	*ACDC	BX28N2.5	27-29	2.5	0.01	0.01	0.5	abd	137
	*ACDC	BC28N5.0	27-29	5	0.5	0.5	5	abd	178
	*ACDC	BX28N5.0	27-29	5	0.01	0.01	0.5	abd	184
M 35	Abbott	R28S5	27-29	5	±0.05	±0.05	5	bdgj	225
	*ACDC	BC28N10	27-29	10	0.5	0.5	5	abd	265
	*ACDC	BX28N10	27-29	10	0.01	0.01	0.5	abd	274
	*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	req
M 36	*Nucor	NPS Series	26.8-29.2	3-12	0.05	0.05	3	dju	req
	CEA	CEA6AY101	10-29.9	0.1	0.01	0.04	0.01%	rs	85
	CEA	CEA6BY101	10-29.9	0.1	0.002	0.008	0.001%	rs	95
	CEA	CEA6CY101R	10-29.9	0.1	0.0005	0.002	0.005%	rs	145
	CEA	CEA6DY101R	10-29.9	0.1	0.0001	0.0004	0.0005%	rs	215
	CEA	CEA6AY252	10-29.9	2.5	0.01	0.04	0.01	rs	175
	CEA	CEA6BY252	10-29.9	2.5	0.002	0.008	0.001%	rs	185
	CEA	CEA6CY252R	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
	CEA	CEA6C502R	10-29.9	5	0.0005	0.002	0.0005%	r	280
	CEA	CEA6AY253	10-29.9	25	0.01	0.04	0.01%	r	375
	CEA	CEA6BY253	10-29.9	25	0.002	0.008	0.001%	r	385
	AUL	MS Series	0-30	0.25-3	0.1	0.01	1		35-38
	*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
	*Powertec	9D Series	3-30	1-6	±0.05	±0.1	2.5-10	su	180
M 38	Litton	541410	3-30	6	±0.25	±0.25	50		req
	*Trygon	TPSA Series	3.2-30	1.25	0.02	0.05	1	su	111-121
	*Trygon	TPSC Series	3.2-30	5	0.02	0.05	1	su	125-147
	Elasco	Q Series	5-30	0.015-0.065	0.1	0.1	2	dsu	60
	Valor	CS30-0.3	10-30	0.3	2mV	0.05	0.05	abdg	60
	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	bdgj	145-185

	Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
M 32	*Techni	HF80 Series	15-30	0.75-12	±0.05	±0.1	0.2%	su	145-430
	Wanlass	30-OEM-3	17-30	2.5	±1	±1	0.1%		46
	Wanlass	60-OEM-3	17-30	5	±1	±1	0.1%		58
	Wanlass	120-OEM-3	17-30	10	±1	±1	0.1%		86
	Rose-mount	SPS-2101P	20-30	0.1	10mV	10mV	1	bd	62
	Rose-mount	SPS-2111P	20-30	0.175	15mV	15mV	1	bd	69
	*ACDC	JR25k2	22-30	2	0.1	0.1	3	abd	250
M 33	*Sorensen	QSA28-6.0	22-30	6.8	±0.005	±0.005	0.3	abdegj	209
	*Sorensen	QSA28-8.8	22-30	10.2	±0.005	±0.005	0.3	abdegj	249
	Power Des	UPM-6	24-30	1.5	0.01	0.01	1	abd	158
	*Acopian	29L Series	28-30	0.4	±0.5	±0.5	5	abdfj	60-70
	*Acopian	29J Series	28-30	1	±0.05	±0.05-0.1	0.5-1.0	abdfj	70-105
	Valor	CG29 Series	28.5-30	4,8	5mV	0.05	0.5	abdg	165-197
M 34	SCI	P2.30.50	±30	0.05	0.01	0.05	1	df	65
	Dynage	D Series	27.6-30.4	0.05-0.5	±0.025	±0.025	1	abdgu	80-111
	*Acopian	R Series	2.75-30.5	10	±0.05	±0.2-1.0	1	abdj	195
	*Acopian	K Series	2.75-30.5	10	±0.05	±0.2-1.0	1	abdj	205
	Valor	CG30 Series	29.5-30.5	4,8	5mV	0.05	0.5	abdg	165, 197
M 35	*Power/Mate	RD-28	26-31	0.5	0.12	0.2	8	abdj	55
	*Power/Mate	RC-28	26-31	0.5	0.06	0.1	4	abdj	65
	*Acopian	30J Series	29-31	2	±0.05	±0.05-0.2	0.5-1.0	abdfj	60-175
	*Acopian	30L Series	29-31	2	±0.5	±0.5	5	abdfj	60-165
	Elasco	MS30	29-31	0.1-0.75	0.05	0.05	0.01%	dsu	70-100
M 36	*ACDC	BX30N0.3-5.0	29-31	0.3-5	0.01	0.01	5	abdgk	92-257
	SCI	370	0-32	0.3	0.01	0.01	1	cd	90
	SCI	401	0-32	0.3	0.01	0.01	1	cdf	195
	R-S	NGR30/30	0-32	30	±10	0.001	0.3	cd	750
	R-S	NGRM30/40	0-32	40	±10	0.001	0.5	cd	750
	Scint	PC Series	2-32	1.5	0.05	0.05	1	bdgj	66
	*Powertec	7B Series	3.6-32	1.4-7.5	0.03-0.2	0.03-0.05	3p-p	su	492
M 37	*Powertec	7C Series	3.6-32	3.8-17	0.03-0.2	0.03-0.05	3p-p	su	593
	*Powertec	7D Series	3.6-32	7.5-34	0.03-0.2	0.03-0.05	3p-p	su	789
	*Acopian	31L20	30-32	0.2	±0.5	±0.5	5	abdfj	65
	*Acopian	31J Series	30-32	1	±0.05	±0.05-0.1	0.5-1.0	abdfj	65-105
	*Nucor	NPS Series	29.2-32.7	0.05-1.5	0.05	0.05	2	dju	req
M 38	*ERA	WR Series	1-33	0.6-9.6	±0.01	0.05	0.8	abdeg	130-305
	Elasco	SVS-10A	3-33	10	0.05	0.05	0.01%	dsu	300-335
	*Acopian	32J Series	31-33	1.5	±0.05	±0.05-0.15	0.5-1.0	abdfj	65-175
	*Acopian	32L Series	31-33	2	±0.5	±0.5	5	abdj	60-165
	*ACDC	BX32N0.3-5.0	31-33	0.3-5	0.01	0.01	5	abdgk	112-248

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 Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
M 39	Dynage	D Series	30.4-33.6	0.05-0.5	±0.025	±0.025	5	abdgu	80-111
	*Power/Mate	UNI Series	0-34	0.5-1.5	0.005	0.005	0.25	abdgj	76-99
	*Sorensen	QSA28-.7	22-35	0.77	±0.005	±0.005	0.3	abdegj	89
	*Sorensen	QSA28-1.3	22-35	1.4	±0.005	±0.005	0.3	abdegj	109
	*Sorensen	QSA28-2.0	22-35	2.2	±0.005	±0.005	0.3	abdegj	129
	*Acopian	34L10	33-35	0.1	±0.5	±0.5	5	abdj	60
	*Acopian	34J Series	33-35	1.5	±0.05	±0.05-0.2	0.5-1.0	abdfj	65-175
M 40	*ACDC	BX34N0.3-5.0	33-35	0.3-5	0.01	0.01	5	abdgk	118-247
	*Kepco	PAX36-0.3	0-36	0.3	0.05	0.05	0.25		94
	Litton	541440	4-36	30	±0.25	±0.25	225		req
	*Acopian	35L10	34-36	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
	*Kepco	PAR-36	36	2.8	0.005	0.01	0.25		205
	*Power/Mate	RD-34	31-37	0.5	0.1	0.2	8	abdj	55
M 41	*Power/Mate	RC-34	31-37	0.5	0.05	0.1	4	abdj	65
	*Acopian	X Series	4-37	0.2	±0.05	±0.05	0.25-0.5	abdj	75-110
	Dynage	H Series	20.6-37	0.8-2.3	±0.025	±0.025	1	abdgu	124-162
	Dynage	H Series	22.7-37	3.3-19	±0.025	±0.025	±0.025	abdgu	195-470
	Dynage	D Series	33.6-37	0.05-0.5	±0.025	±0.025	5	abdgu	80-111
M 42	*Acopian	36L10	35-37	0.1	±0.5	±0.5	5	abdj	60
	*Acopian	36J Series	35-37	1.5	±0.5	±0.05-0.2	0.5-1.0	abdfj	65-175
	*ACDC	BX36N0.3-5.0	35-37	0.3-5	0.01	0.01	5	abdgk	118-257
	*Acopian	37J Series	36-38	1	±0.05	±0.05-0.1	0.5-1.0	abdfj	65-125
	*Acopian	38L10	37-39	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
M 43	*ACDC	BX38N0.3-5.0	37-39	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
	Scint	ACF Series	7.2-39.5	1.5	0.01	0.03	0.5	bdgj	70
	*Kepco	PAT40-0.5	0-40	0.5	0.0005	0.005	0.1		121
	*Kepco	PCX40-0.5	0-40	0.5	0.0005	0.005	0.1		111
	Deltron	B	0-40	0.2-1.2	0.02	0.02	0.5	abdgj	59-69
M 44	*Techni	RA40-3	0-40	3	±0.1	±0.15	0.2%		235
	*Techni	RA40-6	0-40	6	±0.1	±0.15	0.2%		265
	*Techni	RA40-12	0-40	12	±0.1	±0.15	0.2%		320
	*Techni	RA40-25	0-40	25	±0.1	±0.15	0.2%		395
	Litton	541220	4-40	2	±1	±1	15p-p		req
	Litton	541200	4-40	2	±1	±1	15p-p		req
	Litton	541210	4-40	2	±1	±1	15p-p		req
	Litton	541250	4-40	2	±1	±1	15p-p		req
	*Techni	SCR40 Series	20-40	12-50	±0.5	±0.5	1%	u	395-715
M 45	*Techni	PL80 Series	29.2-40	0.05-1.5	±0.5	±0.5	1	su	55-155
	*Techni	MCS65 Series	29.2-40	0.065-15	±0.5	±0.5	5	su	65-510
	*Acopian	39L10	38-40	0.1	±0.5	±0.5	5	abdj	60
	*Acopian	39J Series	38-40	1	±0.05	±0.05-0.2	0.5-1.0	abdfj	65-125
	Rosemount	SPS-2102P	30-40	0.075	10mV	10mV	1	bd	62
	Rosemount	SPS-2112P	30-40	0.15	15mV	15mV	1	bd	71

Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
Dynage	D Series	37-40.8	0.05-0.3	±0.025	±0.025	5	abdgu	80-111
*Acopian	40L10	39-41	0.1	±0.5	±0.5	5	abdj	60
*Acopian	40J Series	39-41	1	±0.05	±0.05-0.2	1	abdfj	65-125
*ACDC	BX40N0.3-5	39-41	0.3-5	0.01	0.01	5	abdgk	118-257
*Acopian	41L10	40-42	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
*Power/Mate	RD-40	37-43	0.5	0.01	0.02	8	abdj	55
*Power/Mate	RC-40	37-43	0.5	0.05	0.1	4	abdj	65
*Acopian	42J Series	41-43	0.6	±0.05	±0.05-0.15	0.5-1.0	abdfj	70-115
*Acopian	42L10	41-43	0.1	±0.5	±0.5	5	abdj	60
*ACDC	BX42N0.3-5	41-43	0.3-5	0.01	0.01	5	abdgk	118-257
*Acopian	43L10	42-44	0.1	±0.5	±0.5	5	abdj	60
*Acopian	43J Series	42-44	0.3	±0.05	±0.05	0.5-1.0	abdfj	70-95
Acme	PS-57356	44	25	±1	±2	1%		ina
Dynage	D Series	40.8-45	0.05-0.3	±0.025	±0.025	5	abdgu	80-111
Elasco	VS Series	20-45	0.05-0.5	0.05	0.05	0.01%	dsu	75-95
*Techni	HF Series	22.5-45	0.5-8	±0.05	±0.1	0.2%	su	145-435
*Acopian	44L10	43-45	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	70-120
*ACDC	BX44N0.3-5.0	43-45	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	45J Series	44-46	0.6	±0.05	±0.05-0.15	0.5-1.0	abdfj	70-125
*Acopian	46L10	45-47	0.1	±0.5	±0.5	5	abdj	60
*Acopian	46J Series	45-47	0.6	±0.05	±0.05-0.15	0.5-1.0	abdfj	70-125
*ACDC	BX46N0.3-5	45-47	0.3-5	0.01	0.01	5	abdgk	118-257
*Power/Mate	OEM-A	3-48	1.25	0.01	0.01	0.25	abdj	79
*Power/Mate	OEM-B	3-48	2.5	0.01	0.01	0.25	abdj	102
*Power/Mate	OEM-C	3-48	4	0.01	0.01	0.25	abdj	137
*Power/Mate	OEM-D	3-48	8	0.01	0.01	0.25	abdj	154
Deltron	OEM	3-48	0.7-9	0.05	0.05	1	abdgj	75-85
*Power/Mate	OEM-E	3-48	12	0.01	0.01	0.25	abdj	177
*Power/Mate	OEM-F	3-48	18	0.01	0.01	0.25	abdj	208
*Power/Mate	OEM-G	3-48	24	0.01	0.01	0.25	abdj	260
*Power/Mate	OEM-H	3-48	34	0.01	0.01	0.25	abdj	318
Deltron	N	3-48	0.21-36	0.005	0.005	0.5	abdgj	79-299
*Powertec	3B Series	3.6-48	0.05-0.35	0.075-0.3	0.075-0.3	1	su	34
*Powertec	3C Series	3.6-48	0.18-1.5	0.075-0.3	0.075-0.3	1	su	42
*Powertec	5B Series	3.6-48	0.5-2.5	±0.05	±0.05	0.01	su	229
*Powertec	3D Series	3.6-48	0.3-3.5	0.075-0.3	0.075-0.3	1	su	49
*Powertec	5C Series	3.6-48	1-5	±0.05	±0.05	0.01	su	259

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.

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	Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
M 46	*Powertec	3E Series	3.6-48	0.8-5	0.075-0.3	0.075-0.3	1	su	89
	*Powertec	3F Series	3.6-48	1.6-10	0.075-0.3	0.075-0.3	1	su	119
	*Powertec	5D Series	3.6-48	2-10	±0.05	±0.05	0.01	su	299
	*Powertec	5E Series	3.6-48	4-20	±0.05	±0.05	0.01	su	379
	*Powertec	3G Series	3.6-48	3.2-20	0.075-0.3	0.075-0.3	1	su	169
	*Powertec	3H Series	3.6-48	6.4-35	0.075-0.3	0.075-0.3	1	su	249
M 47	*Techni	F115 Series	20.2-48	0.05-12	±0.05	±0.05	1	su	135-2850
	*Techni	P80 Series	20.2-48	0.05-25	±0.5	±0.5	5	su	70-475
	*Techni	PM95 Series	20.2-48	0.05-25	±0.5	±0.5	5	su	90-630
	*Acopian	47L10	46-48	0.1	±0.5	±0.5	5	abdj	60
	*Acopian	47J Series	46-48	0.3	±0.05	±0.05	0.5-1.0	abdfj	70-95
	*Kepco	PAR-48	48	2.3	0.005	0.01	0.25		205
M 48	GE	9T66Y93	48	4	±1	3	1%	d	139
	GE	9T66Y94	48	10	±1	2	1%	d	191
	Acme	PS Series	48	4-25	±1	±2	1%	g	ina
	*Acopian	48L10	47-49	0.1	±0.5	±0.5	5	abdj	60
	Elasco	MS Series	39-49	0.1-0.5	0.05	0.05	0.01%	dsu	70-100
	*Acopian	48J Series	47-49	0.6	±0.05	±0.05-0.15	0.5-1.0	abdfj	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
	*Trygon	LVW Series	0-50	1.4	0.01	0.01	0.5	su	122
	R-S	NGR50/20	0-50	20	±10	0.001	0.3	cd	700
	*ERA	SV Series	5-50	0.015	0.5	0.5	0.05	abdeg	65-75
	Dynage	H Series	37-50	3.1-14	±0.025	±0.025	1	abdgu	195-470
	*Power/Mate	RD-48	43-50	0.5	0.01	0.02	8	abdj	55
M 50	*Acopian	49J Series	48-50	0.3	±0.05	±0.05	0.5-1.0	abdfj	70-95
	*Acopian	49L10	48-50	0.1	±0.5	±0.5	5	abdj	60
	Elasco	SVS-1A	3-51	1	0.05	0.05	0.01%	dsu	105-140
	Elasco	SVS-2A	3-51	2	0.05	0.05	0.01%	dsu	135-165
	Elasco	SVS-3.5A	3-51	3.5	0.05	0.05	0.01%	dsu	145-210
	Elasco	SVS-5A	3-51	5	0.05	0.05	0.01%	dsu	185-290
M 51	*Acopian	50L10	49-51	0.1	±0.5	0.5	5	abdj	60
	*Acopian	50J Series	49-51	0.5	±0.5	±0.05-0.1	0.5-1.0	abdfj	70-135
	*ACDC	BX50N0.3-5.0	49-51	0.3-5	0.01	0.01	5	abdgk	118-257
	Dynage	D Series	49.5-54.5	0.05-0.3	±0.025	±0.025	5	abdgu	80-111
	Elasco	VS Series	40-55	0.05-0.25	0.05	0.05	0.01%	dsu	85-100
	*Acopian	55J Series	54-56	0.5	±0.05	±0.05	1	abdfj	65-140
M 52	Elasco	MS Series	49-59	0.05-0.25	0.05	0.05	0.01%	dsu	75-100
	*Techni	PL80 Series	40-59	0.05-1.5	±0.5	±0.5	1	su	65-170
	Lambda	LCD-3	0-60	0.7	0.01	0.01	1	abdfg	150
	Lambda	LCS-3	0-60	1.2	0.01	0.01	1	abdg	90
	Wanlass	60IC Series	3.6-60	7.5	±0.25	±0.25	5	d	125
	Wanlass	60HP Series	3.6-60	7.5	±0.05	±0.05	5	d	150
	Wanlass	120IC Series	3.6-60	15	±0.25	±0.25	5	d	170
	Wanlass	120HP Series	3.6-60	15	±0.05	±0.05	5	d	195

Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
Wanlass	200HP Series	3.6-60	25	±0.05	±0.05	5	d	250
Wanlass	200IC Series	3.6-60	25	±0.25	±0.25	5	d	200
Scint	RC Series	±9-60	1	0.05	0.05	1	bdfgj	79
Power Des	UPM-22	16-60	0.5	0.01	0.01	1	abdf	199
Power Des	UPM-44	16-60	1	0.01	0.01	1	abd	148
Wanlass	30-OEM-4	30-60	2.5	±1	±1	0.1%		46
*Techni	HF80 Series	30-60	0.375-6	±0.05	±0.1	0.2%	su	145-440
Wanlass	60-OEM-4	30-60	5	±1	±1	0.1%		58
Wanlass	120-OEM-4	30-60	10	±1	±1	0.1%		86
*Sorensen	QSA48-.4	35-60	0.44	±0.005	±0.005	0.3	abdegj	89
*Sorensen	QSA48-.8	35-60	0.88	±0.005	±0.005	0.3	abdegj	119
*Sorensen	QSA48-1.2	35-60	1.3	±0.005	±0.005	0.3	abdegj	129
Dynage	H Series	37-60	0.5-1.4	±0.025	±0.025	1	abdgu	135-179
Dynage	D Series	54.5-60	0.05-0.2	±0.025	±0.025	5	abdgu	80-96
Burr-Brown	508/16	±60	0.5	±0.1	±0.1	1	q	480
*Kepco	PAR-60	60	2	0.005	0.01	0.25		205
*Acopian	60J Series	59-61	0.4	±0.05	±0.05	1	abdfj	75-140
*NJE	HT Series	0-62	0.12-10	0.05	0.05	1	abd	69-207
*NJE	SC Series	2-62	0.12-12	0.05	0.05	1	abd	77-219
*ERA	ST Series	1-63	1-2	±0.01	0.05	0.8	abdefg	165-195
Elasco	VS Series	50-65	0.05-0.25	0.05	0.05	0.01%	dsu	85-100
*ACDC	BX60N0.1-1.2	55-65	0.1-1.2	0.01	0.01	5	abdgk	93-193
*Acopian	65J Series	64-66	0.3	±0.05	±0.05	1	abdfj	75-125
Dynage	D Series	60-66.1	0.075-0.2	±0.025	±0.025	5	abdgu	95-125
Elasco	MS Series	59-69	0.05-0.25	0.05	0.05	0.01%	dsu	75-85
*Acopian	70J Series	69-71	0.3	±0.05	±0.05	1	abdfj	75-125
*Kepco	PAX72-0.15	0-72	0.15	0.05	0.05	0.25		94
*Kepco	PCX72-0.3	0-72	0.3	0.0005	0.005	0.1		111
*Kepco	PAT72-0.3	0-72	0.3	0.0005	0.005	0.1		121
*Techni	MCS65 Series	40-72	0.065-15	±0.5	±0.5	5	su	75-570
Dynage	D Series	66.1-72.8	0.05-0.2	±0.025	±0.025	5	abdgu	95-125
*ACDC	BX70N0.1-1.2	65-75	0.1-1.2	0.01	0.01	5	abdgk	93-193
*Acopian	75J Series	74-76	0.2	±0.05	±0.05	1	abdfj	85-125
Elasco	MS Series	69-78	0.05-0.25	0.05	0.05	0.01%	dsu	75-85
CEA	CEA6AY103	10-79.9	10	0.01	0.04	0.01%	r	375
CEA	CEA6BY103	10-79.9	10	0.002	0.008	0.001%	r	385
CEA	CEA6CY101R	30-79.9	0.1	0.0005	0.002	0.0005%	rs	160
CEA	CEA6BY101	30-79.9	0.1	0.002	0.008	0.001%	rs	110
CEA	CEA6AY101	30-79.9	0.1	0.01	0.04	0.01%	rs	100
CEA	CEA6DY101R	30-79.9	0.1	0.0001	0.0004	0.0003%	rs	230
CEA	CEA6CY252R	30-79.9	2.5	0.0005	0.002	0.0005%	rs	330
CEA	CEA6BY252	30-79.9	2.5	0.002	0.008	0.001%	rs	280
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

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 Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
M 53	CEA	CEA6CY 502R	30-79.9	5	0.0005	0.002	0.0005%	r	395
	R-S	NGGS80/5	0-80	5	±10	0.05	0.5	cd	500
	*Techni	RA80 Series	0-80	1.5-25	±0.1	±0.15	0.2%		240-525
	*Techni	SCR80 Series	40-80	6-25	±0.5	±0.5	1%	u	415-780
	Dynage	D Series	72.8-80.1	0.05-0.15	±0.025	±0.025	5	abdgu	95-125
M 54	*Acopian	80J Series	79-81	0.2	±0.05	±0.05	1	abdfj	85-125
	Elasco	VS Series	70-85	0.05-0.25	0.05	0.05	0.01%	dsu	85-100
	*ACDC	BX80N0.1-1.2	75-85	0.1-1.2	0.01	0.01	5	abdgk	93-193
	*Acopian	85J Series	84-86	0.2	±0.05	±0.05	1	abdfj	90-135
	*Techni	PL80 Series	59-88	0.05-0.75	±0.5	±0.5	1	su	80-175
M 55	Dynage	D Series	80.1-88.2	0.05-0.15	±0.025	±0.025	5	abdgu	95-125
	Elasco	MS Series	79-89	0.05-0.1	0.05	0.05	0.01%	dsu	80-85
	*Sorensen	QSA75-.5	60-90	0.55	±0.005	±0.005	3	abdegj	119
	*Sorensen	QSA75-.8	60-90	0.88	±0.005	±0.005	0.3	abdegj	139
	GE	9T66Y985	90	10	±1	3	1	d	265
	*Acopian	90J Series	89-91	0.2	±0.05	±0.05	1	abdfj	95-135
	*ACDC	BX90N0.1-1.2	85-95	0.1-1.2	0.01	0.01	5	abdgk	93-249
M 56	*Techni	F115 Series	48-96	0.05-6	±0.05	±0.05	1	su	165-2380
	*Techni	P80 Series	48-96	0.05-12	±0.5	±0.5	5	su	80-535
	*Techni	PM95 Series	48-96	0.05-12	±0.5	±0.5	5	su	95-725
	*Acopian	95J Series	94-96	0.2	±0.05	±0.05	1	abdfj	95-135
	Dynage	H Series	60-97.1	0.38-1	±0.025	±0.025	1	abdgu	139-181
M 57	Dynage	D Series	88.2-97.1	0.05-0.15	±0.025	±0.025	5	abdgu	95-125
	Elasco	MS Series	89-99	0.05-0.1	0.05	0.05	0.01%	dsu	80-85
	*Kepco	PAX100-0.1	0-100	0.1	0.05	0.05	0.25		94
	*Kepco	PAT100-0.2	0-100	0.2	0.0005	0.005	0.1		121
	*Kepco	PCX100-0.2	0-100	0.2	0.0005	0.005	0.1		111
M 58	Deltron	CD/CA	0-100	0.15-2	0.01	0.01	0.25	abdegj	99-119
	R-S	NGRS100/3	0-100	3	±10	0.001	0.5	cd	670
	Scint	1113 Series	2-100	5	0.05	0.05	0.5	bdgj	100
	Abbott	R Series	4.5-100	20	±0.05	±0.05	0.02%	bdgj	86-397
	*Mid-Eastern	Ht-HTA Series	6-100	4	0.025	0.02	1	abdg	169
	Scint	RS5 Series	9-100	0.6	0.05	0.05	1	dgj	66-89
M 59	Elasco	VS Series	80-100	0.05-0.25	0.05	0.05	0.01%	dsu	85-100
	Power Des	UPMD-X9	100	0.25	0.03	0.03	1	abdf	260
	Acme	PS47718	100	4	±1	±2	1%		ina
	*Acopian	100J Series	99-101	0.2	±0.05	±0.05	1	abdfj	95-145
	*Techni	MCS65 Series	72-105	0.065-8	±0.5	±0.5	5	su	100-695
	*Nucor	NPS Series	96-105	0.05-1.5	0.05	0.05	4	dju	req

Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
Dynage	D Series	97.1-106.8	0.025-0.1	±0.025	±0.025	5	abdgu	95-125
*Acopian	105J Series	104-106	0.2	±0.05	±0.05	1	abdfj	115-145
*ERA	ME Series	0-110	0.05-2	±0.01	0.05	0.8	abdeg	ina
*ERA	TR Series	5-110	0.1-0.2	±0.05	0.5	0.05%	bd	70-90
*ACDC	BX100N0.2-1.2	90-110	0.2-1.2	0.01	0.01	5	abdgk	148-249
*Acopian	110J Series	109-111	0.2	±0.05	±0.05	1	abdfj	115-145
*Acopian	115J Series	114-116	0.2	±0.05	±0.05	1	abdfj	125-155
Dynage	D Series	106.8-117.2	0.025-0.1	±0.025	±0.025	5	abdgu	95-125
Elasco	MS Series	99-118	0.05-0.1	0.05	0.05	0.01%	dsu	105-110
Lambda	M.1-E-CS-1	0-120	0.2	0.01	0.01	1	abdg	115
Lambda	M.1-E-CD-2	0-120	0.25	0.01	0.01	1	abdg	230
Lambda	LCS-1	0-120	0.275	0.01	0.01	1	abdg	70
Lambda	LCD-2	0-120	0.3	0.01	0.01	1	abdfg	125
Lambda	M.1-E-CS-2	0-120	0.45	0.01	0.01	1	abdg	130
Lambda	LCS-2	0-120	0.55	0.01	0.01	1	abdg	80
Lambda	LCD-A	0-120	1	0.01	0.01	1	abdg	155
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
*Techni	HF80 Series	70-120	0.2-3	±0.05	±0.1	0.2%	su	145-445
Lambda	LCS-4	0-120	3.3	0.01	0.01	1	abdg	130
*Kepco	PRM 180F Series	5.2-120	1.5-25	±1	0.7-3.8	0.003-.04	su	178
*Kepco	PRM 120 Series	5.2-120	1-15	±1	0.5-4.6	0.3-0.4	su	104
*Kepco	PRM 180 Series	5.2-120	1.5-25	±1	0.5-2.2	0.3-0.4	su	125
Elasco	VS Series	100-120	0.05-0.1	0.05	0.05	0.01%	dsu	115-120
SCI	C2.120.50	±120	0.05	0.05	0.1	1	bdf	135
Burr-Brown	509/16	±120	0.25	±0.1	±0.1	1	q	480
*Acopian	120J Series	119-121	0.2	±0.05	±0.05	1	abdfj	135-155
GE	9T66Y970	125	4	±1	2	1%	d	194
Acme	PS Series	125	2-6	±1	±2	1%		ina
*Acopian	125J Series	124-126	0.2	±0.05	±0.05	1	abdfj	135-155
*Dynage	D Series	117.2-128.7	0.025-0.1	±0.025	±0.025	5	abdgu	95-125
*Acopian	J Series	2-130	2.0	±0.05-0.5	±0.05-1.0	1.0-5.0	abdj	70-160
*TDI	SCR	6-130	2.5-15	0.5	0.5	0.3	bdgj	99-360
*Acopian	130J Series	129-131	0.2	±0.05	±0.05	1	abdfj	125-155
*Acopian	135J Series	134-136	0.2	±0.05	±0.05	1	abdfj	145-155
Elasco	MS Series	118-138	0.05-0.1	0.05	0.05	0.01%	dsu	105-110
CEA	CEA6AY500	80-139	0.05	0.01	0.04	0.01%	rs	125
CEA	CEA6BY500	80-139	0.05	0.002	0.008	0.001%	rs	135
CEA	CEA6CY 500R	80-139	0.05	0.0005	0.002	0.0005%	rs	185
CEA	CEA6DY 500R	80-139	0.05	0.0001	0.0004	0.0003%	rs	255
CEA	CEA6AY252	80-139	2.5	0.01	0.04	0.01%	rs	400

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.

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	Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
M 60	CEA	CEA6BY252	80-139	2.5	0.002	0.008	0.001%	rs	410
	CEA	CEA6CY 252R	80-139	2.5	0.0005	0.002	0.0005%	rs	460
	CEA	CEA6A502	80-139	5	0.01	0.04	0.01	r	440
	CEA	CEA6B502	80-139	5	0.002	0.008	0.001%	r	450
	CEA	CEA6C502R	80-139	5	0.0005	0.002	0.0005%	r	500
	SCI	415	0-140	0.1	0.01	0.01	1	cdf	235
	Elasco	VSSeries	120-140	0.05-0.1	0.05	0.05	0.01%	dsu	115-120
	*Acopian	140JSeries	139-141	0.2	±0.05	±0.05	1	abdfj	145-155
	Dynage	D Series	128.7-141.6	0.05-0.1	±0.025	±0.025	5	abdgu	107-132
	*Techni	P80Series	96-144	0.05-6	±0.5	±0.5	5	su	120-655
M 61	*Techni	PM95 Series	96-144	0.05-6	±0.5	±0.5	5	su	150-870
	*Techni	F115Series	96-144	0.05-3	±0.05	±0.05	1	su	260-2180
	Lambda	LM-B	0-150	3.8	0.01	0.02	0.05	abdg	109
	Lambda	LM-C	0-150	5.3	0.01	0.02	0.05	abdg	139
	Lambda	LM-D	0-150	13.1	0.01	0.02	0.05	abdg	180
	Lambda	LM-E	0-150	22	0.01	0.02	0.05		249
	Lambda	LM-EE	0-150	33	0.01	0.01	0.05	abdg	320
	D-B	301	3-150	3.8	0.01	0.02	0.5		117-137
	D-B	401	3-150	5.3	0.01	0.02	0.5		137-157
	D-B	501	3-150	11	0.01	0.02	0.5		117-197
M 62	D-B	601	3-150	13.1	0.01	0.02	0.5		207-237
	D-B	701	3-150	22	0.01	0.02	0.5		267-297
	D-B	801	3-150	33	0.01	0.02	0.5		318-348
	D-B	901	3-150	48	0.01	0.02	0.5		448-528
	*Sorensen	QSA120-.5	90-150	0.55	±0.01	±0.01	0.3	abdegj	149
	Acme	PS-41426	150	2	±1	±2	1%		ina
	Lambda	LM-OC	150	11	0.01	0.02	0.05	abdg	179
	Lambda	LM-F	150	48	0.01	0.02	0.5	abdg	450
	Lambda	LM-G	150	95	0.01	0.02	0.5	abdg	575
	*Acopian	150JSeries	149-151	0.2	±0.05	±0.05	1	abdfj	145-160
M 63	*Nucor	NPS Series	145-155	0.05-1.5	0.05	0.05	4	dju	reg
	Dynage	H Series	97.1-156.1	0.2-0.65	±0.025	±0.025	1	abdgu	139-2-3
	Dynage	D Series	141.6-156.1	0.05-0.075	±0.025	±0.025	5	abdgu	115-146
	Elasco	MS Series	138-158	0.05-0.1	0.05	0.05	0.01%	dsu	105-135
	*Techni	RA160 Series	0-160	0.75-12	±0.1	±0.15	0.2%		250-545
	*Techni	SCR-160 Series	80-160	3-12	±0.5	±0.5	1%		425-810
	*Techni	PL80Series	88-160	0.05-0.375	±0.5	±0.5	1	su	100-195
	*Techni	MCS65 Series	105-160	0.065-4	±0.5	±0.5	5	su	125-555
	Elasco	VS Series	140-160	0.05-0.1	0.05	0.05	0.01%	dsu	115-145
	*ACDC	BX150-N0.1-0.6	140-160	0.1-0.6	0.01	5		abdgk	138-193

Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
*Trygon	LVS Series	2.5-161	2.1	0.01	0.01	0.5	su	86-111
CP	PM722	170	0.035	±0.5	20.5	15	s	43.90
Elasco	MS Series	158-178	0.05-0.1	0.05	0.01%	0.01%	dsu	130-135
Dynage	D Series	156.1-172.1	0.05-0.075	±0.025	±0.025	5	abdgu	115-146
Elasco	VSSeries	160-180	0.05-0.1	0.05	0.05	0.01%	dsu	140-145
CP	PM723	180	0.04	±0.5	±0.5	15	s	43.90
Dynage	D Series	172.1-189-6	0.025-0.075	±0.025	±0.025	5	abdgu	125-150
*Techni	PM95 Series	144-192	0.05-3	±0.5	±0.5	5	su	185-725
Elasco	MSSeries	178-198	0.05-0.1	0.05	0.05	0.1%	dsu	130-135
Deltron	L	0.5-200	0.5-72	0.005	0.005	0.5	abdgj	190-924
D-B	15S	3-200	0.75	0.01	0.01	1		70
D-B	20S	3-200	1.4	0.01	0.01	1		85
D-B	30S	3-200	3.1	0.01	0.01	1		118
D-B	41S	3-200	6	0.01	0.01	1		138
Arnold	PIL	3-200	8	0.01	0.03	5	d	360
Arnold	PIG	3-200	8	0.01	0.03	5	df	310
Arnold	PIB	3-200	8	0.01	0.03	5	d	260
D-B	51S	3-200	12-9	0.01	0.01	1		198
D-B	61S	3-200	24	0.01	0.01	1		265
Assoc Spec	12	75-200	0.1	1	1	5		74.50
*Sorensen	QSA175-.25	150-200	0.28	±0.01 :	±0.01	0.3	abdegj	160
Elasco	VS Series	180-200	0.05-0.1	0.05	0.05	0.01%	dsu	140-145
Acme	PS-41427	200	1	±1	±2	1%		ina
*Acopian	200LSeries	199-201	0.1	±0.5	±0.5	5	abdj	125-135
Elasco	MS Series	198-203	0.05-0.1	0.05	0.05	0.01%	dsu	130-135
Dynage	D Series	189.6-208	0.025-0.05	±0.025	±0.025	5	abdgu	125-150
*Techni	F115Series	144-210	0.05-3	±0.5	±0.5	1	su	315-1960
*Techni	P80Series	144-210	0.05-3	±0.5	±0.5	5	su	140-565
*ACDC	BX200 N0.1-0.6	190-210	0.1-0.6	0.01	0.01	5	abdgk	158-249
Dynage	D Series	208-228.5	0.025-0.05	±0.025	±0.025	5	abdgu	130-155
*Mid-Eastern	PM Series	5-240	3	±0.01	0.02	1	abdg	130-225
*Mid-Eastern	LA Series	5-240	3	±0.01	0.02	1	abdg	130-225
Deltron	C	3-250	0.026-36	0.003	0.003	0.5	abdgj	75-470
*Techni	HF80 Series	150-250	0.05-1.5	±0.05	±0.1	0.2%	su	125-450
Acme	PS 41428	250	1	±1	±2	1%		ina

Reader service numbers for literature and application notes, see page D6.

Additional features explained on p. D65.

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	Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
M 64	Dynage	H Series	156.1-252	0.13-0.4	±0.025	±0.025	1	abdgu	161-210
	Dynage	D Series	228.5-252	0.025-0.05	±0.025	±0.025	5	abdgu	130-155
	CEA	CEA6D Z500R	140-259	0.05	0.0001	0.0004	0.0003%	rs	275
	CEA	CEA6C Z500R	140-259	0.05	0.0005	0.002	0.0005%	rs	205
	CEA	CEA6BZ500	140-259	0.05	0.002	0.008	0.001%	rs	155
	CEA	CEA6AZ500	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	abdgk	158-249
	*TDI	STR	3-300	0.25-10	0.05	0.05	0.2	abdgj	75-215
	*Acopian	RFI Series	85-300	0.025	±1-3	±1-2	2-18	j	39
	*TDI	TDM	1-306	2.8-60	0.01	0.01	0.2	abdgj	109-475
	*ERA	MS Series	0-310	0.05-8	±0.01	0.05	0.8	abdeg	220-595
	*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	abdw	90-360
	*ACDC	BX300N0.1-0.6	290-310	0.1-0.6	0.01	0.01	5	abdgk	186-282
	Assoc Spec	2	200-325	0.1	1	1	10		64.50
	*Sorensen	QSA265-.15	200-330	0.17	±0.01	±0.01	0.3	abdegj	175
	*Techni	PM95 Series	192-340	0.05-3	±0.5	±0.5	5	su	210-900
M 67	*Techni	F115 Series	210-340	0.05-1.5	±0.05	±0.05	1	su	355-2401
	*Techni	P80 Series	210-340	0.05-3	±0.5	±0.5	5	su	165-670
	*ACDC	BX350N0.1-0.6	340-360	0.1-0.6	0.01	0.01	5	abdgk	186-282
	*Techni	HF80 Series	225-375	0.03-1	±0.05	±0.1	0.2%	su	130-455
	*ACDC	BX400N0.1-0.6	390-410	0.1-0.6	0.01	0.01	5	abdgk	186-282
M 68	CEA	CEA6D Z102R	260-500	1	0.0001	0.0004	0.0003%	rs	690
	CEA	CEA6C Z102R	260-500	1	0.0005	0.002	0.0005%	rs	620
	CEA	CEA6BZ102	260-500	1	0.002	0.008	0.001%	rs	570
	CEA	CEA6AZ102	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

Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
Fluke	423A	0-3000	0.01	0.001	0.001	5p-p		460
*Spellman	MRM3P 1500	1.5-3k	0.0005	0.01	0.25	3000	ad	req
Power Des	UPMD-530N	200-3k	0.01	0.0025	0.0025	10	dh	385
Power Des	UPMD-530P	200-3k	0.01	0.0025	0.0025	10	dh	420
Abbott	U Series	4.7-3650	13.83	±0.2	±0.5	0.2%	dghj	175-716
Abbott	GBk17D-3460A	3260-3650	0.049	±0.5	±2	1%	djh	716
*Spellman	FRHM5P 10D	5000	0.002	0.01	0.01	1000	ad	235
Abbott	HN2D-4860A	4580-5140	0.004	±0.5	2	2%	djh	495
*Spellman	MRM6P 1500	3-6k	0.0002	0.01	0.25	6000	ad	req
Abbott	GN4D-7000A	6600-7400	0.004	±0.5	2	2%	djh	765
*Spellman	FRHM10P 10D	10000	0.001	0.01	0.01	2000	ad	260
Abbott	T Series	47-10,400	19.44	±0.2	±0.5	0.2%	dghj	140-885
Abbott	V Series	4.7-10,400	19.44	±0.2	±0.2	0.2%	dghj	145-885
Abbott	GN4D-9900A	9300-10,400	0.004	±0.5	±2	2%	dhj	885
*Spellman	MRM12P 1000	6-12k	0.0001	0.01	0.25	12000	ad	req
*Spellman	FRHM15P 10D	15000	0.0006	0.01	0.01	3000	ad	435
*Spellman	MRM18P 1800	9-18k	0.0001	0.01	0.25	18000	ad	req
*Spellman	FRHM20P 10D	20000	0.0005	0.01	0.01	4000	ad	435
*Spellman	FRHM30P 10D	30000	0.0003	0.01	0.01	6000	ad	480
Del	TRHV Series	1-30kV	0.005	0.25	0.25	0.5%	dg	245-615
Uni-Volt	BPER	1-30k	5nA	0.1	0.1	0.1-0.25	g	250-1000
Del	HRM Series	0.6-50kV	0.005	0.03	0.03	0.03%	adg	315-1080

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.

Advertisers' Index

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.

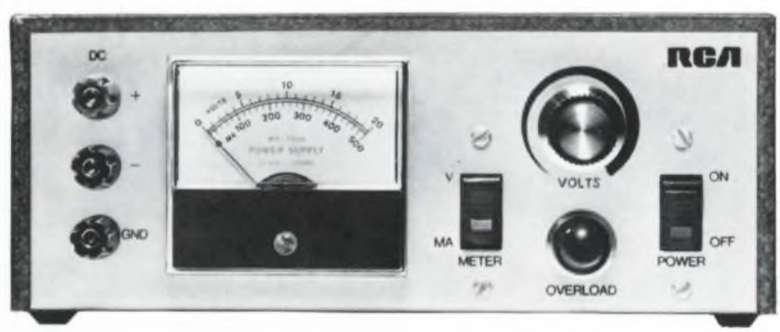
Output voltage of the WP-700A and WP-702A is continuously adjustable from 0 to 20 volts at current levels up to 200 mA.

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

RCA

INFORMATION RETRIEVAL NUMBER 632

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 μV/digit to 1000 V full scale in six ranges, with a standard accuracy of 0.05% +1 digit. Resolution is from 1 μV to 100 mV, and input impedance covers 10 to 10,000 MΩ.

Ac voltages can be measured from 10 μV/digit to 1000 V full scale in five ranges, with a standard accuracy of 1% +0.05% of full scale. Resolution is 10 μV to 100 mV, and input impedance is 10 MΩ.

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 μA, and input impedance extends over 0.1 Ω to 10 kΩ.

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 μA, and input impedance ranges from 0.1 Ω to 10 kΩ.

Resistances are measured from 1 mΩ/digit to 10 MΩ 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 mΩ to 1 kΩ, at a sampling current of 0.5 μA 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 $750 counter measures 1 Hz to 1 MHz

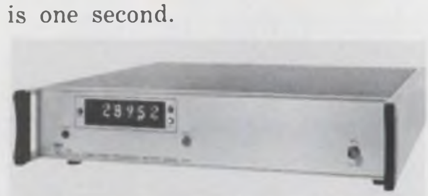
Time Systems Corp., 265 Whisman Rd., Mountain View, Calif. Phone: (415) 961-9321. P&A: $750; 30 days.

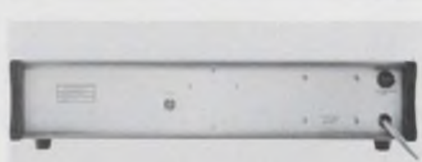
Truly a fully automatic instrument—free of control knobs and mid-operation adjustments—a new computing frequency meter can measure any frequency between 1.0000 Hz and 1.0000 MHz to five significant digits. This means that you can now accurately pinpoint very low frequencies without paying for a broadband 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

Low-cost digital clock has two time modes

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

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

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 μs/division to 5 s/division.

CIRCLE NO. 254

Compact panel meters indicate to five digits

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

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

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.

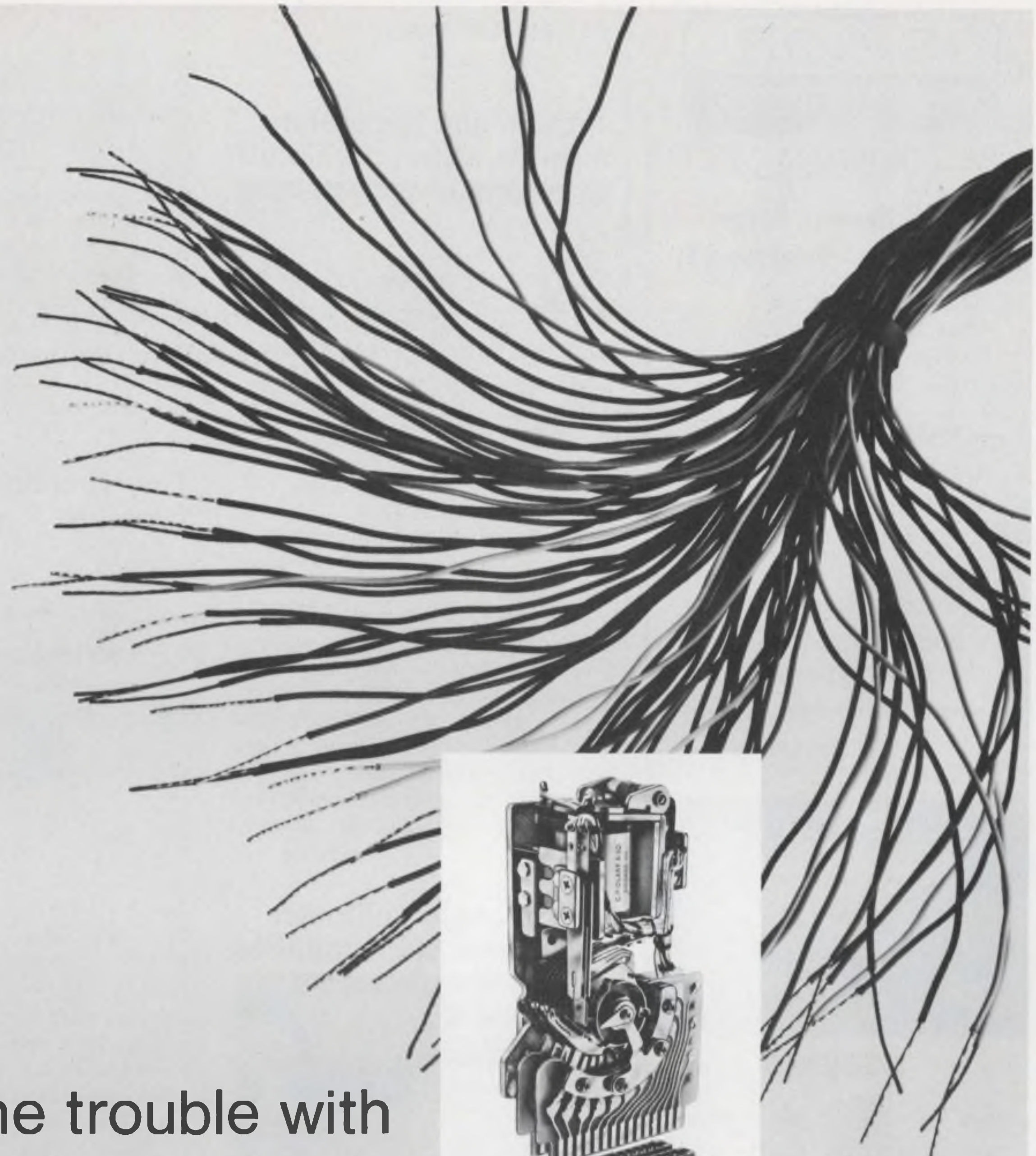
CIRCLE NO. 256

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



Type 210 and 211

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 20 and 26

Bracket Mount

Card Cage Mount

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

INFORMATION RETRIEVAL NUMBER 54

Tri-function generator outputs within ±0.05 dB

Clarke-Hess Communications Research 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 output amplitude variations of less than ±0.05 dB. Model 743 has sine, square and triangular-wave outputs and includes tone-burst and synchronization capabilities.

CIRCLE NO. 258

Tiny function generator supplies 3 waveforms

Varitron Corp., Box 2594, St. Louis., Mo.

Developed for requirements of continuously variable waveforms in the audio and ultra-sonic frequency 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 negative or positive pulses, and for adjusting the triangular waveform to right or left-sawtooth outputs.

CIRCLE NO. 259

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 measures total ac voltage and five other quantities of the total voltage. The model 210 can measure in-phase, quadrature and fundamental 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.

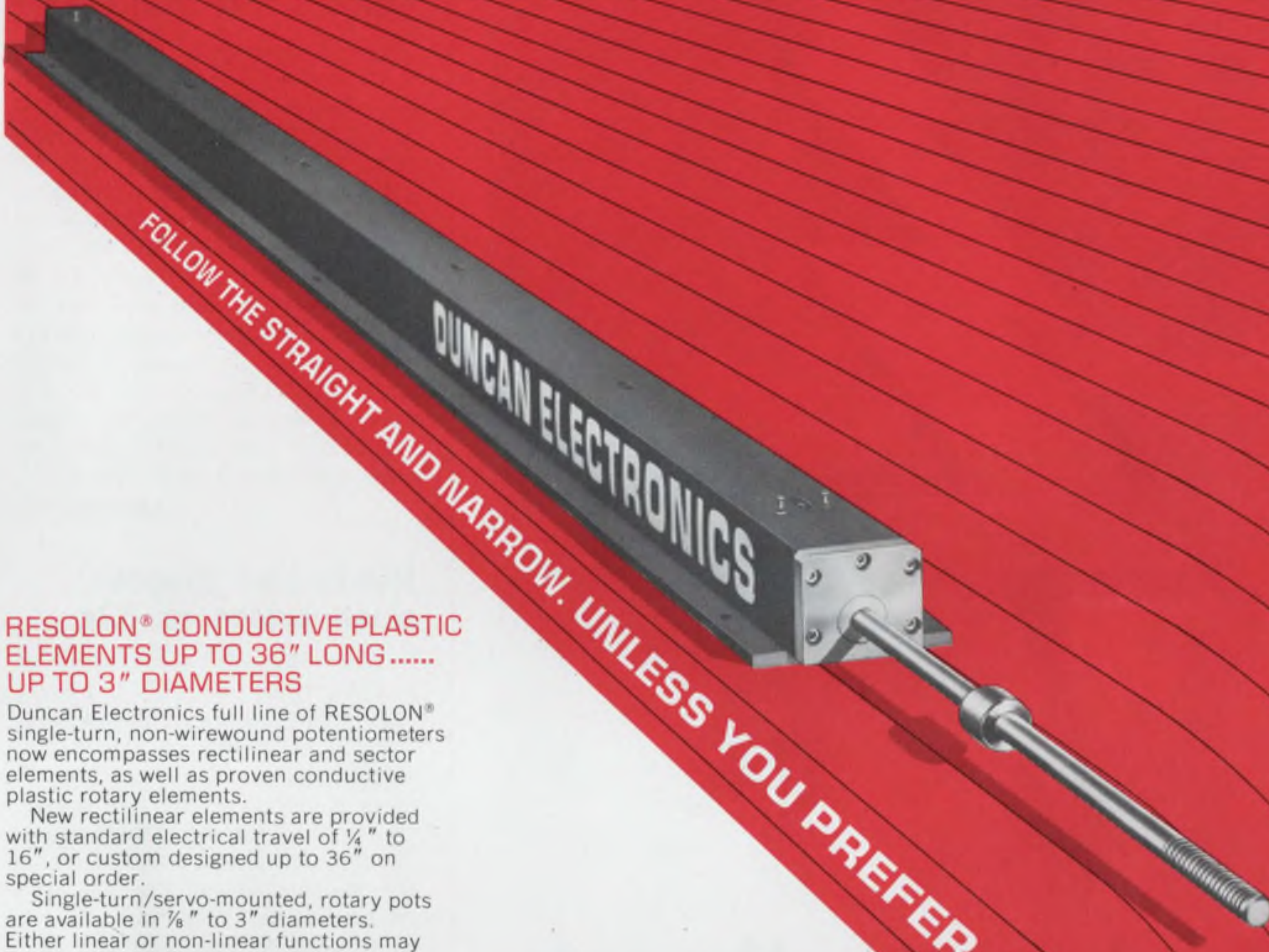
CIRCLE NO. 260

IC and module analyzer eliminates peripherals

Pulse Monitors Inc., 351 New Albany Rd., Moorestown, N. J. Phone: (609) 234-0556. Price: $1290.

Eliminating the need for peripheral instrumentation is a new analyzer that tests ICs and modules. Model 2080 has a built-in generator 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 modules.

CIRCLE NO. 261



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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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RESOLON® CP HIGH PERFORMANCE FEATURES:

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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

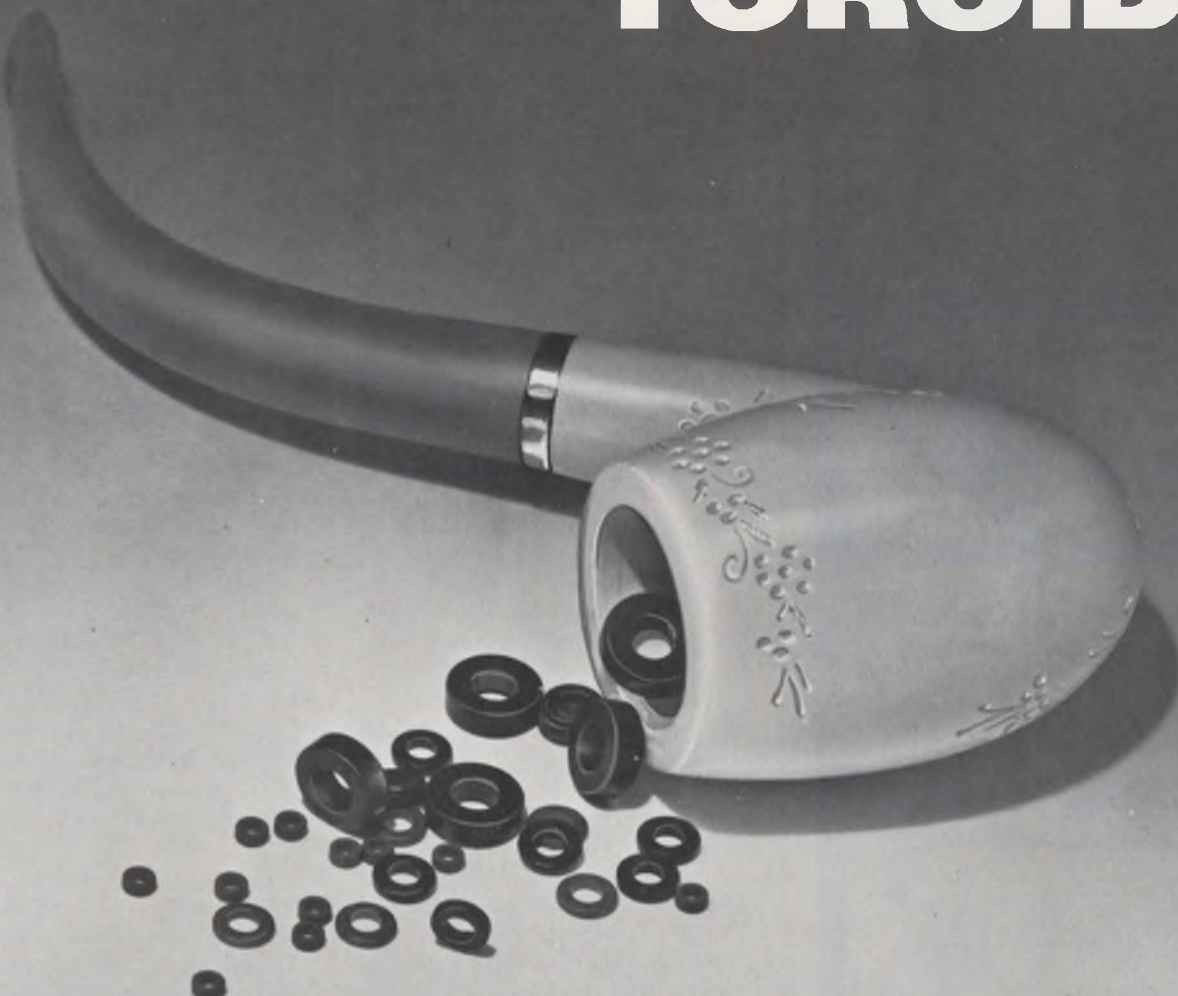
Gunn-effect devices give 75 mW at 9.5 GHz

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 820-CXY/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

THE 5000 PERM TOROID



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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.

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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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Electronic Components Division

ALSO A LEADER IN THE MANUFACTURE OF QUALITY FIXED COMPOSITION RESISTORS

INFORMATION RETRIEVAL NUMBER 58

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 ±0.5 or ±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 ±0.5 to ±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

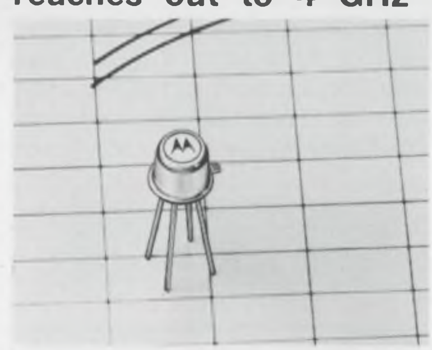
Directional coupler lowers cost to $49

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

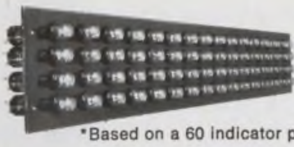


Motorola Semiconductor Products Inc., Box 20924, Phoenix, Ariz. Phone: (602) 273-6900. P&A: $8.75; stock.

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

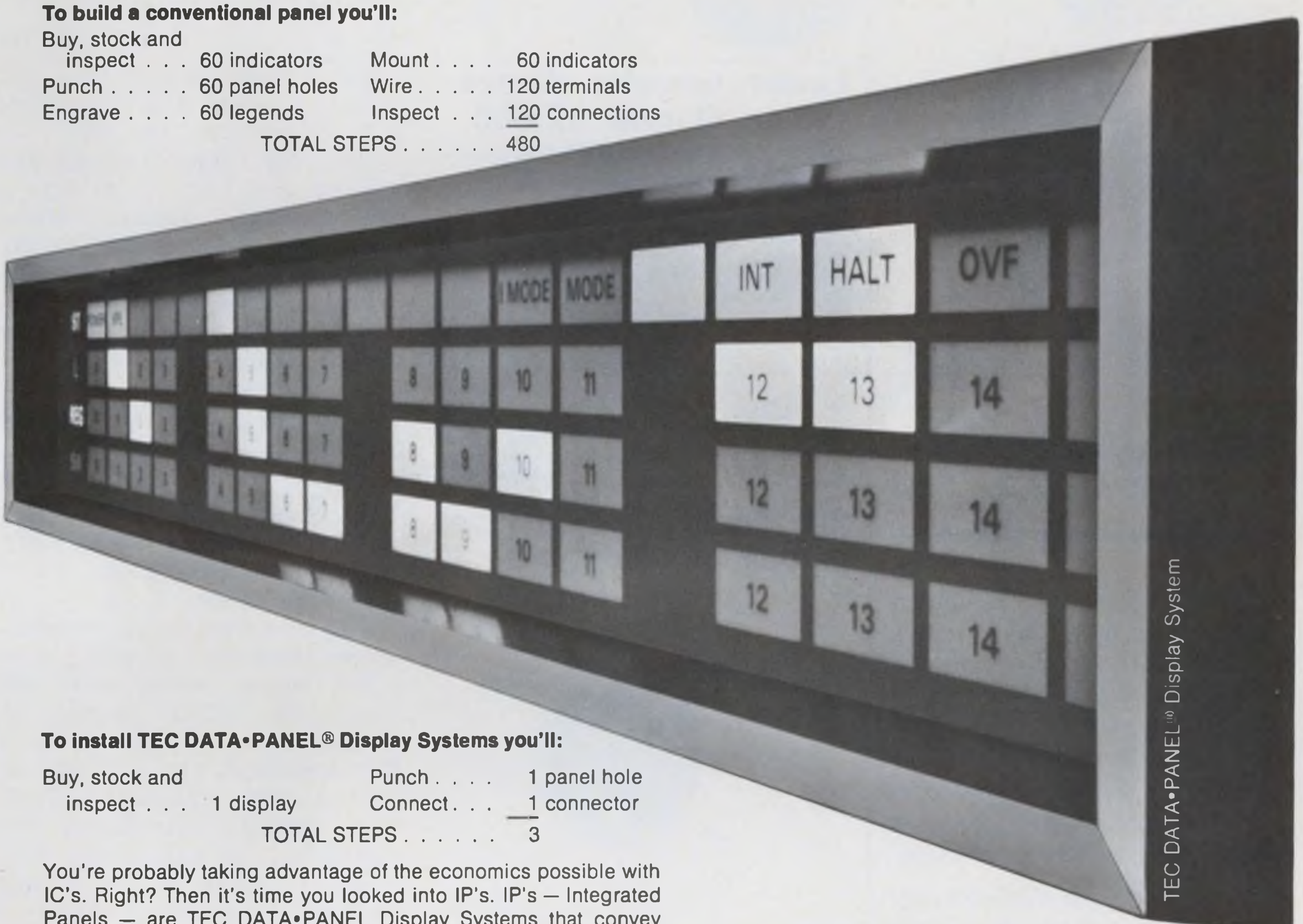
TEC Can Save You 477* Steps on Your next Display Panel



*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
	TOTAL STEPS		480



To install TEC DATA•PANEL® Display Systems you'll:

Buy, stock and inspect . . .	1 display	Punch	1 panel hole
		Connect . . .	1 connector
	TOTAL STEPS		3

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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TEC is the leading independent supplier of a complete line of display/control products and systems. For information, call: (612) 941-1100. Or write: TEC, Incorporated, 6700 So. Washington Avenue, Eden Prairie, Minnesota 55343.

TEC® INCORPORATED

INFORMATION RETRIEVAL NUMBER 62

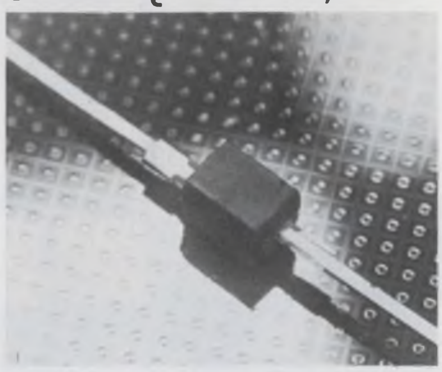
Impatt oscillators span 8 to 18 GHz

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.

CIRCLE NO. 268

Linear varactor diodes extend Q over 12,000

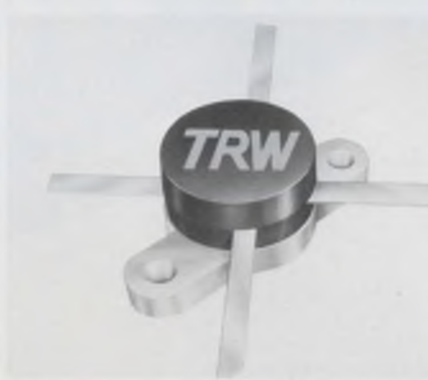


Standard Kollsman Industries Inc., 111 New York Ave., Westbury, N.Y. Phone: (516) 997-8300.

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.

CIRCLE NO. 269

Broadband transistors handle 80-W outputs

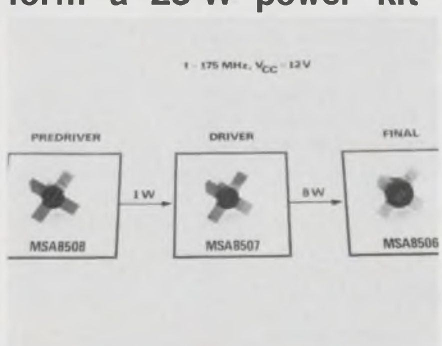


TRW Semiconductor Div., 14520 Aviation Blvd., Lawndale, Calif. Phone: (213) 679-4561. P&A: $140, $160; stock.

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%.

CIRCLE NO. 270

Three vhf transistors form a 25-W power kit



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 MSA-8508 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.

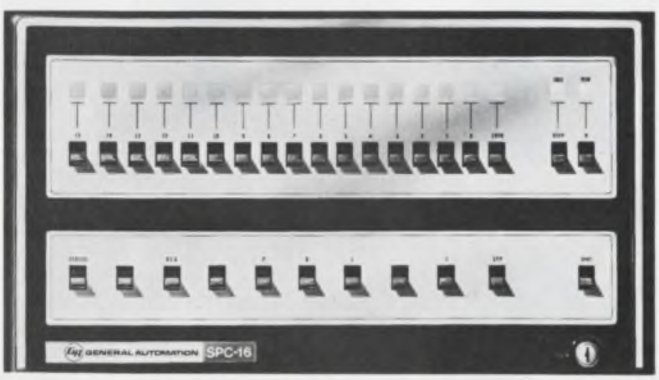
CIRCLE NO. 271

INFORMATION RETRIEVAL NUMBER 64 ▶

SPEED LIMIT 960

And that's fast for a 16 bit machine ...for less than $10,000

and Much Less in OEM Quantities



SPC-16 is a powerful new 16-bit machine . . . 960 nanoseconds fast . . . expandable 4K memory.

It's organized to provide for efficient handling of bits, bytes and words in read/write and macroprogramming in ROM . . . and ready-to-use GA productized software reduces programming time, effort and cost to a minimum.

SPC-16 gives you big computing power, accuracy, reliability and programming simplicity . . . and flexibility in interfacing with peripherals through the GA family of mini-controllers . . . and the SPC-16 is supported by expert consultation, systems engineering, programming and customer training services.

You'll be surprised just how fast you can add the SPC-16 to your product or system . . . so find out today.

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Wren House, Portsmouth Rd.
Esher, Surrey, Esher 65764

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 × 2 × 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

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.

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milgo
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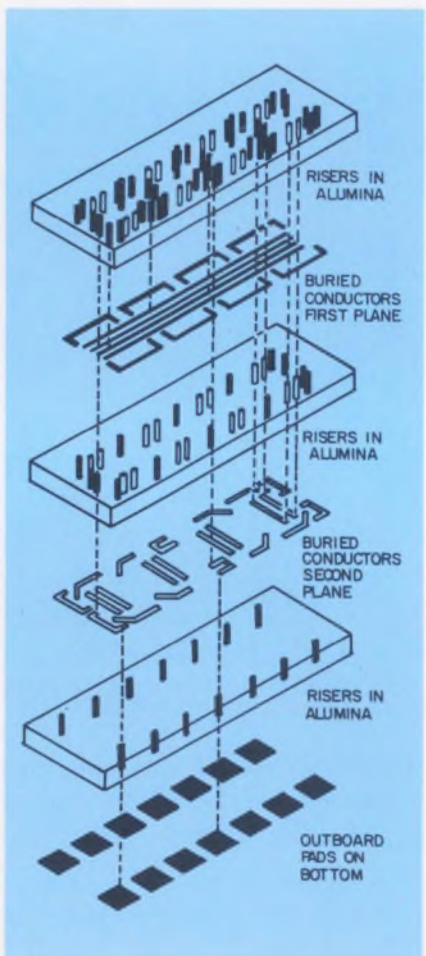
INFORMATION RETRIEVAL NUMBER 66

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.



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.

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.

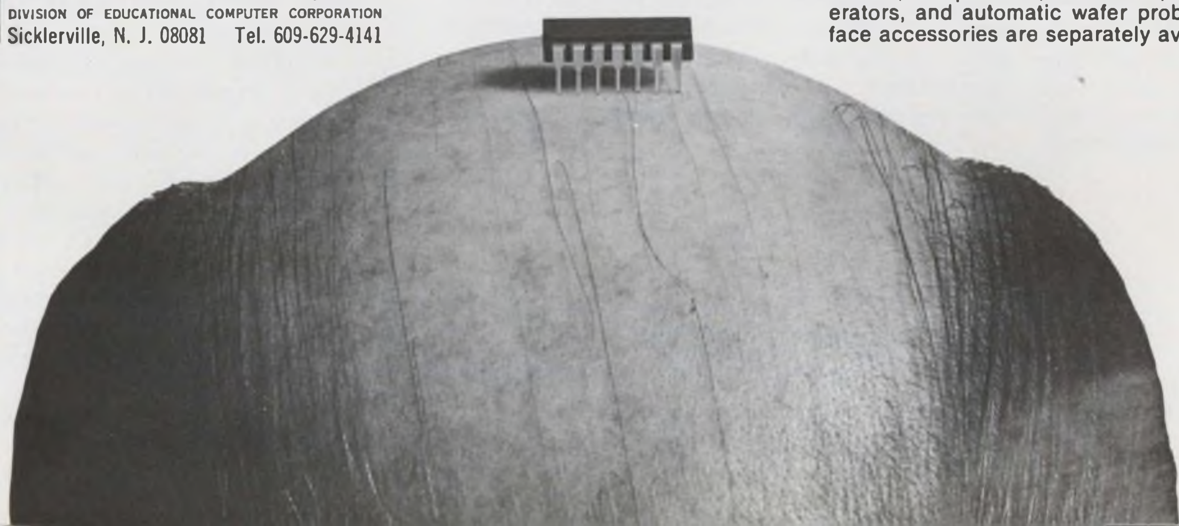
The structure shown is an example of how a standard buried-wiring configuration can be used to form more than 50 different logic functions from four IC chips by discretionary top-surface wiring. It also demonstrates how four IC chips can be packaged in the space normally required for one.

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.

CIRCLE NO. 274



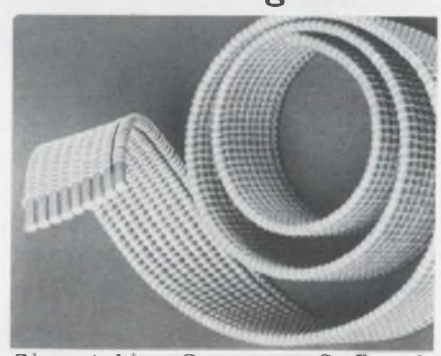
Silicone rubber sealant eliminates corrosion

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

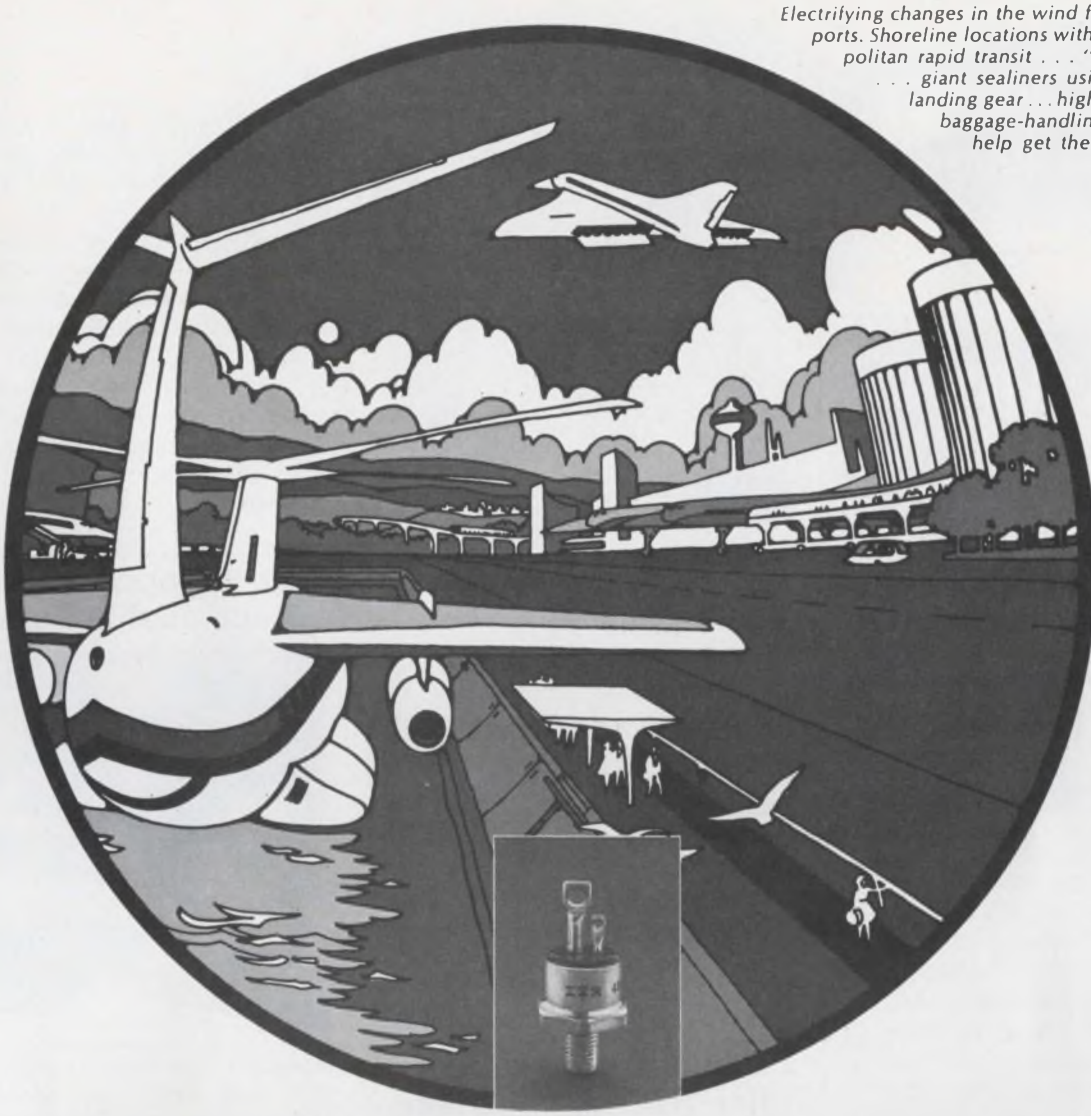


Zippertubing Co., 13000 S. Broadway, Los Angeles, Calif. Phone: (213) 321-3901.

Meeting the need for high-speed signal transmission in data processsing 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^2t 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 hermiticity 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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Semiconductor Division, 233 Kansas Street, El Segundo, California 90245, Phone (213) 678-6281

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INFORMATION RETRIEVAL NUMBER 71

PC transistor socket lowers its profile

Interdyne, 2217 Purdue Ave., Los Angeles, Calif. Phone: (213) 477-6051. Availablity: 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.

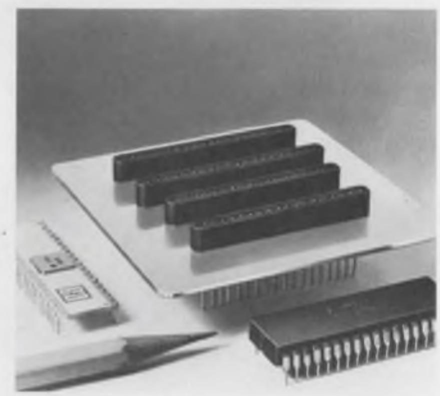
CIRCLE NO. 280

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

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.

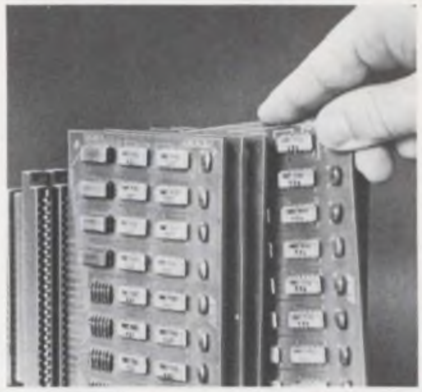
In a typical logic design project, you can spend over 200 hours generating "from-to" wire lists, and other routine activities. That's work designers shouldn't have to do; and that's why EECO developed Logic-Ware, a computer automated system for design, hardware and production.

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.

Modular memory cards boast 10-ns cycle time



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

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

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

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

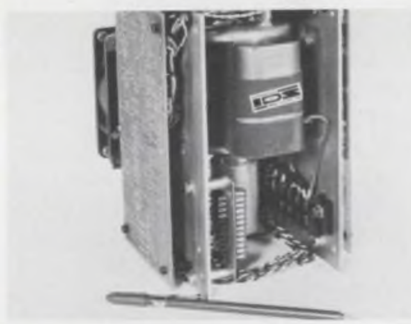
Cassette demagnetizer keeps heads in tune

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.

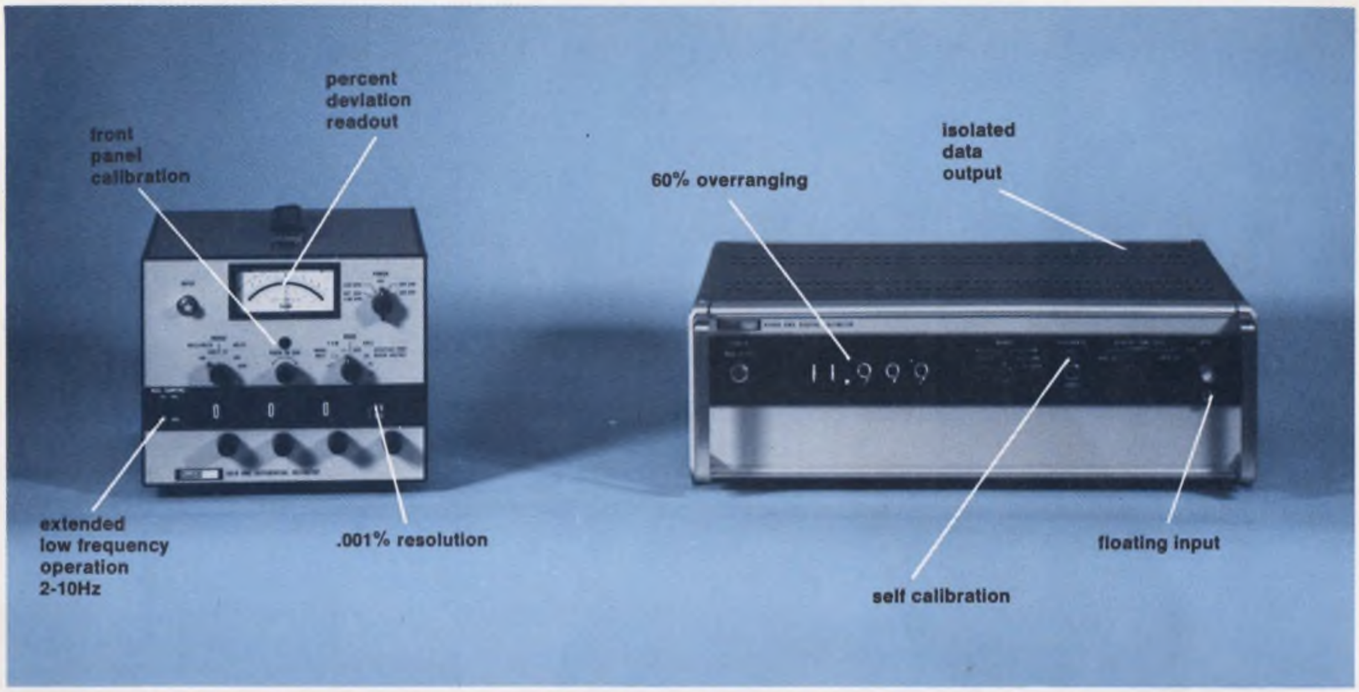
CIRCLE NO. 287

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.

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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

Teleprinter control allows communication

Rydax, 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

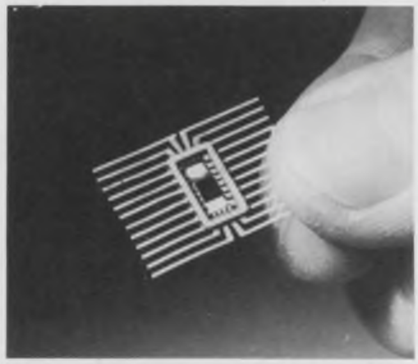
Acoustic data sets expand telephone use

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 × 10^6 bits. Model 102B is for operation through type 80 telephones.

CIRCLE NO. 292

Twelve-bit ladder fits on single chip



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 × 3/8 in.) or in a 24-lead DIP, either hermetically sealed or epoxy encapsulated.

CIRCLE NO. 293

Monolithic $3 circuit indicates fine tuning

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

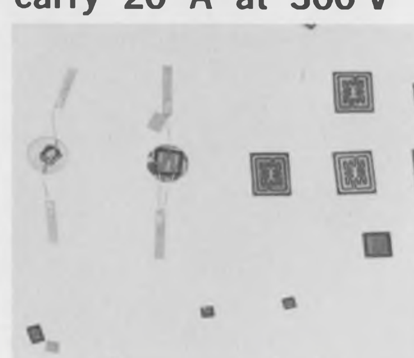
Dual matched FETs occupy same chip

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 μA, a low leakage of 100 pA and a high gain of 1000 μmhos. Uses include balanced modulators.

CIRCLE NO. 295

Power transistor chips carry 20 A at 300 V

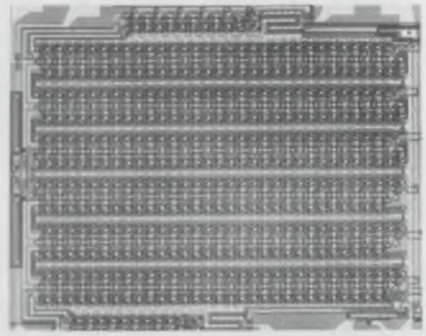


Solitron Devices, Inc., Transistor Div., 1177 Blue Heron Blvd., Riviera Beach, Fla. Phone: (305) 848-4311.

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

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[2] 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.

ACTUAL SIZE

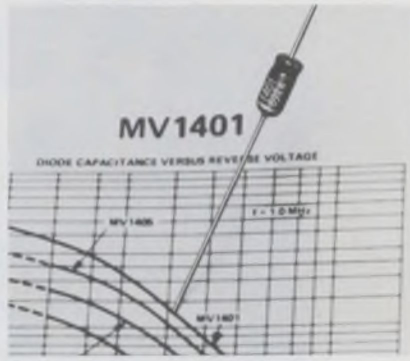
Though there's more room inside to give you all these advantages, the outside dimensions—top-to-bottom (.275") and side-to-side (.370")—are the same as any transistor-size relay.

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.

GENERAL ELECTRIC

INFORMATION RETRIEVAL NUMBER 82

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

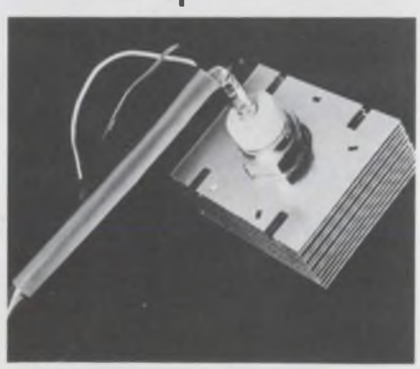
Power transistors take 300 W at 100 A

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

High-voltage thryistor handles up to 2000 V

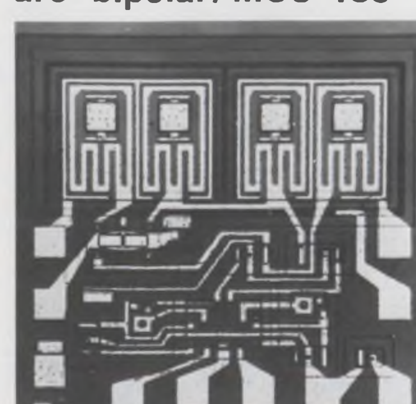


Westinghouse Semiconductor Div., Youngwood, Pa. Phone: (412) 925-7272. P&A: $300 or $320; 2 to 3 wks.

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

Driver switches are bipolar/MOS ICs

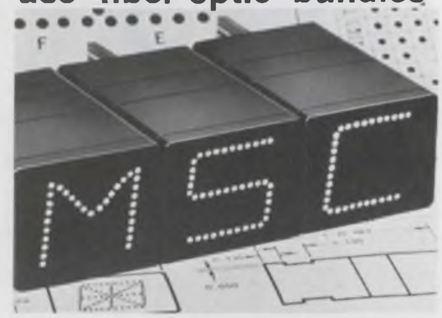


Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. Phone: (408) 246-8000. P&A: $18 or $31; stock.

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

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

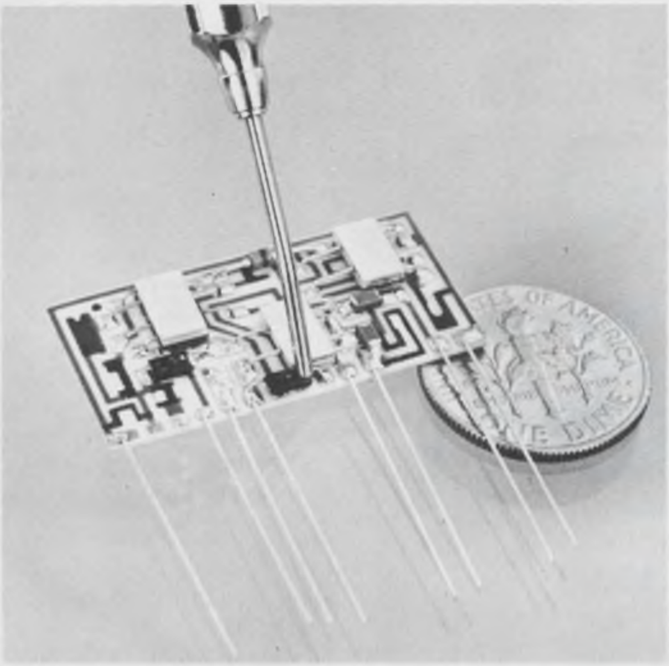
Colorful indicators are one-piece units

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 Spacetac heart pacer modules.



NOW ...more microfarods 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.

Flexibility To Fit! 11 resin-sealed mylar case sizes . . . rectangular and tubular shapes . . . axial or radial leads. Easy-soldered nickel leads, as well as gold-plated kovar ribbon leads for maximum IC compatibility. Standard tolerances to ±5%.

Proven Reliability! 1,679,000 Life Test Hours @ 85°C with only one failure. 130% surge voltage rating. Operating temp. range from —55°C to 125°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

BIDDEFORD, MAINE 04005

INFORMATION RETRIEVAL NUMBER 86

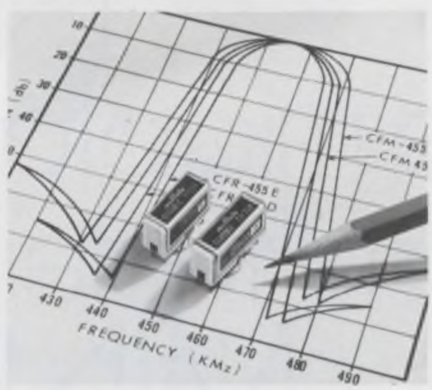
Mercury-film relay undersizes TO-5 can

FR Electronics Div., Flight Refuelling 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 ±7 kHz and a 60-dB bandwidth of ±20 kHz. Maximum insertion loss is 5 dB, and both input and output impedances are 1.5 kΩ. The unit operates over the full temperature range of −20 to +60°C.

CIRCLE NO. 341

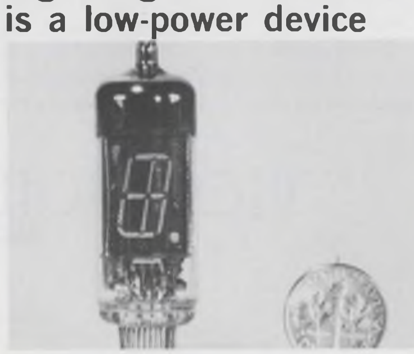
Resistor modules are 8-lead DIPS

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 ±2-1/2%; temperature coefficient is ±250 ppm/°C; and resistances range from 50 Ω to 1 MΩ. Lead spacing is 0.1 in.

CIRCLE NO. 342

Eight-segment readout is a low-power device



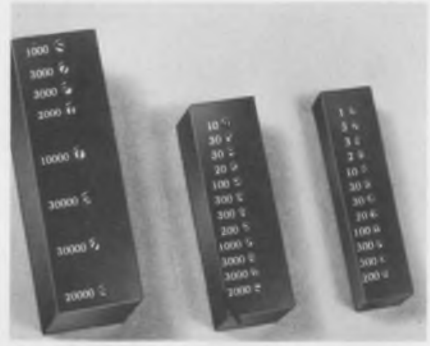
Legitron, 3118 W. Jefferson Blvd., Los Angeles, Calif. Phone: (213) 733-9105. P&A: $5.50: stock.

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

INFORMATION RETRIEVAL NUMBER 88

Capacitance trimmers adjust incrementally

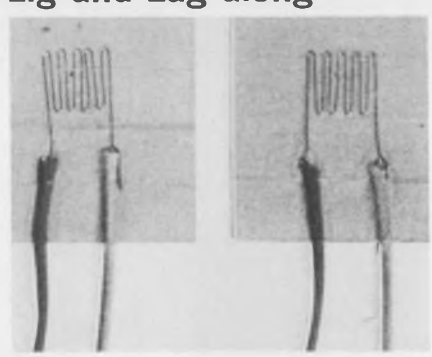


Consolidated Resistance Instruments, Inc., 44-46 Prospect St., Yonkers, N.Y. Phone: (914) 963-5900. P&A: $7.50 to $23; stock.

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 microminiature 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 surfacc 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

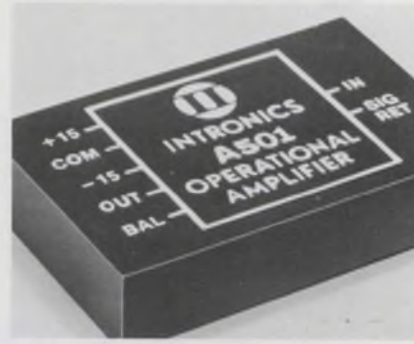
Analog multiplier can modulate too

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 kH and full-power response is 100 kH.

CIRCLE NO. 346

Wideband amplifier slews at 1000 V/μs

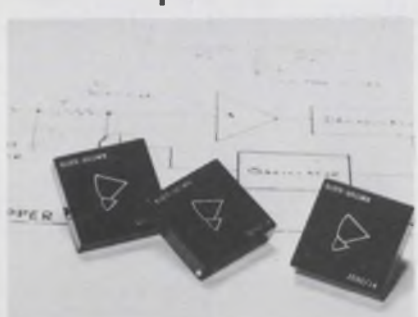


Intronics, 57 Chapel St., Newton, Mass. Phone: (617) 332-7350. P&A: $122.50; stock.

Designed for high-frequency inverting applications, a new operational amplifier will drive loads of ±50 mA to ±10 V while slewing at 1000 V/μs. Model A501 offers a wide bandwidth of 100 MHz and operates over a temperature range of −25 to +85°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

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 μV/°C for voltage and 0.5 pA/°C for current. In addition, noise is low (2 μV 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.

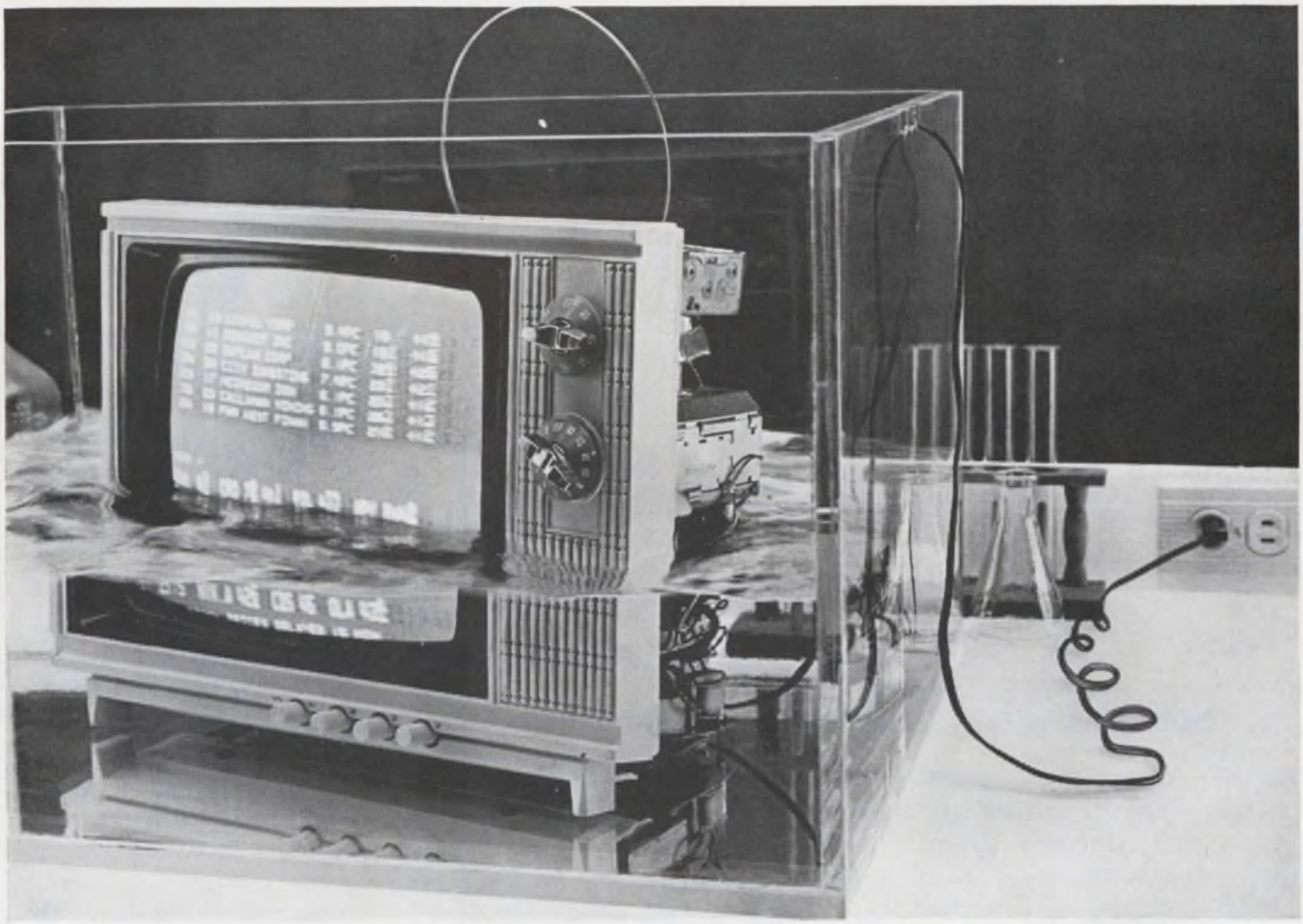
CIRCLE NO. 347

High-voltage op amps slew at 50-V/μs 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/μs, the AN290 operational amplifier settles to 0.01% in 25 μs for a 200-V step input, while the AN291 op amp settles to a 0.01% in 50 μs 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® BRAND Electronic Liquids 3M COMPANY

3M Company, Chemical Division, 3M Center
St. Paul, Minn. 55101
Dept. KAP2-70

Send me all the details about Fluorinert Brand Electronic Liquids.

Name________

Company________ Title________

Address________

City________ State________ Zip________

INFORMATION RETRIEVAL NUMBER 92

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 ±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.

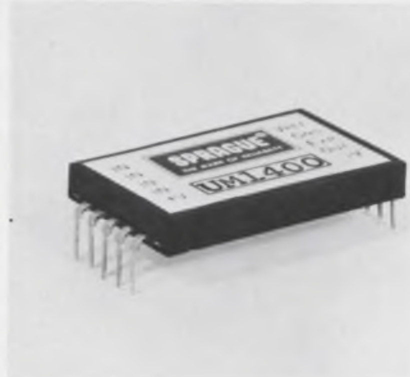
Selling for only $19.95 in single-unit quantities, series LCD dual-output power supplies provide ±6, ±12 or ±15 V at 25 mA. Models P2.6.25, P2.12.25 and P2.15.25 have a maximum line regulation of 0.05%, and a maximum load regulation of 0.2% from 0 to 100%. Their ripple and noise are less than 2 mV pk-pk; temperature coefficient is 0.02%/°C maximum from −25 to +71°C.

CIRCLE NO. 419

INFORMATION RETRIEVAL NUMBER 94

INFORMATION RETRIEVAL NUMBER 95

D/a converters are plastic DIPs



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

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 ±0.01% of output, a common-mode rejection of more than 120 dB from dc to 60 Hz, a drift of 1 μV/°C, and noise of 5 μV rms at full bandwidth.

CIRCLE NO. 421

Digital counting unit can be seen for 150°

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°. 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

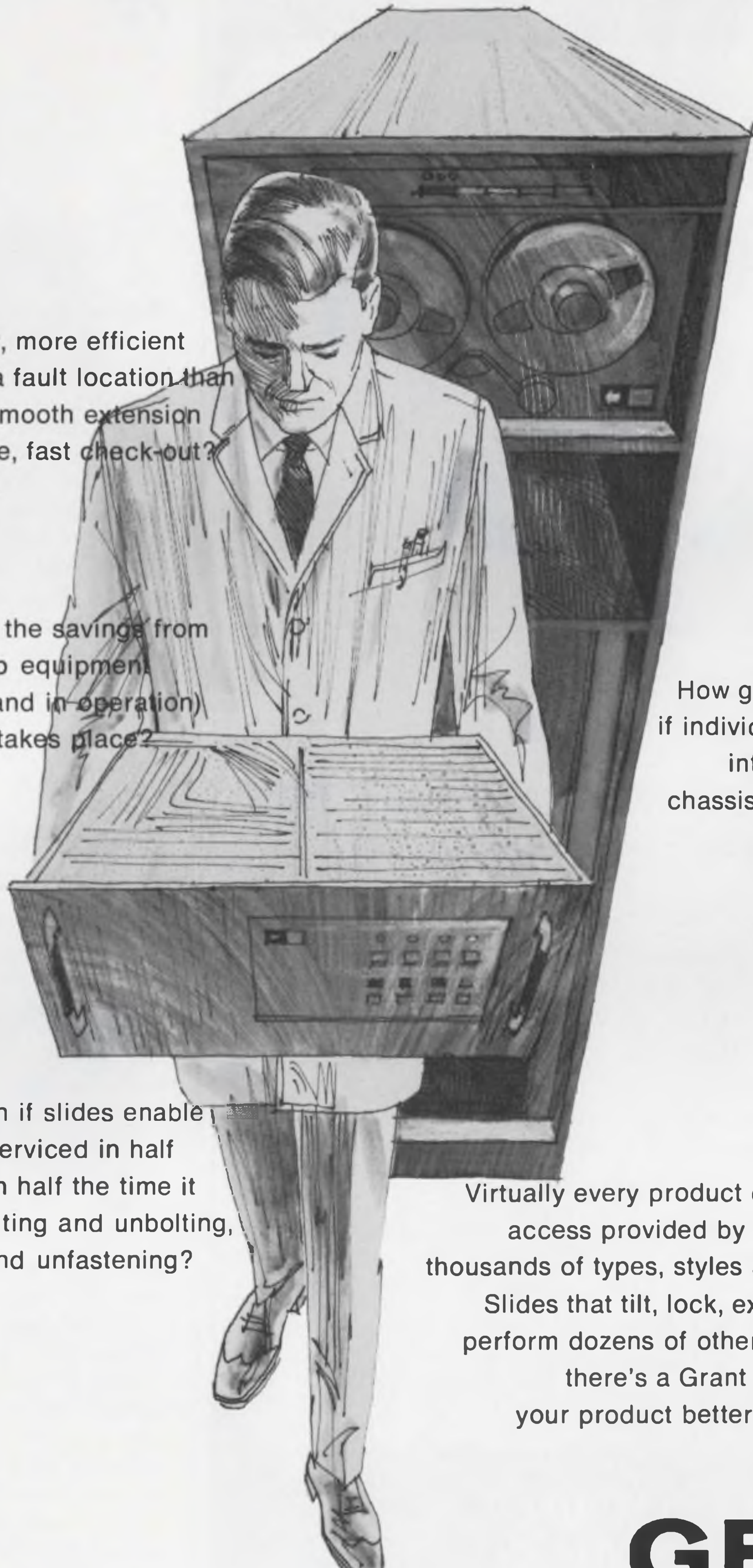
Modular power supply measures only 0.8 in.^{3}

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 × 2 × 0.4 in. The BPM 5-300 has an output of 5 V at 300 mA and regulates to ±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

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?

How great is the value of slides if individual chassis' can be interchanged with similar chassis' in moments?

What's it worth if slides enable equipment to be serviced in half —or less than half the time it ordinarily takes bolting and unbolting, fastening and unfastening?

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.

GRANT

PULLEY & HARDWARE CORPORATION

EASTERN DIVISION: 21 HIGH STREET, WEST NYACK, NEW YORK 10994
WESTERN DIVISION: 944 LONG BEACH AVE., LOS ANGELES, CALIF. 90021

INFORMATION RETRIEVAL NUMBER 96

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 plexiglass right angle that is graduated in inches, and a self-adjusting protractor that is graduated in degrees with a zero adjustment at the angle.

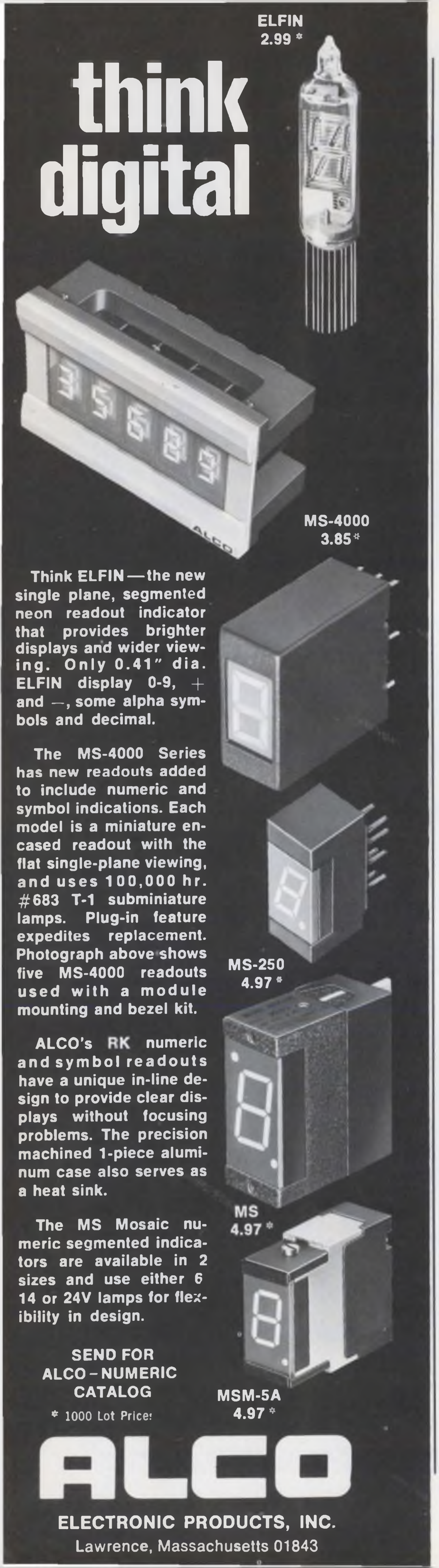
CIRCLE NO. 424

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



Solder/desolder tool accepts up to 85 tips

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

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

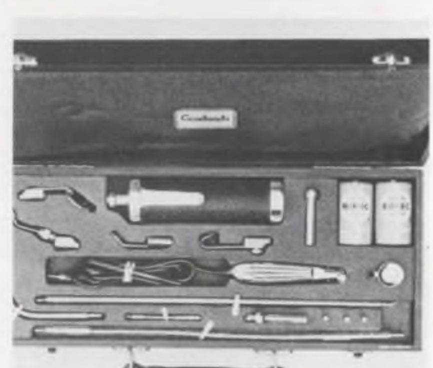
Two connector tool kits insert/remove contacts

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



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

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

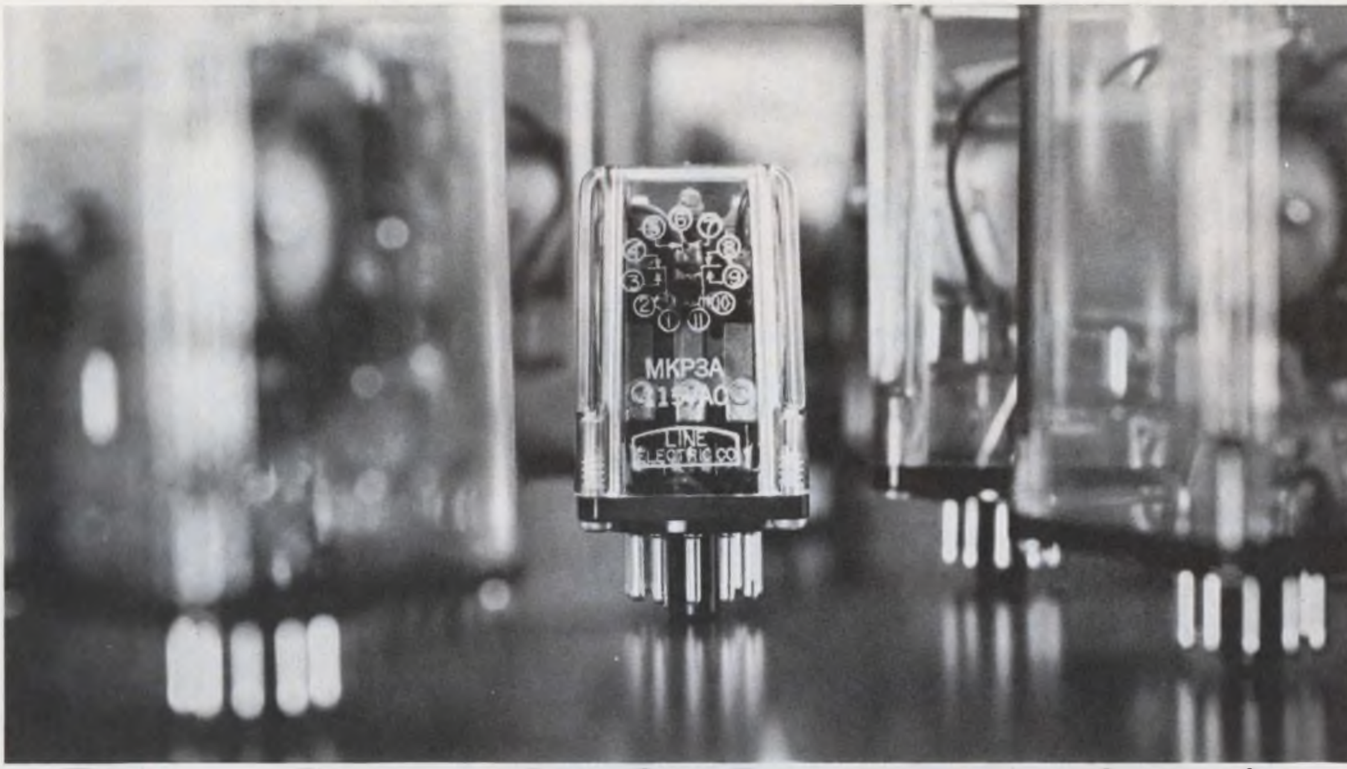
A new type of Teflon TFE plastic V-ring packing offers good sealing characteristics and long life due to its unique spring-action design. Series 6225 self-energizing lip-type rings have a 12-degree differential angle between the slopes of the top and bottom surfaces. When stacked and compressed, they 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.

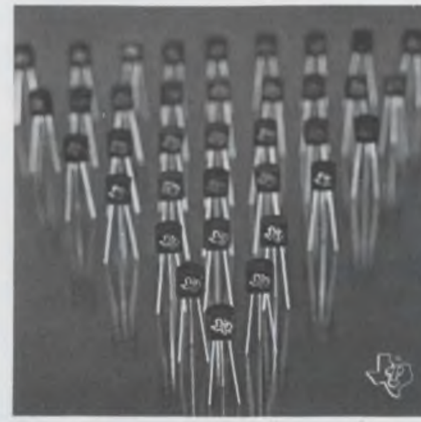
About the price – as low as $1.60 in quantity. For a prototype, please specify coil and contact requirements.

SINGER

Line Electric Company, U.S. Highway 287, Parsippany, N.J. 07054 201/887-2200

INFORMATION RETRIEVAL NUMBER 105

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, unijunction transistors, and field-effect transistors. In addition, an applications section shows recommended device uses and lists electrical parameters. Texas Instruments Inc.

CIRCLE NO. 434

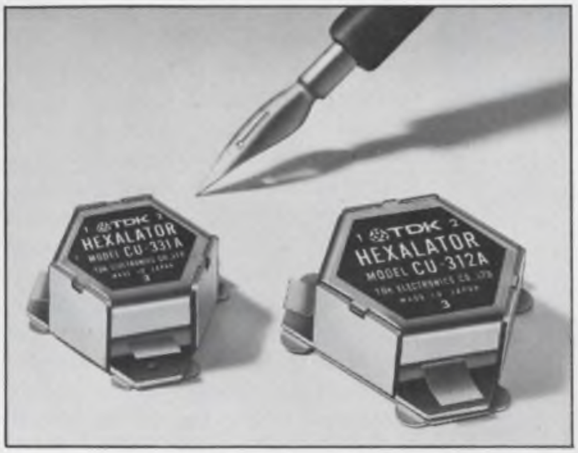
Lettering wall chart

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

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

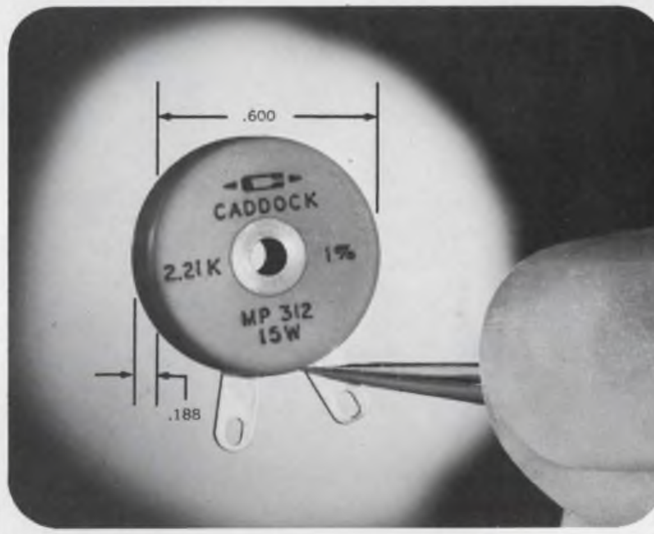
MH&W INTERNATIONAL CORPORATION
280 Midland Avenue, Saddle Brook, N.J. 07662
Phone: (201) 791-6277 (212) 244-0695

TDK

TDK ELECTRONICS CO., LTD.
2-14-6 Uchikanda, Chiyoda-ku, Tokyo Japan

INFORMATION RETRIEVAL NUMBER 109

MINIATURE POWER RESISTORS



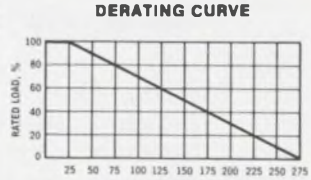
CHASSIS-MOUNT TYPE • NEW LAMINAR DESIGN • LOW PROFILE • 50% REDUCTION IN SIZE AND WEIGHT • COMPLETELY NON-INDUCTIVE • T.C.: 50 PPM/°C • RESISTANCE TOLERANCE: ±1%

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

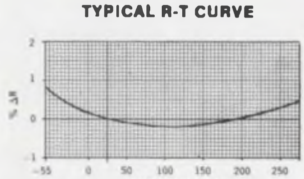
†Power rating based on chassis mounting — MP311 and MP312 on 6"x4"x2"x.040 aluminum chassis
‡TC-50ppm/°C Referenced to 25°C, ΔR taken at +150°C and +275°C. (Low temp. TC will be nominally —85ppm/°C at —55°C. See typical R-T curve.)

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

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INFORMATION RETRIEVAL NUMBER 108

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

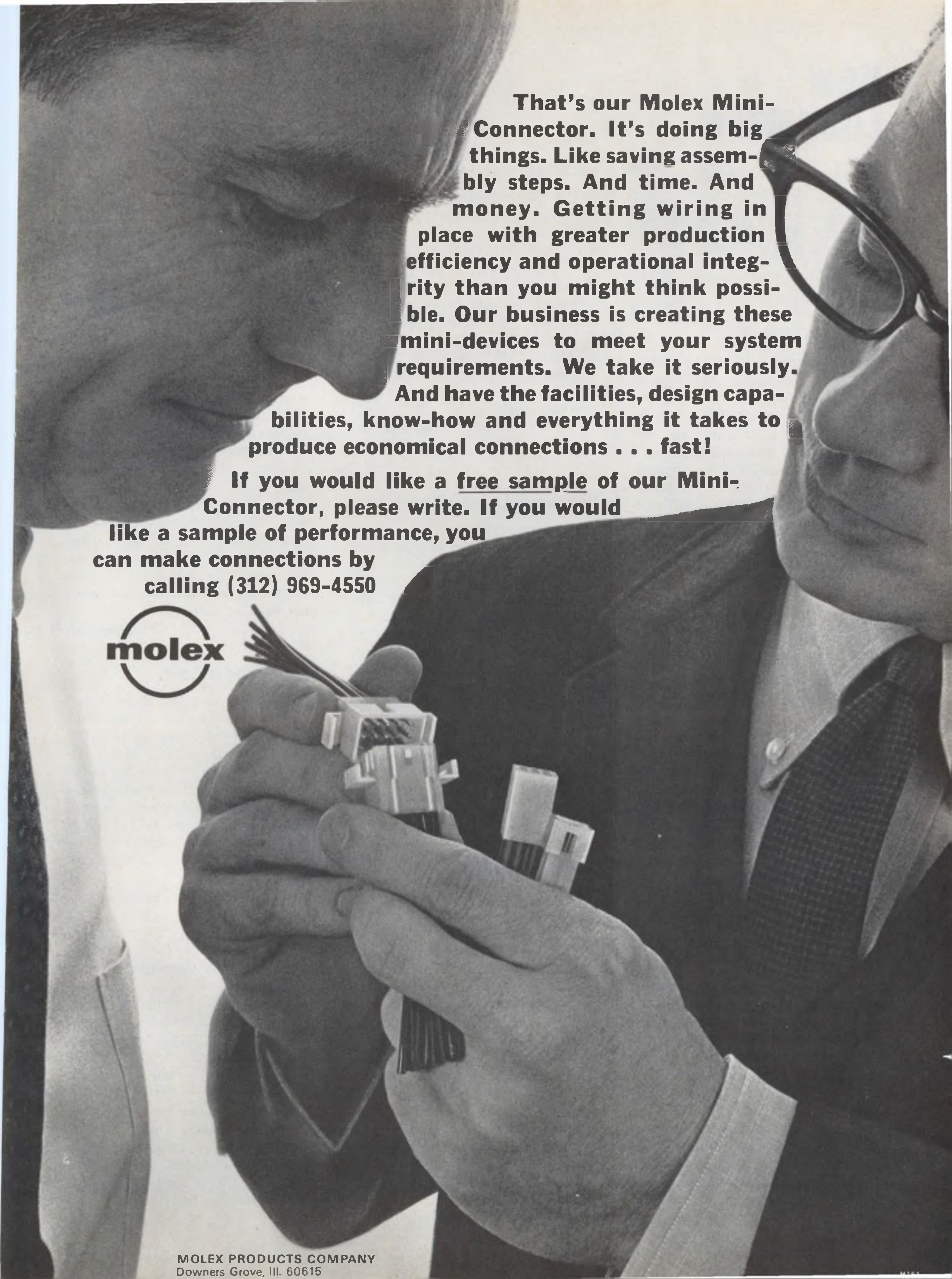
A 24-page engineering manual on passive repeater systems gives an extensive treatment to these reflectors of microwave energy. The text regards the antenna and passive repeater as effective point sources of radiated power and as a function of aperture and direction. This theoretical discussion is amply 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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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
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MOLEX PRODUCTS COMPANY
Downers Grove, Ill. 60615

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-tip 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 Designs" 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

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 evaluaton. Shown are specfications of typical types of motors, related performance curves and a table of conversion factors. Aeroflex Laboratories Inc.

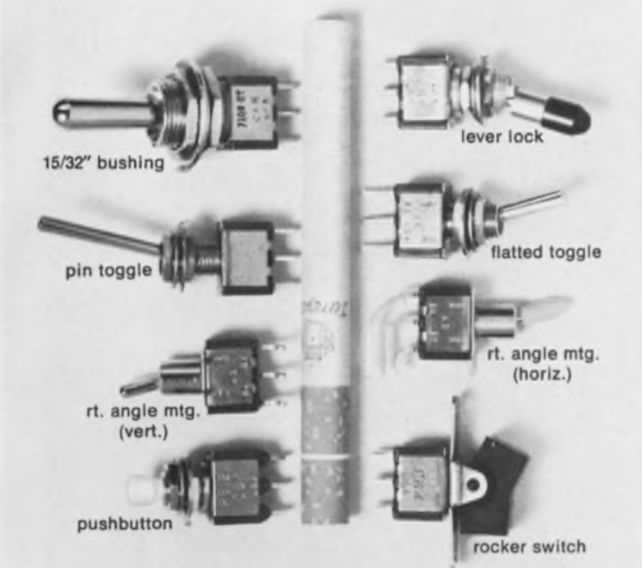
CIRCLE NO. 454

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



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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.

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INFORMATION RETRIEVAL NUMBER 114

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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.

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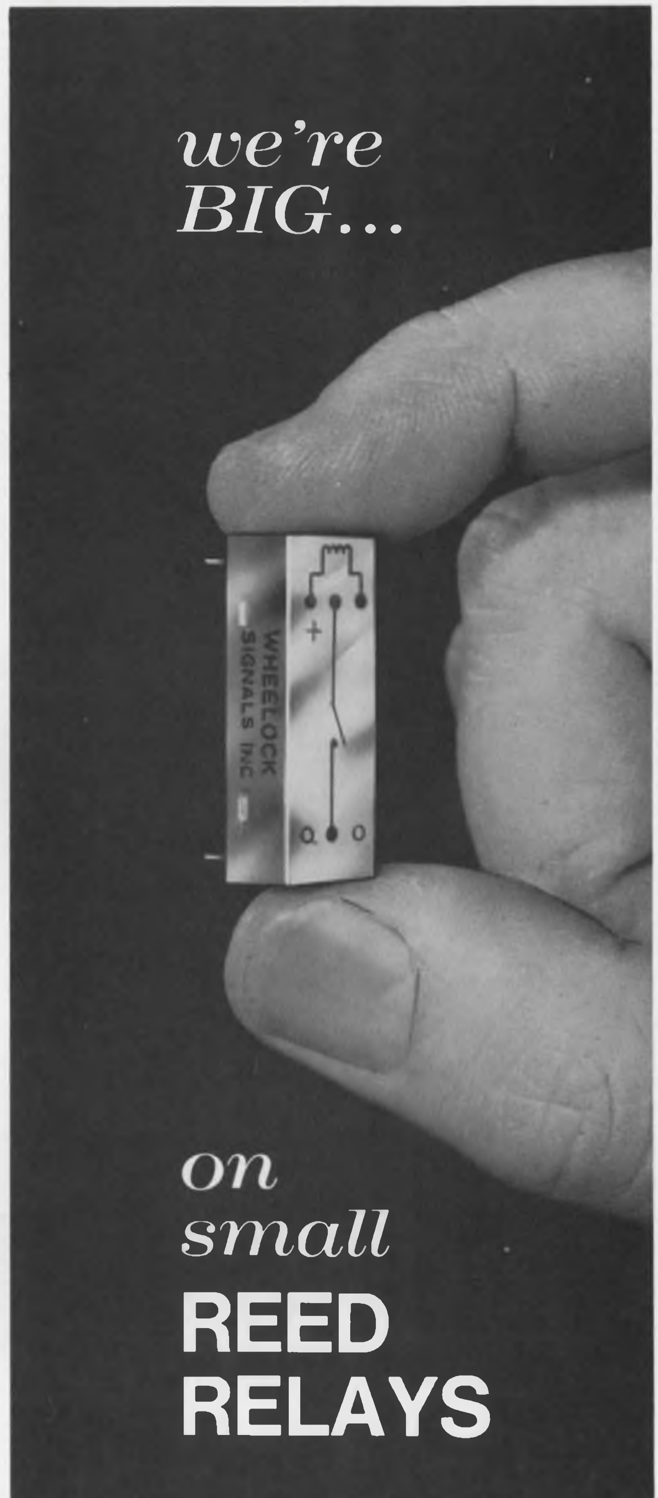

Wheelock probably has the reed relay you're looking for. Write for catalog describing the Wheelock Big Family of Small Relays

Wheelock
SIGNALS, INC.
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INFORMATION RETRIEVAL NUMBER 116

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 intemateable and interchangeable with MIL-C-26482 connectors. Both connectors operate in temperatures from −55 to +175°C and can be made to operate from −55 to +200°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° C to +125° C.

Low Aging. Less than 5×10^{-10}/day.

And if you need a non-standard oscillator, let us know your requirements. We'll design one specifically to meet your needs.

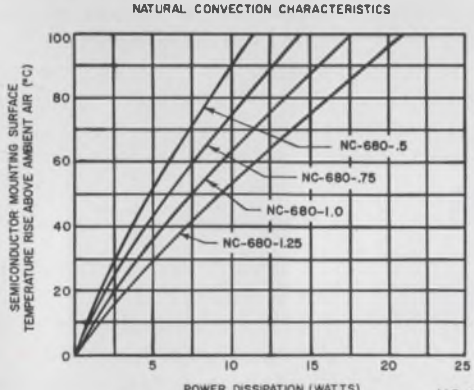
For complete information send for your free copy of Bulletin TIC-3401 today. Write Component Products Dept., Motorola Communications & Electronics Inc., 4501 W. Augusta Blvd., Chicago, Illinois 60651.

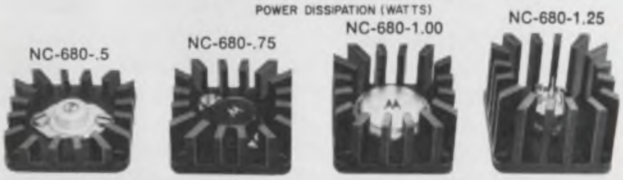
MOTOROLA

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°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.

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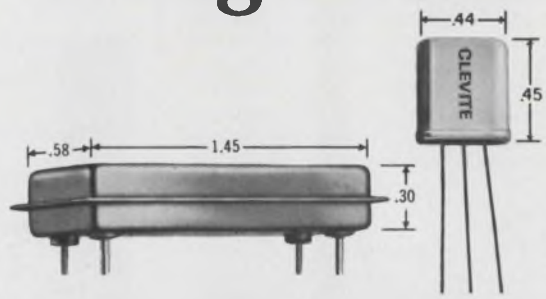
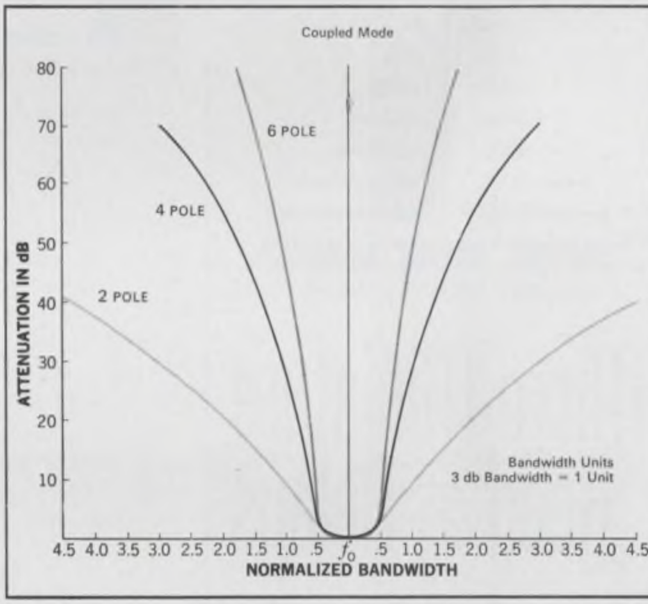
INFORMATION RETRIEVAL NUMBER 121

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 flatpacks 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.

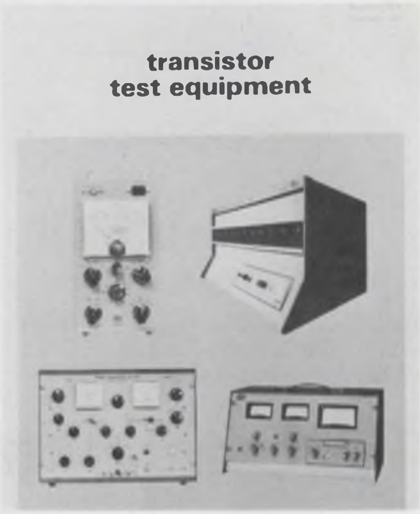
GOULD CLEVITE

INFORMATION RETRIEVAL NUMBER 120

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



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 semiconudctors. 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

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.

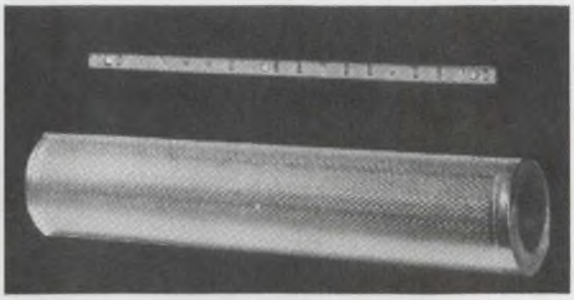
CIRCLE NO. 459

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.

For more information, see your nearest Buckbee-Mears representative. Or contact Bill Amundson, our industrial sales manager. You'll be glad you did.

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INFORMATION RETRIEVAL NUMBER 124

ENGINEERS

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■ 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.

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INFORMATION RETRIEVAL NUMBER 901

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.

Celco YOKES

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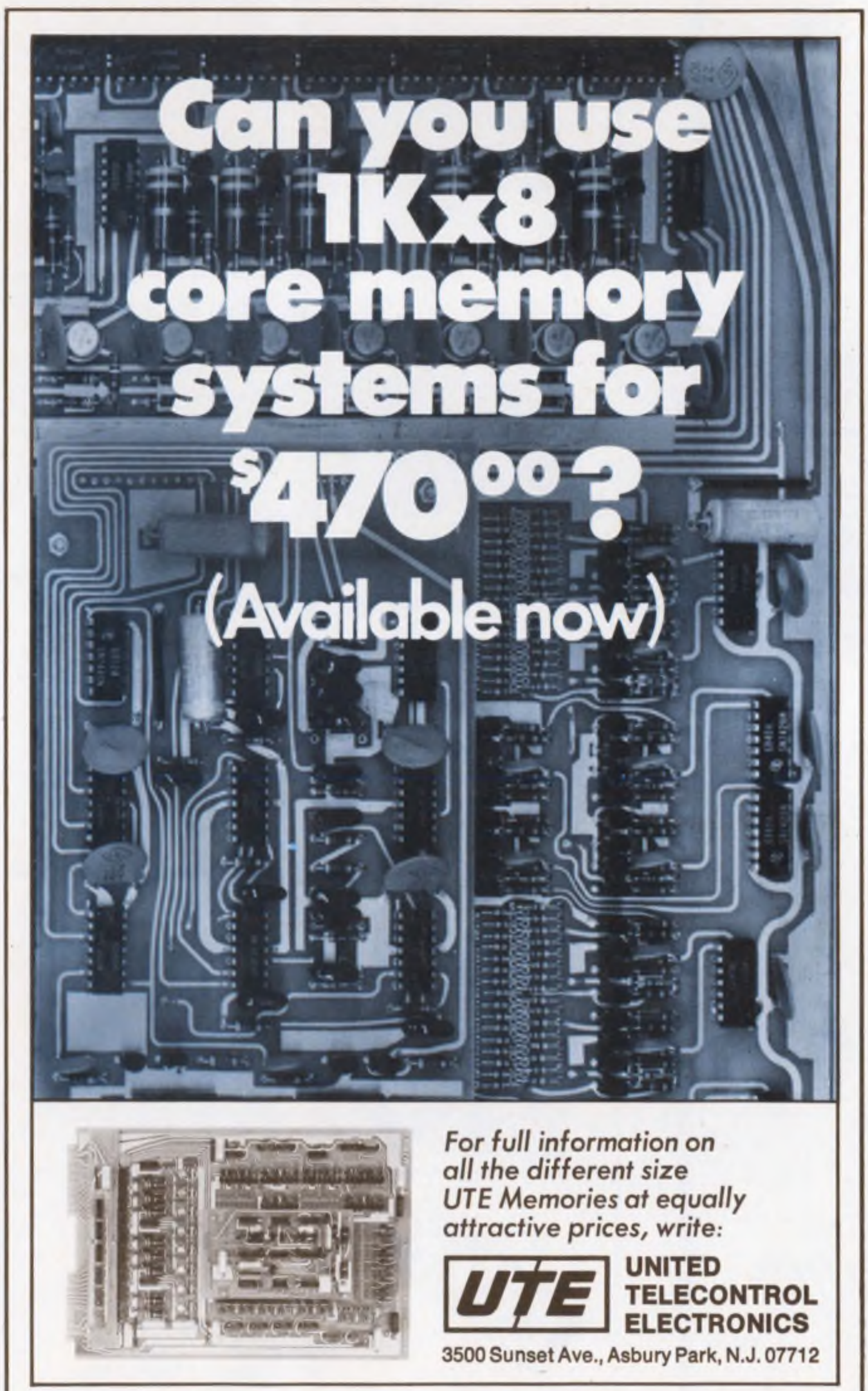
Upland, Cal. 714-982-0215

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 temperature-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

INFORMATION RETRIEVAL NUMBER 126

NOT SOMEDAY NOW

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—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*.

BROAD-HORIZON, PRESENT-TENSE, NON-DEFENSE, NON-STOP ENGINEERING AND PROGRAMMING OPPORTUNITIES AT NCR, SOUTHERN CALIFORNIA

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 concepts 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, multiprocessor 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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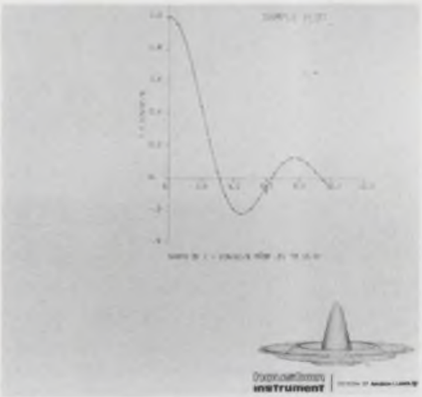
INFORMATION RETRIEVAL NUMBER 902



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 × 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

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

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, pippets and planchets. Also included are pulse-height analyzers, ratemeters, scalers, 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

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Desired Salary	**Availability Date**

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City, State			
Dates	to	to	to
Title			
Specialty			

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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 counterbore 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 counterbore, 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.

Aeroflex Laboratories Incorporated
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.

Dzus Fastener Co., Inc.
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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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Manufacturers

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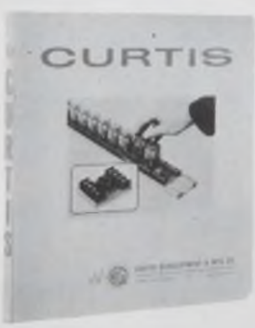
NEW RELAY SOCKET ASSEMBLIES CATALOG



The new Curtis line of printed circuit snap-in track-mounted relay socket assemblies is completely illustrated in this new 2-color, 6 page catalog. Variations include RS8 octal relay sockets, as well as RS11 and RS15 with eleven and fifteen pin relay sockets. Complete dimensional drawings and list prices are included. All units snap in or pop out vertically from prepunched vinyl track and feature Curtis barrier terminal blocks. CSA approved. Send today for your free copy.

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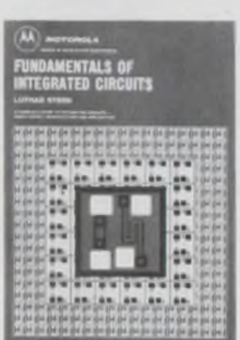
FUNDAMENTALS OF INTEGRATED CIRCUITS



A practical guide to integrated circuits, their theory, manufacture, and applications. This new guide by Lothar Stern offers compete, highly readable coverage of the various techniques of circuit fabrication, and their effect on circuit design and performance. As to marketing considerations, it compares the characteristics of the numerous IC structures devised to date in terms of economics and logistics. A volume in the **Motorola Series in Solid-State Electronics.** 198 pages, 7 x 10, illustrated. $8.95, clothbound. Send for 15-day examination copies.

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Electronic Design

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- To give the electronic design engineer concepts and ideas that make his job easier and more productive.
- To provide a central source of timely electronics information.
- To promote two-way communication between manufacturer and engineer.

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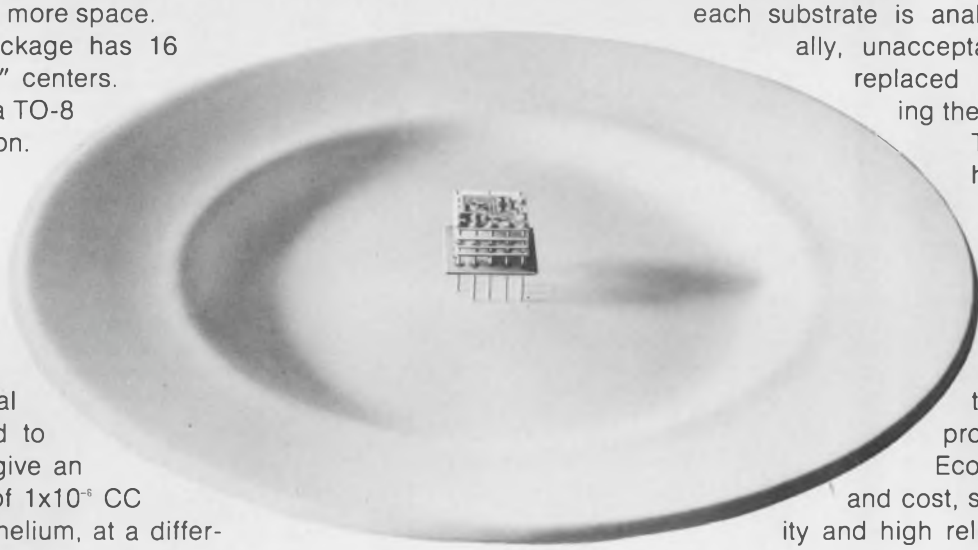
Advertisers' Index

Career Advertisings

We put so much in this hybrid thick-film sandwich, we call it our hero.

But it's a hero for more reasons than that. For while our exclusive custom package gives you 50% more circuit area than conventional TO-8 substrates, it doesn't use any more space.

A typical package has 16 leads on 0.100" centers. Conforming to a TO-8 pin configuration. The outer dimension is .610" square, with height depending upon the number of substrates. A metal cover is sealed to the header to give an hermetic seal of 1×10^{-6} CC per second of helium, at a differential pressure of one atmosphere.



So now you can design a complete system into one module. For instance, a four substrate unit may consist of an operational amplifier, switching circuits, resistor networks and a D/A converter.

What's more, it's not expensive like other hybrid thick-film packages. First, because it contains more. Also, because it's more economical to produce. Since each substrate is analyzed individually, unacceptable ones are replaced without affecting the others.

That means we have higher yields and lower costs. Also, it means extremely high reliability of the delivered product.

Economy of space and cost, system capability and high reliability make a great combination for a sandwich. To find out what you can put on it, call or write:

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INFORMATION RETRIEVAL NUMBER 133

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All products, design aids (DA), application notes (AN), new literature (NL), and reprints (R) in this issue are listed here with Page and Information Retrieval numbers. Reader requests will be promptly processed by computer and mailed to the manufacturer within three days.


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Now...rugged Dale Wirewounds with your choice of coatings!
Coating makes a difference in the performance of industrial power wirewounds. That's why it's easier to call Dale when you're not sure what's best for your application. We make both silicone (HL) and vitreous (VL) coated models. Before coating they're identical. HL models receive multi-layer coatings of a special silicone formulation. This low-temperature process has less effect on resistor windings—and we sell more HL resistors where customers are primarily concerned with maintenance of tolerance and low TC. Our vitreous enamel coating is baked on to provide maximum resistance to moisture and chemical action—and VL sales are highest where these conditions are a factor. Today many companies—like General Railway Signal—make good use of Dale's single-source capability for power resistors. You can, too.
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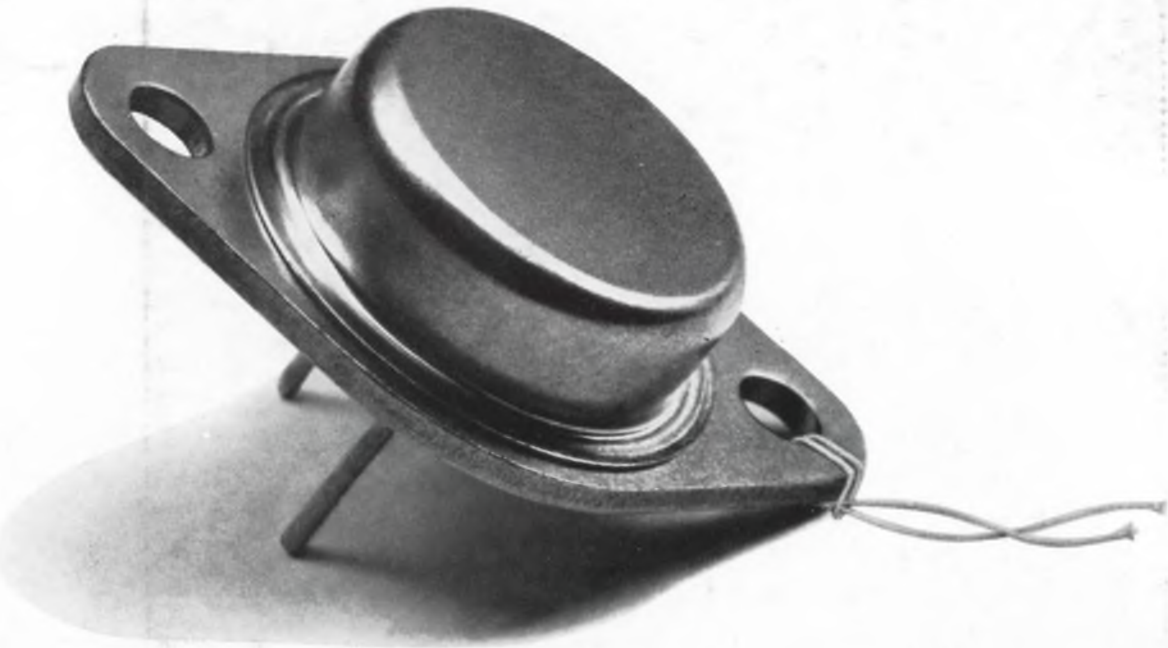

RCA's ESP (Exceptional Switching Performance) type 2N5805 and its companion 2N5804 are veritable "switch hitters" through an unusual combination of capabilities: *both transistor types have excellent current handling—at high voltage — in economic TO-3 packages.* For example, the 2N5805 can switch 375 volts and 5 amperes in less than 2 μs.

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 μs @ 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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