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 seven 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)

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

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

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

**HP 1917A Variable Transition Time Output**—varies pulse risetime and falltimes from 7 ns to 500 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 pseudorandom noise sequence generation capabilities. ($850)

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

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

HEWLETT PACKARD

SIGNAL SOURCES
The $1200 Bad-Apple Finder....

GR's New 1662 Resistance Limit Bridge!

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

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

Use the 1662 for manual sorting and get precise meter readings in one second or use the HIGH-GO-LOW lights for faster sorting limited only by the speed of the operator. Use automatic sorting equipment like the GR 1782 Analog Limit Comparator (from $550) to get maximum test rates of four components per second. The 1782 allows simultaneous multiple-tolerance-limit sorting. (Apples can be tested only with a core-memory device.)

For straight resistance measurements, 1662 has a basic bridge accuracy of 0.02%, a comparison accuracy of 100 ppm, and a total range of 1 ohm to 111,111,111 ohms. 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

ELECTRONIC DESIGN 4, February 15, 1970

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.

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

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

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

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Cover: Designed by Art Director Cliff Gardiner and photographed by Henry Ries
Universal Interconnect is the only system that can perform all interconnection missions. It includes connectors in all shapes and sizes, terminal modules and individual wires—even plug-in components such as relays, meters and switches.

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

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*ITT CANNON ELECTRIC PATENTS 3310093, 33156424

INFORMATION RETRIEVAL NUMBER 4
Yes, we know . . . we used to recommend Beldfoil Shielded Cable only for fixed applications. We were too modest. Extended testing proves Beldfoil, even after repeated flexing, provides more physical shield coverage than braided wire or spiral wrapped (served) shields. And greater shield effectiveness. Beldfoil is a layer of aluminum foil bonded to a tough polyester film (for insulation and added strength). A Belden invention. We apply it in different ways for different applications. We can even form a unique shield that’s like a continuous aluminum tube. This we call ISO-Shield™. When new (or in fixed applications) Beldfoil ISO-Shield is extremely effective in limiting crosstalk or interference . . . whether from outside sources or between shielded elements in the same cable. Under frequent flexing minor separations may occur in the foil. But special Beldfoil construction features prevent performance from becoming seriously affected. We do, however, recommend that you tell us if cable flexing is to be extreme. We have special designs available to meet severe flexing requirements. Beldfoil makes possible a small, lightweight cable that terminates easily and is modest in price. Your Belden distributor stocks or can quickly obtain just about any size or type you need . . . from single conductor audio and sound cable up to data cable having 27 individually shielded pairs (more pairs available on special order). Ask him for the latest "Belden Electronic Wire and Cable Catalog." Or for technical information, contact Belden Corporation, P. O. Box 5070-A, Chicago, Illinois 60680; phone (312) 378-1000.
Beldfoil® Shielded Cable
-shield effectiveness remains outstanding
"The Clevite electrostatic printer increases our printout capability anywhere from eight to two hundred times."

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

"We use the Clevite 4800 in three principal areas... text editing; intermixing text and pictures; circuit diagrams, plotting and perspective drawings. Currently, we're experimenting with applying it to our billing procedures and are exploring its use for high-speed label printing. It looks as if the printer is useful for just about any output. "Take text, for example. The 4800 is ideal because of the speed with which it provides copies. Change, delete, add, then program the computer accordingly. Almost instantly the electrostatic printer provides a clean copy of the edited material. "Our experience with core dump has been quite impressive. Here is an area where the printer's diagnostic ability really comes to play. Our computer stores some four million binary bits of information, and core dumping used to take around twenty minutes. With the Clevite Printer, we're now completing a core dump in just two minutes," Mr. Curry concludes.

MORE FACTS ON THE CLEVITE 4800
Clevite 4800 reproduces signals from any source of digital input or data transmission by telemetry, radio microwave, and/or land line. It produces accurate printouts of both alphanumerics and graphics almost as fast as the computer supplies them. A productivity rate of 412,000 characters per minute means fast-acting computers are no longer hampered by mechanical equipment, noisily hammering out a few hundred lines per minute. No other printer gets as much out of your computer as fast as Clevite 4800. And no other printer is so economical. The Clevite 4800 reduces capital investment, because conventional equipment costs more per unit. Also, there are few moving parts, reducing the need for constant maintenance and servicing. Clevite 4800. It's faster, more versatile, quieter, and more dependable than anything else you can buy. Drop us a line to find out how it fits into your computer room. Graphics Division, Gould Inc., 3631 Perkins Ave., Cleveland, Ohio 44114.

GOULD CLEVITE

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

INFORMATION RETRIEVAL NUMBER 6
TI's quiet revolution in Linear ICs
Here's your biggest choice for system interface design—10 sense amps, 2 memory drivers, 6 line circuits.

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

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

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If you're ready to whip interface problems the IC way, we'll send you our new brochure on our Computer System Interface Circuits. Circle 288 on the Reader Service Card or write Texas Instruments Incorporated, P.O. Box 5012, M.S. 308, Dallas, Texas 75222. That's where the quiet revolution is going on. Or call your authorized TI Distributor.
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We're new in L.E.D.'s. So our first of three new device announcements — the MLED600 red L.E.D. — offers you performance advantages unseen elsewhere.

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

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

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

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

Both should be seen to be appreciated.
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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

Mar. 31-Apr. 2
International Symposium on Submillimeter Waves (New York City) Sponsor: IEEE et al. J. Fox, Microwave Research Institute, Polytechnic Institute of Brooklyn, 333 Jay St., Brooklyn, N. Y. 11201
CIRCLE NO. 322

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

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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.

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

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

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

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>PACKAGE</th>
<th>TEMPERATURE RANGE</th>
<th>(1-24) PRICE</th>
<th>(25-99) PRICE</th>
<th>(100+) PRICE</th>
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<tbody>
<tr>
<td>U4L931551X</td>
<td>Flat</td>
<td>-55°C to +125°C</td>
<td>$22.00</td>
<td>$17.00</td>
<td>$14.65</td>
</tr>
<tr>
<td>U4L931559X</td>
<td>Flat</td>
<td>0°C to +125°C</td>
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<td>7.30</td>
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<td>16.00</td>
<td>13.30</td>
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<td>U6B931559X</td>
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<td>0°C to +75°C</td>
<td>10.00</td>
<td>8.00</td>
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<td>22.40</td>
<td>18.70</td>
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<td>14.00</td>
<td>11.20</td>
<td>9.35</td>
</tr>
<tr>
<td>U7B9317513</td>
<td>DIP</td>
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<td>25.40</td>
<td>20.30</td>
<td>17.00</td>
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<tr>
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<td>10.15</td>
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<td>10.50</td>
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<tr>
<td>U7B9327591</td>
<td>DIP</td>
<td>0°C to +75°C</td>
<td>11.90</td>
<td>9.55</td>
<td>8.00</td>
</tr>
</tbody>
</table>
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.

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A HAND-SIZE V-O-M
WITH 10 MEGOHM INPUT RESISTANCE

With a 10 megohm input resistance and a high-sensitivity (0.3 V DC full scale) meter, this handy little Triplett Model 310-FET can handle practically any in-circuit electrical measurement you may need.

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Never one to stand short when it comes to offering features and real value in its instruments, Triplett has even equipped the Model 310-FET with a rugged suspension-type meter to soak up the hard knocks and a polarity-reversing switch to simplify operation.

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.
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

<table>
<thead>
<tr>
<th>TYPE</th>
<th>PACKAGE</th>
<th>OUTPUT PHASES</th>
<th>INPUT COUPLING</th>
<th>INPUT LEVEL TRANSLATOR</th>
<th>MAX REP RATE - MHz</th>
<th>MAX OUTPUT SWING - V</th>
<th>IOUT - mA</th>
<th>PMAX - mW @25°C/70°C</th>
<th>POFF mW</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH0007</td>
<td>TO-5</td>
<td>1</td>
<td>dc</td>
<td>Yes</td>
<td>5</td>
<td>±500</td>
<td>800/800</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>NH0009</td>
<td>TO-8</td>
<td>2</td>
<td>dc or Cap</td>
<td>Yes</td>
<td>3</td>
<td>±500</td>
<td>1500/1000</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>NH0012</td>
<td>TO-8</td>
<td>1</td>
<td>dc</td>
<td>No</td>
<td>10</td>
<td>±1000</td>
<td>1500/1000</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>NH0013</td>
<td>TO-8</td>
<td>2</td>
<td>Cap</td>
<td>No</td>
<td>5</td>
<td>±500</td>
<td>1500/1000</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

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FIGURE 3. Capacitively Coupled Dual Driver

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

\[ \text{P.W.} \propto C_{IN} \times V_{\text{drive}} \times I_{\text{drive}} \]

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:

- \( f = 2 \text{ MHz} \)
- \( t_r = 50 \text{ ns} \)
- \( \text{P.W.} = 200 \text{ ns} \)
- \( V_{CC} = +5V \)
- \( V_2 = -16V \)
- \( V_3 = 0V \)
- \( T_A = 70^\circ C \)

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

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

\[ P_{\text{max}} = P_{\text{dc}} + P_{\text{ac}} \]

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

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

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

\[ P_{-1''} = (21 \times 20 + 16^2/1.1) \times 0.4 \times 10^{-3} \approx 261 \text{ mW} \]

This allows \( P_{\text{ac}} \) to be 239 mW in the NH0009.

In the NH0013, the input voltage component is only the TTL "1" level of about 4.5V, so its \( P_{-1''} \) is only 125 mW and \( P_{\text{ac}} \) can be 375 mW. In all drivers,

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

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

\[ C_{L_{(\text{max})}} = I \times t_r / V \]

where \( I \) is the output current limit and \( V \) the output voltage swing. These drivers will withstand transient currents of 600 mA, so \( C_{L_{(\text{max})}} \) would be 1,875 pF at \( V_2 = -16V \), \( V_3 = 0V \) and \( t_r = 50 \text{ ns} \), 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 \( C_{L_{(\text{max})}} \). But don't exceed it (a precaution that has sometimes been overlooked on the data sheets of rival devices).
Auto Scale-Factor Readout

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Note: 7904 DC-90 MHz Four Plug-In Oscilloscope with Auto Scale-Factor Readout $2000

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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.
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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
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INFORMATION RETRIEVAL NUMBER 14

ELECTRONIC DESIGN 4, February 15, 1970
The underlying theme in the $200.8-billion U. S. budget request for fiscal year 1971 is the Administration's declaration of war on inflation, with austerity its chief weapon.

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

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

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

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

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

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

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

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

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

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

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

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

Dr. Paine firmly rejects a statement by a top White House official alluding to elimination of additional NASA centers. In a budget press briefing, Dr. Lee Dubridge, Presidential Scientific Adviser, indicated that more NASA research centers might be axed. But Dr. Paine says he has a Presidential obligation 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 micro-programmable, dedicated computer with a read-only memory that has 1024 instructions. The larger CIP/2100 has three read-only memories plus a 4K core memory that is expandable. The company is offering the two models to the OEM market, and it has not announced any plans for using the machines in conjunction with its machine-tool product line.

Bell to test waveguide communications system

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

A spokesman for the Long Lines Div. of the Bell System says construction of the waveguide system will begin in 1975, with commercial service slated for the late 1970s.

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

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

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

MIT Alumni Center attacks urban problems

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

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

Belgian manufacturers set up New York office

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

Léon Félix, Fabrimental'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.

Computers can spot offshore oil leaks

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

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

"The system is fail-safe," says Montgomery. "Any failure noted in a valve or line pressure or oil flow rate will automatically shut the whole system off. No one need be around. The computer can be miles away. The computer's console has a built-in diagnostic aid that shows 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.

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.

INFORMATION RETRIEVAL NUMBER 15
Not everyone needs a multimeter that can measure the resistance of a piece of solder.

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

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But it's possible that the 5500 is more or less multimeter than you need. If that's the case, don't buy one. Buy one of our 32 others instead. We make them for labs and production lines, for use on the bench and in systems, militarized models, 4- and 5-digit, from $1150 to over $8000. (Actually, with our unique plug in modules, you can create some 300 different configurations. For every imaginable application. To fit every budget).

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AN INSIDE LOOK AT HOSPITAL ELECTRONICS

Where EE and MD

John N. Kessler, News Editor

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

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

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

Machines sustain life

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

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

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

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

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

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

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

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

Major expansion likely

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

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

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

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

Electronics in ICU

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

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

- Hypothermia units. These have taken the place of the hot water bottle and the ice pack. They raise or lower body temperature. Basically the unit consists of a cooling compressor, heating elements and pumps to circulate a heat-transfer liquid (20% alcohol in distilled water) from the unit to a vinyl pad. Pad temperature can be reduced from 105° to 40°F in about five minutes, depending on the size of the unit. Settings are usually accurate to ±1/2 degree F. A thermistor probe for esophageal or rectal use provides a constant temperature readout.

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

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

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

In Overlook’s laboratory, a serum analyzer made by Technicon Corp.—the SMA 12/60—typifies the interdependence of chemistry and electronics in modern medicine. The Tarrytown, N.Y., company has programmed its Sequential Multiple Analyzer to analyze 12 constituents of blood serum. The chart on which these measure-
The operating rooms at Overlook all have anti-spark outlets, intercoms, cardiac monitors and fiber optic scopes. Electronics can aid in designing new types of scalpels, drills, cauterizers.

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

ment 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 breathes in. He creates a vacuum in his chest—lower pressure in the chest
Blood serum analyzer can measure the 12 constituents of blood in one minute. A new, time-shared computer program will route such reports from Overlook's laboratory to any nursing station in 10 seconds.

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 CO₂ 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 number is nine.

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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 CO₂ lasers. The output power of the transmitter laser will be 547 mW at a transmitter wavelength of 10.6 microns (P-20 line). A 5-cm GaAs piezoelectric crystal in the laser cavity will be used to modulate the laser. The modulation will be fm, with a signal bandwidth of from 30 Hz to 5 MHz.

If the system is successful, it will make possible the first broad-band, point-to-point laser communication in space. The target date for a start on experimental operation is early 1972.

NASA has given Aerojet-General a $5-million contract for the developmental work, and the company has awarded a subcontract to RCA, Ltd., Montreal, for the CO₂ laser subsystem.

"CO₂ 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 CO₂ 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.

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. • •

Laser communications package will be on board the Applications Technology Satellite F scheduled for launch in early 1972.
New radar will solve mysteries of storms

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

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

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

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

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

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

World's first.

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Pee Cee Ductor... another first from Nytronics.
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, "we can get the finished product down to a price that is competitive with cores."

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

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

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

Intersil's method cuts package and assembly costs and eliminates duplication of effort by systems and semiconductor companies.

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

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

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

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

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

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

For example, he points out, Intersil's new 256 x 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.
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)
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.

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 Qi, Q2, Q3 is considered, the emitter of Qi, which has a logic “0” presented to it, will allow current to flow through it to ground. This insures, through the VBE drops of Qi and Q2, that Q3 is turned off. Therefore, no current will flow in any of the 8 emitters of Q3. Thus, transistors Qi through Q11 will be turned off, causing a logic “1” condition to appear at the outputs. In the “selected” state all 5 emitters of Qi 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 Q3 to turn on, allowing current to flow in all 8 emitters. In turn, transistors Qi through Q11 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.
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.

### Table 1. General Reliability Specification

<table>
<thead>
<tr>
<th>I. Production Screens</th>
<th>Reliability Level</th>
<th>Standard Sample</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-seal Visual Inspection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option A</td>
<td>100% (91-928)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stabilization Bake</td>
<td>48 hours (91-176)</td>
<td>24 hours (91-176)</td>
<td>16 hours (91-176)</td>
</tr>
<tr>
<td>Temperature Cycle</td>
<td>20 Cycles (91-205)</td>
<td>10 Cycles (91-205)</td>
<td>5 Cycles (91-144)</td>
</tr>
<tr>
<td>Constant Acceleration</td>
<td>30K 6’s; Y1 and Y2 (91-194)</td>
<td>30K 6’s; Y1 only (91-194)</td>
<td>None</td>
</tr>
<tr>
<td>Electrical Screen</td>
<td>DC, (Go/No-go at temp. extremes)</td>
<td>DC, (Go/No-go at temp. extremes)</td>
<td>Specified DC, &amp; AC Go/No-go tests</td>
</tr>
<tr>
<td>Burn-in</td>
<td>RL to simulate 15 (RL=270 ohms) 168 Hrs., 125°C (91-929)</td>
<td>RL to simulate 7 (RL=470 ohms) 96 Hrs., 125°C (91-929)</td>
<td>None</td>
</tr>
<tr>
<td>Electrical Screen</td>
<td>DC, Go/No-go at temp. extremes; AC at 25°C</td>
<td>DC, Go/No-go at temp. extremes; AC at 25°C</td>
<td>None</td>
</tr>
<tr>
<td>Fine Leak Screen</td>
<td>5 x 10^{-8} cc/sec. (91-163)</td>
<td>5 x 10^{-8} cc/sec. (91-163)</td>
<td>None</td>
</tr>
<tr>
<td>Gross Leak Screen</td>
<td>(91-162)</td>
<td>(91-162)</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2. Product Acceptance Tests

<table>
<thead>
<tr>
<th>Inspection</th>
<th>Acceptance Criteria</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Verification</td>
<td>Reliability Level</td>
<td>A</td>
</tr>
<tr>
<td>DC at 25°C</td>
<td></td>
<td>5 / 2</td>
</tr>
<tr>
<td>AC at 25°C</td>
<td></td>
<td>5 / 2</td>
</tr>
<tr>
<td>DC at High Temperature</td>
<td></td>
<td>10 / 3</td>
</tr>
<tr>
<td>DC at Low Temperature</td>
<td></td>
<td>10 / 3</td>
</tr>
<tr>
<td>Mechanical Verification</td>
<td></td>
<td>5 / 2</td>
</tr>
<tr>
<td>(91-908)</td>
<td>(91-908)</td>
<td>(91-908)</td>
</tr>
<tr>
<td>Fine &amp; Gross Leak Verification</td>
<td></td>
<td>10 / 1</td>
</tr>
<tr>
<td>(91-911)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Test</th>
<th>Acceptance Criteria per Subgroup</th>
<th>Reliability Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-200 Group B</td>
<td></td>
<td>10 / 3</td>
</tr>
<tr>
<td>88-200 Group C</td>
<td></td>
<td>10 / 3</td>
</tr>
</tbody>
</table>

### Table 4. Traceability

<table>
<thead>
<tr>
<th>Reliability Level</th>
<th>A</th>
<th>B</th>
<th>Std.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot travel card from pre-seal visual inspec.</td>
<td></td>
<td></td>
<td>Date code</td>
</tr>
<tr>
<td>Lot travel card from pre-seal visual inspec.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*LTPD = Lot tolerance percent defective
a (max) = Maximum acceptance number
Interface family solves transmission-line noise problems.

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

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

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

The two receivers feature diode decoupling of the inputs.

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.

SS-342 series quad high-threshold logic 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 $+11\,\text{V}$ referenced to receiver ground.

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

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

Although the input threshold of the logic-level drivers is approximately the same as SUHL I, the output logic "1" is about 1 V higher than TTL logic. This is achieved by two variations from conventional TTL circuitry. First, the base of the upper cascode is returned to $+12\,\text{V}$ 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 $\pm 1.5\,\text{V}$ 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 $-5.25\,\text{V}$, referenced to receiver ground. The differential receiver is normally driven by two complementing logic signals. These could be derived from the Q, 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.

---

**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.
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.

HOT LINE INQUIRY SERVICE

Need information in a hurry? Use Sylvania's "Hot Line" inquiry service. It's easy and it's free. Just circle the reader service number(s) you're most interested in. Then fill in your name, title, company and address. We'll do the rest and see that you get further information by return mail.

You can also get information by using the publication's inquiry card elsewhere in this issue. However, using the card shown here will simplify handling and save time.
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
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

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

You get the most advanced MSI and IC construction plus a thin film attenuator... which, by the way, eliminates 75% of the normal calibration requirements. Single plane Digivac readout tubes result in the lowest power consumption of any digital multimeter, and make full-day battery operation possible. The same amplifier used in the most costly instruments provides an input impedance ten times greater than any meter in its class.

The basic instrument gives you 5 ranges of DC voltage measurement with 5th digit overrange, autoranging in all functions, autopolarity, and pushbutton selection. Add remote control, AC, resistance, print output and the 8-hour battery pack options, and you have full remote programming capability anywhere. And it's computer compatible. The 6453... just 8 pounds and 3½" x 8" x 12", sells for only $1,125. A full multimeter is less than $1,600. Call us for a demonstration. Phone (714) 276-3200 or write Cimron, Dept. D-129, 1152 Morena Blvd., San Diego, Cal. 92110.
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.

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(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.

**Portables 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 cradledlike 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.

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 x 9 x 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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And we’ve got something to offer when economy and value are the prime considerations. We’ve developed the Glass-K capacitor to give you the volumetric efficiency and economy of monolithic ceramic capacitors, but with the much improved stability and reliability that only a glass dielectric can add. In resistors, our tin oxide resistors already offer long term economy over metal film, precision wire wound and metal glaze resistors.

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

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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.

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-
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tion to ground via the satellite.

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

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

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

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 measurement from the aircraft with the help of the Navy's Omega vlf (10-14 kHz) navigation transmission, will establish the aircraft position at the point it intersects with the circular line of position.

**Spin problem under study**

NASA scientists are now working out an answer to the spin problem encountered with 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 sidetone measurement techniques, originally developed for the Goddard range and range rate tracking system, the center says. To determine range, propagation times or phase delays in a multi-tone signal will be measured and compared as they traverse both radio paths from ground-to-satellite-to-aircraft.

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

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

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

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

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

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

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

A less-expensive Main Battle Tank is the new goal

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

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

Domestic-satellite recommendation pleases carriers

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

This about sums up the response here by industry to the recent White House recommendation that ownership and operation of U.S. domestic communications satellites be opened to competition. The nod had been expected to go to Comsat.
The Executive recommendation is contained in a report to the Federal Communications Commission by a Presidential committee headed by Dr. Clay Whitehead. The FCC chairman, Dean Burch, has promised that the recommendation will receive the “highest priority.” An FCC decision is expected by the end of this month or early March.

**Prospects rosy for international weather satellites**

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

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

**Federal law enforcement assistance climbs**

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

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

**Electronic clothing tags aim to reduce shoplifting**

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

The anti-shoplifting system uses a transmitter-receiver to radiate a signal through a cluster of loop antennas around an exitway. This field generates a very low-level rf response from the passive Knogo printed-circuit tags attached to apparel, according to Robert Burch, president of the Washington franchise. The printed circuit is contained within a patented plastic wafer, which includes an unusual connecting device that penetrates and locks onto fabric. “It can be removed, without destroying the fabric, only by a special tool,” Burch asserts.
No one offered thick film microcircuitry as a serious answer to reliability and miniaturization requirements 25 years ago. But Centralab got right into the thick of it. And it's difficult to catch someone with a 25 year head start. In numbers alone our lead is commanding. We've produced more than 500,000,000 units, with some 5,000 custom designs. No one can approach this production record. In material selection our experience again gives us a sharp edge. Ceramics, metallizing compounds, resistor inks, glaze and sealing materials have all been specially developed by Centralab's Material Sciences Group to our specifications for durability in processing and application. The Semiconductor Division is a ready source for a wide variety of chips. We even manufacture our own ceramic substrates through an exclusive thin sheet process that is superior to any other method in the industry. And our computer-aided analysis service provides prompt, practical answers to circuit design problems. We don't mean that thick film chip hybrids are the answer to every problem in microcircuitry. But you'll be surprised at how many solutions these low-cost custom units provide. For more information on how you can get into the thick of it with Centralab, turn the page.
Centralab pioneered thick film microcircuitry in 1945 when we developed a miniature oscillator-amplifier circuit for a mortar shell proximity fuse. This first-of-a-kind unit, admittedly crude by today's standards, consolidated carbon composition resistors, silver-ceramic capacitors and silver circuit paths screened onto a ceramic substrate, which met tough shock requirements. The completely sealed unit was about 3 inches in diameter and 4 inches long.

This assembly, which became known as a Packaged Electronic Circuit (PEC), opened the door to an entirely new technology. By 1959, we had produced our 100,000,000th unit. A plaque commemorating this historic production is on permanent display at the Smithsonian Institute, a milestone in the electronic industry.

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, Centralab's new thick wiring and capacitors to provide a film chip hybrid reliable circuit module. These are smaller, harder working, more sophisticated devices that are custom designed for specific applications.

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Our computer-aided design and circuit analysis services can provide optimum design to minimize failures, enhance performance, and reduce cost. Our comprehensive thick film background gives us another head start in being able to program our computer so that improved design is assured at the most reasonable cost.

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.

One more thing. With all our capabilities, we realize that speed is often the most important criteria for judging a thick film microcircuit manufacturer. That's why we are geared to provide production samples to your specifications in as little as three weeks; production quantities eight weeks after prototype approval.

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South San Francisco, Calif. • International: c/o American Lava Corporation, Chattanooga, Tenn. 37405, U.S.A., TELEX 558432.
Probe lights up to check logic levels in a flash

Make contact with the new Kurz-Kasch Logic Probe ... With the speed of light, you can visually trace pulses or test the logic levels of DTL, TTL and related circuits. Probe flashes "true" and "zero" logic readings by illuminating signal lamps in the end of the instrument. Like having a lab of test equipment at your fingertips. Indicates "infinity" too, identifying improper logic or a disconnection. Displays symmetrical wave forms by illuminating both lamps.

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---

SIDELIGHTS

From editor to hospital attendant

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

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

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

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

Jack’s article, reporting on his week’s observations, begins on p. 24.
Here's the latest Allen-Bradley resistor—the Type BB ¾ 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, ¾ watt, ¼ watt, and ¼ 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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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 megarhms, except Type BB which is from 10 ohms to 22 megarhms. Shown actual size.
Looking for a quick solution to a particularly knotty connector problem? Look to Winchester Electronics first. We've got a reputation for producing answers to problems before they exist. So there's always a chance yours might not be a problem after all. For example, we produced our MRE series of miniature rectangular connectors before any specs existed. They've since become the standard for mil spec MIL-C-008384. Our MRAC crimp-contact connectors set the standard for MIL-C-22857.

So you see, it's a good idea to contact Winchester Electronics first before you call a problem a problem. With our pioneering spirit, we may have solved your problem years ago. To find out, write or call Winchester Electronics, Main Street and Hillside Avenue, Oakville, Conn. 06779.
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. 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—that'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.

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.
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.
### Table: Specifications of DTS Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Ic Cont.</th>
<th>Ic Pulsed</th>
<th>Vces @ 5mA</th>
<th>Voc @ 25mA</th>
<th>Voc(sus) @ 250mA</th>
<th>hfe @ 5A</th>
<th>hfe @ 20A (Min.)</th>
<th>Voc(sat) @ 10A (Max.)</th>
<th>f1 (Min.)</th>
<th>P1 (Max.)</th>
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<tr>
<td>DTS-103</td>
<td>15</td>
<td>20</td>
<td>80</td>
<td>60</td>
<td>60</td>
<td>20-55</td>
<td>5</td>
<td>1.8</td>
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<td>125</td>
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<tr>
<td>DTS-104</td>
<td>15</td>
<td>20</td>
<td>80</td>
<td>60</td>
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<td>50-120</td>
<td>10</td>
<td>1.5</td>
<td>4</td>
<td>125</td>
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<td>DTS-105</td>
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<td>100</td>
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<td>75</td>
<td>20-55</td>
<td>5</td>
<td>1.8</td>
<td>4</td>
<td>125</td>
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<tr>
<td>DTS-106</td>
<td>15</td>
<td>20</td>
<td>110</td>
<td>90</td>
<td>80</td>
<td>20-55</td>
<td>5</td>
<td>1.8</td>
<td>4</td>
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<tr>
<td>DTS-107</td>
<td>15</td>
<td>20</td>
<td>120</td>
<td>100</td>
<td>85</td>
<td>20-55</td>
<td>5</td>
<td>1.8</td>
<td>4</td>
<td>125</td>
</tr>
</tbody>
</table>

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- **Union, New Jersey** • 07083
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- **Santa Monica, Calif.** • 90401
  - 726 Santa Monica Blvd. (213) 870-8807
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YES  NO  4  Do you smoke cigarettes?
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- 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.

**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.)

**High Voltage Divider—10 KV**
- 10,000:1 fixed division ratio.
- 10 KVDC maximum voltage in.
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- 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.
The more complicated it gets...
The more engineers control your market

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

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Electronic Design concentrates its circulation exclusively among electronic engineers and engineering managers. Of the three leading publications, Electronic Design provides by far the greatest number of prime specifiers in the EOEM! Primary circulation now exceeds 72,515, December, ’69 (up more than 2,000 from June). From an estimated total engineering universe of 275,000 Electronic Design’s total readership projects to more than 261,000. Right away, Electronic Design brings you the biggest slice of the market!

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Electronic Design

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Electronic Design 4, February 15, 1970
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.

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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:

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>Outstanding Features</th>
<th>5[V_{GG1} - V_{GG2}] ((\mu V/°C))</th>
<th>5[V_{GG1} - V_{GG2}] ((mV))</th>
<th>I_{D} ((pA))</th>
<th>g_{s} ((\mu mho))</th>
<th>e_{n} ((nV/\sqrt{Hz}))</th>
<th>[R_{BDS1} - R_{BDS2}] ((\mu mho))</th>
<th>Conditions</th>
<th>Pkgd. Series</th>
<th>Chip Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENERAL PURPOSE</td>
<td>Meets most OP AMP requirements where low I_{D} and low noise are important.</td>
<td>5-40</td>
<td>5-15</td>
<td>15</td>
<td>700</td>
<td>20 (1 kHz)</td>
<td>1.0</td>
<td>I_{D} = 200 (\mu A)  (V_{DG} = 20 V)</td>
<td>2N5196-2N5199</td>
<td>CDNP01*</td>
</tr>
<tr>
<td>ELECTRO-METERS</td>
<td>Ultra-Low I_{D}.</td>
<td>5-40</td>
<td>5-15</td>
<td>1.0</td>
<td>50</td>
<td>200 (100 Hz)</td>
<td>0.2</td>
<td>I_{D} = 30 (\mu A) (V_{DG} = 10 V)</td>
<td>U248A-U251A</td>
<td>CDNT01*</td>
</tr>
<tr>
<td>LOW-NOISE, HIGH CMRR</td>
<td>Extremely low noise, high common mode rejection ratio.</td>
<td>5-40</td>
<td>5-15</td>
<td>100</td>
<td>500</td>
<td>15 (10 Hz)</td>
<td>0.1</td>
<td>I_{D} = 200 (\mu A) (V_{DG} = 20 V)</td>
<td>2N5520-2N5524</td>
<td>CDNS01*</td>
</tr>
<tr>
<td>WIDEBAND DIFFERENTIAL AMPLIFIERS</td>
<td>High (g_{s}), and low noise to very high frequencies. High (g_{s}/C_{1}) ratio.</td>
<td>20-40</td>
<td>10-15</td>
<td>100</td>
<td>5,000</td>
<td>20 (10 kHz)</td>
<td>20</td>
<td>I_{D} = 5 mA (V_{DG} = 10 V)</td>
<td>U252-U253</td>
<td>CDNZ01*</td>
</tr>
<tr>
<td>BALANCED MIXERS</td>
<td></td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>5,000</td>
<td>20 (10 kHz)</td>
<td>20</td>
<td>I_{D} = 5 mA (V_{DG} = 12 V)</td>
<td>U257</td>
<td>CDNZ01*</td>
</tr>
</tbody>
</table>

* 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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Siliconix incorporated
2201 Laurelwood Road • Santa Clara, Calif. 95054
Phone (408) 246-8000 Ext.201 • TWX: 910-338-0227
Need a low-voltage dc converter?
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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 \( E_r \) 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 \( (V_s - V_{ce\text{ (sat)})} \). With \( E_r \) equal to \( V_s \), and \( E_r \) equal to 0 V, the voltage at point A reaches \( (2V_s - 2V_{ce\text{ (sat)})} \), and \( C_2 \) charges to \( (2V - 2V_{ce\text{ (sat)})} \), assuming equal saturation voltages. Actual circuits, built with transistors having saturation voltages of 10 mV, have achieved output voltages of 2.68 V using a supply voltage of 1.35 V.

The clock is the key

The key to the successful operation of the circuit of Fig. 1 is generating the clock voltages \( E_s \) and \( E_r \). 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 \( E_s \), whereas \( Q_2 \) and \( Q_4 \) saturate for large positive values of \( E_s \). Since \( E_s \) and \( E_r \) are 180° out of phase, this means that for

N. Poirier, Research Associate, and B. L. Cochun, Associate Professor, Northeastern University, Boston, Mass.
3. A complete doubler for a 1.35-V source (a) achieves a load voltage of 2.52 V at 1.25 mA and an efficiency of 55.7%. Efficiency falls to 20.8% for a load current of 0.26 mA (b), and open-circuit output voltage rises to 2.62 V.

One-half of a cycle of the square wave both Q2 and Q1 will be in saturation with Q1 and Q2 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.

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.

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.
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.

A voltage tripler configuration with dual-polarity output uses the same circuit techniques. It supplies a nominal \(\pm3.6\) V from a 1.35 V source and is ideally suited to hybrid construction.

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

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

A dual-polarity tripler circuit is shown in Fig. 6. The block labeled CLOCK is the clock circuit of Fig. 2. \(Q_1\), \(Q_2\), and \(Q_3\) make up the positive output tripler circuit which generates an output voltage of 3.6 V. Assuming negligible values for \(V_{ce(sat)}\), \(C_1\) is charged to 3.6 V through \(Q_1\) and \(Q_2\), since with \(E_s\) equal to 0, \(Q_1\) will bias \(Q_2\) into saturation. With \(E_s > 0\) and positive, \(Q_2\), \(Q_3\), and \(Q_4\) are open and \(Q_4\) is in saturation. Transistor \(Q_5\), in saturation, grounds the positively charged side of \(C_5\), which effectively shunts the collector of \(Q_5\) and the base of \(Q_4\), 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

Acknowledgment
This work was sponsored by NASA-ERC under NASA Grant NGL 22-011-024.
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Decipher the Gray code. Convert it into binary or decimal equivalents or use it directly in arithmetic computation.

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

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

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

Gray code speeds counting

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

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

The relationship between binary and Gray is defined as follows:

\[ G_i = B_{i+1} \oplus B_i \]

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 is defined as follows:

\[ B_i = B_{i+1} \oplus G_i \]

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 circuits shown in Fig. 2 and Fig. 3 are also quite similar. The only difference between the two cir-
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.

5. 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 $2^{i+1}-1$ 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. One method of correcting this is to use a Gray-code counter.

ELECTRONIC DESIGN 4, February 15, 1970
This can be shown for a 4-bit counter, using J-K flip-flops and NAND gates.

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

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

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

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

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

### Simplifications are possible

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

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

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

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

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 ternary 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 Johnson counter 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.
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 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° bit is always present, as previously described. This 2° 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°), it is only necessary to add n zeros to the modified Gray number (including the 2° bit). For example, Gray number 13 is 10111 (including the 2° bit); to multiply Gray 13 by 2° 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).

Gray code can be considered to be a form of trinary. This truth table illustrates the relationship.
The Johnson partition counter can decode Gray considered as trinary. The truth table is (a) and the circuit is (b).

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

The above operation is equivalent to:
1011100 - 101110 + 101110 - 101111 or
13(11) - 13(10) + 13(11) - 13(10) - 13(6 - 4 + 2 - 1)

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?

References

New— from the industry leader
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For more information on RCA Hybrid Power Circuits, see your local RCA Representative. For technical data, write RCA Electronic Components, Commercial Engineering, Section I-G2/UC1, Harrison, N. J. 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

INFORMATION RETRIEVAL NUMBER 40
For Sales/EE interface: Sell – don’t tell.
When designers and salesmen battle each other, they stand to lose not only the war but the customer as well.

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

Salesman: This is Collins. Why didn’t you return my call?
Engineer: Sorry, we got busy.

Salesman: I’m busy, too, trying to sell your damned product design to a hard-nosed customer!
Engineer: Okay, okay! What do you need this time?
Salesman: I still need what I asked you for two months ago—that product proposal.
Engineer: (Grimaces.) We haven’t started on it yet.
Salesman: What! My customer is expecting your write-up on the special self-calibration feature—and you haven’t even finished the proposal?
Engineer: You’ll get it as soon as you give us the details on the application you promised us seven weeks ago.
Salesman: I got busy, too. Why didn’t you remind me?

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

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

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

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

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

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

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

Getting to know your counterpart

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

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

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

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

Frank J. Burge, Marketing Consultant, Ness Consultants Division, Ness Industries, Inc.
commit • examine • summarize • listen
relevant questions. For he must convince the factory that his needs are important. If he treats every problem as a crisis, his inside contact will soon learn to ignore him.

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

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

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

**Stringing the guidelines**

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

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

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

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

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

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

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

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

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

**Sell it—don’t tell it!**

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

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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.
Improved sawtooth generator
has grounded reference point

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

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

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

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

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

where $V_c(s) = \frac{R_4'}{R_1' R_4' CS + R_1' + R_4'} E_o(s)$

$R_1' = R_1 + a R_5$, $R_4' = R_4 + (1-a) R_4$

Then: $E_o(s) = \frac{-R_1' R_2 R_4' E C S - R_2 E R_1' - R_2 R_4' E}{S(S + R_1' R_4 - R_2 R_4') R_1' R_2 R_4' C} = \frac{R_1' R_2 R_4' C}{R_1' R_4'}$.

If $R_1'R_3 - R_2 R_4' = 0$ or $R_1'/R_4' = R_2/R_3$

$$E_o(s) = -\frac{R_2}{R_3} E - \frac{R_2 (R_1' + R_4') E}{R_1' R_2 R_4' C S^2}$$

$$E_o(t) = -\frac{R_2}{R_3} E - \frac{R_2 (R_1' + R_4') (E) t}{R_1' R_2 R_4' C}, \quad 0 < t < T$$

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.
Krohn-Hite pioneered the development of reliable, variable electronic filters. These filters can offer a variety of functions such as low pass, band pass, high pass and band reject in a single instrument. They also provide complete flexibility of adjustment for both high and low cutoff frequencies over a frequency range of six decades. Since both cutoff frequencies can be independently varied over wide limits, the center of the pass band or rejection band can also be placed at any desired frequency.

Since Krohn-Hite filters are active, they provide an overall gain of unity (no insertion loss). They offer very high input impedance, require no appreciable signal power and are not sensitive to the value of source impedance. Their low output impedance makes the frequency response independent of the load impedance. Lowering the load impedance merely reduces the maximum output voltage obtainable, due to maximum current limitation of the output stage.

Every Krohn-Hite filter provides a choice of Butterworth or Low Q (transient free) transfer characteristic. These filters represent the optimum practical approach to ideal filter characteristics, combined with versatility to give unsurpassed performance.

Yes, Krohn-Hite, innovators in filter design for over twenty years, is making waves again!

The table below lists all of the important features of the complete Krohn-Hite variable electronic filter line.

For complete details, write: The Wavemakers:
Krohn-Hite Corporation, 580 Massachusetts Avenue, Cambridge, Mass. 02139 U.S.A.
IDEAS FOR DESIGN

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, C1 and Rct comprise a differentiating circuit that shapes the triggering pulses. In the absence of triggering pulses Q1 is OFF and Q2 is saturated. When a positive pulse of sufficiently large amplitude is applied to the base of Q1, the circuit goes into a quasi-stable state in which Q1 is active and Q2 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 Q1 OFF.

When Rct is returned to ground in the conventional manner, the average level of Ve is zero volts. The peak value of the triggering pulse appearing at the base of Q1 is:

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

where

\[ V_t = \frac{R_d}{R_d + R_t} V_s \]
\[ R_t = R_b R_d / (R_b + R_b) \]
\[ V_d = \text{forward voltage drop of the diode} \]

The triggering circuit may be improved by returning Rct to V as shown. Now the average level of Ve is V. The peak value of the triggering pulse appearing at the base of Q1 is now:

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

Note that:

\[ V_{p2} = V_{p1} + V \frac{R_b}{R_b + R_t} \]

This assumes that C1 is sufficiently large so that the attenuating effect of C2 (stray capacitance) is negligible.

The modified circuit provides a larger triggering pulse at the base of Q1, with no change in the total number or value of components. This results in more reliable triggering by providing a margin of safety against variations in either the

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ELECTRONIC DESIGN 4, February 15, 1970
Solid state displays

The MAN 1 is a seven-segment light-emitting all-semiconductor alpha-numeric readout.

Put the attention-demanding red light from electrically excited GaAsP to work in your digital displays for industry, computer peripherals, or avionic/marine instrumentation. Our MAN 1 is shock-resistant and long-lived. Offers styling advantages because it's flat, parallax-free and visible within 150°. Reads out all numbers plus A, C, E, F, H, J, O, P and U. Available now. Any quantity.

Brightness: 200 ft-lamberts @ I = 20 ma, 3.4V, per segment
Compatibility: directly interfaces with off-the-shelf IC decoder/drivers
Price: 1-9, $48; 1,000 or more, $25

12 mW @ 1A IR emitters

New high power low cost 9000 A GaAsLITEs give you extra mW for your $. Design these powerful infrared sources into your next card or tape readers, intrusion alarms, or calibration units. Anything that uses silicon detectors wants our ME 2 and ME 5 GaAs infrared emitters. They give you a 2500-mil emitting area with either lambertian (ME 2) or collimated (ME 5) radiation patterns. Guaranteed minimum output: 10 milliwatts at 1 amp. Less expensive ME 2A and 5A versions radiate 7.5 mW.

Peak forward current: (1µs pulse width, 300 pps) 25 amps
Forward voltage: 1.3 V typ (I = 1.0 A)
Rise time: 10 nanoseconds
Prices: ME 2, 5: 1-9, $30; 1,000, $12.50
ME 2A, 5A: 1-9, $14.75; 1,000, $8.00

The superfast detector

Our 500-picosecond silicon PIN photodiodes, MD 1 and MD 2, complement our light-emitting diodes. High speed optical switching has all kinds of sexy uses today: Laser detecting, for instance, and optical encoding. Even simple burglar alarms can use it. Their half-a-nanosecond response cycle makes them perfect mates for Monsanto GaAsLITEs. And they work with other sources, too. Packaged in standard transistor cans, they're easy to handle and mount. Available with either flat lens or built-in optics.

Rise time: .5 nanoseconds (V = 20V; R = 50Ω)
Breakdown voltage: 50V (I = 10mA)
Sensitivity: MD 1 1.5 pA/mW/cm² (min) (.9 microns,
V = 20 volts)

MD 2 3.0 pA/mW cm² (min) (.9 microns,
V = 20 volts)

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

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750 ft-lamberts @ 20ma; thousands ready to be shipped from your Monsanto distributor at $1.50 each. Finally, a price that lets you justify GaAsLITEs for high volume applications. MV 50s can replace miniature and sub-miniature lamps down to the T3/4 size. Their solid-state reliability makes them ideal for indicator lights in computer systems, data processing equipment, communications systems, and as diagnostic lights on pc boards. And just think what you could do with them in large arrays and in optical logic systems.

Size: 0.10" diameter
Output: 750 ft-lamberts (6500 A) @ 1.6V, 20 ma
Switching time: 1 nanosecond
Price: 1-9, $2.30; 1,000, $1.50

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

The multivibrator shown can be reliably triggered with values of \( V \), 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

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**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

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**Use an audible alarm to indicate a blown fuse**

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

An audible alarm wired across all system fuses, as shown in the figure, will be activated whenever a fuse blows. The alarm can be one of the small panel-mounting piezoelectric units now available through electronic distributors, or an inexpensive doorbell buzzer. Diodes are required for isolation when more than one fuse is being monitored, but they also permit the use of alarms.
silicon semiconductor chips made specifically for use in hybrid microcircuits...available from Centralab Semiconductor...designed and fabricated to be compatible with all thick and thin film hybrids...to bond to all types of substrates without problems. We're the chip house. Our hybrid applications engineering group is available to help you with tough problems. Their services are free. And at nominal cost we can supply you with a zener chip sampling kit made for designers' use.

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silicon chips in zeners, temperature-compensated zeners, scr's, rectifiers, core drivers, general purpose diodes and tunnel diodes.
that require dc for proper operation.

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

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

VOTE FOR 314

VOTE! Go through all Idea-for-Design entries, select the best, and circle the appropriate number on the Reader-Service-Card.

SEND US YOUR IDEAS FOR DESIGN. You may win a grand total of $1050 (cash)! Here's how. Submit your IFD describing a new or important circuit or design technique, the clever use of a new component or test equipment, packaging tips, cost-saving ideas to our Ideas-for-Design editor. You will receive $20 for each accepted idea, $30 more if it is voted best-of-issue by our readers. The best-of-issue winners become eligible for the Idea Of the Year award of $1000.

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

2. Temperature calibration curve is within ±1% between -40°C to +125°C.
The best gets better.

The HP 5248 General-Purpose Counter can now measure to 3 GHz with a single plug-in—without any gaps. This is made possible by our new 150 MHz to 3 GHz Heterodyne Converter, Model 5254C, and by extending the direct counting range of the 5248 counter mainframe to 150 MHz.

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

Even before the latest improvements, no other counter could match the usefulness and flexibility of the 5245 Series. We now offer fourteen different plug-ins to help you make all the measurements you need. These include six frequency converters; transfer oscillator to 18 GHz; two time interval units; two prescalers; video amplifier; DVM; and preset unit.

And you can't beat the 5245 line for reliability either. Its remarkable dependability has made it extremely popular, particularly with rental firms—some of our best customers. When their clients rent an HP counter, rental firms know they won't lose rental fees because of downtime.

The price of the new 5254C Heterodyne Converter is $825. The 5248L counter is $2900. You won't find a more economical single-package solution to your dc to 3 GHz counter needs. Your local HP field office has all the details. Give them a call. Or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

There's a new reason why this continues to be the world's most popular counter line.
IDEAS FOR DESIGN

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

Fig. 2 shows the calibration curve.


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.


VOTE FOR 316

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

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

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

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

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

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

VOTE FOR 317

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

Make tables with a time-shared computer

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

Here are a few examples that illustrate how
There isn't another like it.

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Model 374H $3.00 (1-9 pieces)
Model 374 $2.75 (1-9 pieces)

INFORMATION RETRIEVAL NUMBER 46

Electronic Design 4, February 15, 1970
IDEAS FOR DESIGN

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(C1):Z(C2) RETURN LOSS REFLECTION LOSS"  
   140 PRINT  
   150 RTRF  
   160 FOR L=1.25 TO 5 STEP .25  
   170 GOSUB 160  
   180 NEXT L  
   190 FOR M=10 TO 30  
   200 LET L=M  
   210 GOSUB 190  
   220 NEXT M  
   230 STOP  
   240 LET A=1  
   250 LET C=L  
   260 LET D=A  
   270 LET E=EXP((LOG(A/C)/LOG(10)))  
   280 LET F=EXP((1LOG(10))/2))  
   290 PRINT USING 150,L;E;F  
   300 RETURN  
   310 END

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.

   **RTRF**
   
   7259 S2 FRI 08/29/69  
   100 PRINT "VOTE FOR 318"  
   110 PRINT  
   120 PRINT  
   130 PRINT "VOTE FOR 319"  
   140 PRINT  
   150 PRINT "THIS TABLE IS BASED ON PURELY RESISTIVE IMPEDANCES."  
   160 PRINT  
   170 PRINT  
   180 PRINT "Z(C1):Z(C2) RETURN LOSS REFLECTION LOSS"  
   190 PRINT  
   200 RTRF  
   210 FOR L=1.25 TO 5 STEP .25  
   220 GOSUB 160  
   230 NEXT L  
   240 FOR M=10 TO 30  
   250 LET L=M  
   260 GOSUB 190  
   270 NEXT M  
   280 STOP  
   290 LET A=1  
   300 LET C=L  
   310 LET D=A  
   320 LET E=EXP((LOG(A/C)/LOG(10)))  
   330 LET F=EXP((1LOG(10))/2))  
   340 PRINT USING 150,L;E;F  
   350 RETURN  
   360 END

**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, Q1 is ON and Q2 is OFF provided that:

\[ R_1 \leq \beta \left[ V - (V_{ref} + V_{BE1}) \right] / I_{L(max)} \]
\[ I \leq I_{L(max)} / \beta \]
\[ R_3 \leq V_{ref} / I \]
\[ R_4 = (V - V_D) / I - R_3 \]

In case the supply voltage exceeds V, Q2 turns ON, diverting the base current I to ground thus turning Q1 OFF. In the case of wrong polarity, Q1 never turns on due to the absence of base current I, 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.
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.

**Avionics**
Airline communications surge expected by '85

Airlines demonstrate anti-collision system

Airlines moving to spot malfunctions in advance

Anticollision device protects copter pilots

Area navigation: Relief for air traffic jams

Avionics for the private flier ready for takeoff

FAA takes steps to automate airways

Military scopes to show plane's height, identity

$1 million for 747 Superjet electronics

S-3A to get totally integrated avionics

Circuit and simple recorder make inexpensive digital test system

Circuit prevents single phasing of SCR-driven motors

Solid-state alarm to speak its warning

Town goes it alone—equips own airport

Why doesn't radar prevent midair collisions?

**Circuits & Circuit Theory**
Accurate digital clock uses inexpensive IC gates

Active clamp circuit uses only two transistors

Agr controlled oscillator is extremely stable

Amplify biological signals with ICs

Analog-to-period converter can simplify telemetry systems

Analyze nonlinear control systems

Block reverse gain in your transistor amplifier

Bridge amplifier compensates for strain-gauge variations

Build flip-flops with AOI gates

Build stable current-feedback pairs

Circuit and simple recorder make inexpensive digital test system

Circuit prevents single phasing of SCR-driven motors

Circuit keys twin-T oscillator without generating transients

Consider dual JFET input stages

Convert Boolean algebra to arithmetic

Crystal-controlled oscillator operates from one mercury cell

Cut binary-to-BCD conversion costs

Cut Butterworth filter phase distortion

Darlington inverter features turn-off drive and low $V_{CM}$

Don't be fooled by risetime specs on pulsed microwave tubes

Don't shun the shunt regulator

Drive high-C loads, like MOS regis-
Get rid of ground-loop noise.

Generate variable-phase square waves this cheap, easy way.

Epoxy transistor yields 200-watt pi-network.

Flip-flop measures frequency difference between two signals.

Full-wave chopper modulator uses only one transformer.

Generate variable-phase square waves this cheap, easy way.

IC operational amplifiers solve bias level problems.

Inexpensive audio IC serves as regulator.

Inexpensive circuit generates precision voltage output.

Inexpensive IC pulse generator uses TTL and TTL circuits.

Inexpensive radio-controlled door opener uses only one SCR.

Integrated-circuit hi-peaker shapes frequency response.

ICs have advantages as constant brightness sources.

Linear pulse stretcher has wide dynamic range.

Linear pulse-width modulator uses monostable multivibrator.

Low-frequency multiplier uses twin-T network.

Low-power timer drives stepping relay.

Multivoltage monitor circuit uses only a single transistor.

Narrow-band rejection filter uses twin-T.

New log amp cascades to desired range.

Phase-lock detector requires no external power supply.

Precision voltage reference combined with voltage regulator.

Pre-pulsed diode bias is a feature of novel duplexer.

Pulse sequence generator uses delay line and NAND gates.

Pulse-width to pulse-height converter uses standard blocks.

Pulse widths up to 10 seconds provided by hybrid one-shot.

Reduce common mode voltage in multiplexed systems.

Reduce stray reactivities at 

Relay driver provides delay and controls closure time.

Reliable semiconductor replaces centrifugal motor starting switch.

Restorer and op amp convert pulses to dc level.

Shunt diode protects load in SCR circuit.

Simple crystal oscillator uses monostable integrated circuit.

Simple duplexer requires only expensive components.

Single-map method speeds design of sequential logic circuits.

Single op amp equalizes both amplitude and group delay.

Solid-state spdt switch has high speed and isolation.

Streamline feedback-amplifier design.

Symmetrical threshold converter operates over wide conditions.

Sync signal controls frequency of UJT oscillator conveniently.

Temperature stable supply uses IC as error amplifier.

3 extra parts give astable multi a wide frequency range.

Timing circuit has independent turn-on and turn-off delays.

Transformer-less Meacham bridge employs IC op amp.

Transient inrush current is limited by series transistor.

Communications

Aircraft com system has 8000-foot antenna.

Airline communications surge expected by '85.

Communications terminal is self-contained data center.

Dither over data: another phone system crisis?

NASA plans tests in '72 of laser communications.

Navy to modify plans for extra-lf network.

Plan national private-line microwave net.

Pre-pulsed diode bias is a feature of novel duplexer.

Simple duplexer requires only expensive components.

Small microwave firm wins decision from FCC.

Telemetry is down, but don't count it out.

TV brings the university to industry.

What's delaying U.S. satellite communications?

Components

Ceramic 15-mil chips mate directly with ICs.

Double-divider potentiometer is accurate to 1 part in 10^6.

Fast switch devised for light systems.

Four-quadrant $39 multiplier operates with 1% accuracy.

Hall-effect amplifier chip switches dual load to 10 mA.

Transposing emitter capacitor speeds amplifier response time.

Triangular waveform generator is simple yet effective.

Try active overload protection for your dc voltage regulator.

Ultralinear ramp generator uses UJT to drive Darlington.

Variable length counter is switched easily.

Voltage-controlled oscillator uses two integrated circuits.

Wide-range agc amplifier uses optoelectronic control circuit.

Inexpensive staircase generator spans 1 to 16 Vin 1/2-V steps.

Integrated-circuit hi-peaker shapes frequency response.

Transformers, by resonating them.

Dual level detector uses one active device.

Epoxy transistor yields 200-watt picosecond pulses.

Fast differential amplifier has high slew rates.

Feedback amplifiers are a snap.

Flip-flop measures frequency difference between two signals.

Full-wave chopper modulator uses only one transformer.

Generate variable-phase square waves this cheap, easy way.

IC operational amplifiers solve bias level problems.

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INFORMATION RETRIEVAL NUMBER 48

Electronic Design 4, February 15, 1970
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.

CPS/JQE  Kepco’s extensive JOE 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 x 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 JOE, CPS, BOP, OPS and many other Kepco supplies. Serial or parallel input formats with keyboard input too.

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INFORMATION RETRIEVAL NUMBER 601
Product Source Directory

DC Power Supplies

Compiled and edited by Greg Guercio, Directory Manager

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

For convenience power supplies have been divided into five categories.
- High Current
- Constant Current
- High Voltage
- Laboratory type
- Modular type

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

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How to use the tables

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

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

- **High Current**—Includes those supplies having maximum output currents greater than 3 A and cover output voltages up to 1500 V. These are sorted by maximum voltage in the column color-coded white.
- **Constant Current**—Represents those supplies that are current regulated. They are sorted by maximum current in the column color-coded white.
- **High Voltage**—Includes those supplies having output voltages of 1500 V and up. They are sorted by maximum voltage in the column color-coded white.
- **Laboratory Type**—Power supplies in this category have maximum output currents of less than 3 A and cover output voltages up to 1500 V. They are sorted by maximum voltage in the column color-coded white.
- **Modular Type**—These supplies cover the voltage range from 0 V to 50 V. They all have inputs of 95 to 130 Vac. Modular types are sorted by maximum voltage in the column color-coded white.

The following abbreviations apply to all power-supply listings:

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

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

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

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

Those companies advertising in the power-supply section are marked with an asterisk.
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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-
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 m\( \Omega \), a typical value. Similarly, a power supply with an output impedance of 0.2 ohm at 100 kHz and 2 ohms at 1 MHz has an equivalent high-frequency output impedance, \( L_s \), of 0.32 \( \mu \)H—a value typical of high performance supplies.

For determining necessary load-wire sizes, it is usually sufficient to consider only the equivalent lumped constant series resistance and inductance (\( L_0 \), \( R_0 \), \( L_2 \), etc.). 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 \( 2R_s \) with \( R_s \) and \( 2L_0 \) with \( L_0 \). The total impedance seen by the load is

\[
Z_T = (R_s + 2R_s) + j\omega (L_s + 2L_0),
\]

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

\[
e_1 = L_1 \frac{di}{dt},
\]

where \( L_1 = L_s + 2L_0 \), 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—\((R_s + 2R_s) + j\omega (L_s + 2L_0)\)—and the added impedance seen by each load individually—\((R_i + j\omega L_i)\), \((2R_i + j\omega L_i)\), 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 \( R_s \) 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 \( L_s \) seen by the load, since \( L_s \) 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 its power cord and the rack is often connected by a separate wire to safety ground (the cold-water pipe). With the instrument panels screwed to the rack frame, circulating ground currents are inevitable. However, as long as these ground currents are confined to the ground system and do not flow through any portion of the power-supply dc distribution wiring, the effect on system performance is probably negligible. In essence, then, as long as you do not allow the dc distribution circuits to have any conductive paths in common with ground currents, you will in general reduce or eliminate ground-loop problems.

The only way to avoid such common paths is to connect the dc distribution system to ground with only one wire. In Fig. 6, dc (and signal) currents circulate within the upper box, while ground-loop currents circulate within the lower box. So long as there is only one connection between the two boxes, the ground-loop currents, while not eliminated, do not affect the power-supply dc output and load circuits. Notice that any magnetic coupling between the dc system and ground system or any capacitive leakage from the dc system to ground can provide a return path, enabling ground-loop current to link the dc and ground.

The first rule for avoiding ground-loop is:

**B1. Designate one of the dc distribution terminals as the dc common point (DCCP).**

There should be only one dc common point per dc system. If the supply is to be used as a positive source, then the minus DCDT is the dc common point; if it is to be a negative source, then the plus DCDT is the DCCP. Here are some added tips for selecting the best dc common point.

- **Single ungrounded load:** Select either the positive or negative dc distribution terminal as the dc common point. A single isolated load exists when a power supply is feeding only one load, and that load circuit has no internal connections to the chassis or ground. If the power-supply output terminals are to be used as the dc distribution terminals, then the dc common point will be either the positive or negative power-supply output terminal (Fig. 7a). If remote sensing is to be
7a. For single ungrounded load, without remote sensing, select either plus or minus dc distribution terminal as the dc common point.

7b. For single ungrounded load, with remote sensing, select either plus or minus load terminals as the dc common point.

7c, d. This alternative is applicable when there are two or more separate loads with separate pairs of load leads, and none of the load circuits has an internal connection to chassis or ground.

7e, f. Single ground load without remote sensing (e) and with sensing (f). The load terminals of the grounded load must be designated as the DCDTs, and the ground terminal of the load is the DCCP.

7g, h. This method of DCCP selection is followed when there is only one load and it has an essential internal connection to ground or chassis (g) without sensing or (h) with sensing.

7i. Ground current path through dc load wires is inevitable, unless each connection is removed from all but one load.

7j. Loads ungrounded from ground: The dc common point should be shorted to the dc ground point through a 1 µF capacitor instead of through a solid-wire connection.
employed and the load terminals will serve as the DCDTs, then either the positive or negative load terminal is designated as the DCCP. (Fig. 7b).

- **Multiple ungrounded loads**: Select the positive or negative dc distribution terminal as the dc common point. This alternative is applicable when there are two or more separate loads with separate pairs of load leads, and none of the load circuits has an internal connection to chassis or ground (Fig. 7c and 7d).

- **Single grounded load**: The load terminals of the grounded load must be designated as the DCDTs and the grounded terminal of the load is the DCCP. (Fig. 7e and 7f).

This method of DCCP selection is followed when there is only one load and it has an essential (internal) connection to ground or chassis, or when there are multiple loads and only one of them has an internal connection to ground or chassis (Fig. 7g and 7h).

- **Multiple loads, with two or more individually grounded**: This situation must be avoided or eliminated, if possible. There can be no avoidance of ground-loop currents circulating through dc and load wiring as long as separate loads connected to the same power supply (or dc system) have separate ground returns (Fig. 7i). One cure is to break the circuit connection to ground in all of the loads and then select the dc common point following the multiple ungrounded alternative above, or break the circuit connection to ground in all but one of the loads and treat it as in the single grounded case. In other cases the only satisfactory solution is to increase the number of power supplies.

- **Load system floated at a dc potential above ground**: In some applications it is necessary to operate the power-supply output at a fixed voltage above or below ground potential. In these cases it is usually advantageous to designate a dc common point, using whichever of the four above alternatives is appropriate, just as though conductive grounding would be employed. Then this dc common point should be shorted to the dc ground point through a 1 \( \mu \text{F} \) capacitor, instead of through a solid-wire connection (Fig. 7j).

B2. Designate a particular terminal, which is connected to ground as the dc ground point (DCGP)

The dc ground point may be any single terminal, existing or added, which is part of the ground system of Fig. 6, and which is conductively connected to “safety ground” of the building wiring system and eventually to the cold-water pipe and earth. It may be the separate ground terminal located on one of the power supplies or loads in a system, or it may be a special system ground terminal, buss or plane established 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 corresponding sensing and output terminals, and check their effectiveness by opening the sensing path and noting the resulting output voltage rise.

If the diode configuration of Fig. 9b is used, operation will be satisfactory up to 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 \( E_0^2 / R \), where \( E_0 \) is the IR drop from either power-supply output terminal to the corresponding DCDT, and \( R \) is the ohmic value of the protective resistor.

C5. Determine the minimum wire size for the load current leads from the power-supply output terminals to the DCDTs.

Most well regulated power supplies have an upper limit to the load-current IR drop around which remote sensing may be accomplished without losing proper regulation control. This maximum drop limitation is typically 0.5, 1, or 2 V, and may apply to the positive, negative, or both output leads. Consult the instruction manual or the manufacturer if in doubt concerning the exact limitation applicable to a particular supply.

C6. Check for possibility of power-supply oscillation when connected in the system for remote sensing.

Impedance of the load leads is included inside the power-supply feedback loop (Fig. 10). In remote-sensing applications involving small or long load wires, there is a tendency for power-supply oscillation to occur due to phase shift and added time delay.

In some cases readjusting a “transient recovery” or “loop stability” control inside the supply will be adequate; in more severe cases the power-supply loop equalization may have to be redesigned and tailored for the application.

As suggested previously in rule A4, capacitor \( C_o \) 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 \( C_o \) from the supply and use it as \( C_o' \).
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 ac 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.
MORE AIR FLOW THAN ANY OTHER AXIAL FLOW FAN OF THE SAME SIZE!

CENTAUR (TM)

FEATURES

- A new breakthrough in the science of aerodynamics
- Compact — 4 11/16" square and ONLY 1 1/2" deep
- Lightweight — only 1.2 lbs.
- Quiet — as low as 40 db (SIL) on 60 Hz power
- Economically priced
- U.L. Yellow Card Recognition (File No. E31293)
- Impedance protected

New aerodynamic principles by Rotron permit the Centaur fan to achieve greater aerodynamic efficiencies than ever before from axial flow fans — and with low acoustical disturbance and compact size.

The Centaur with its computer designed five-bladed impeller molded of high impact polycarbonate is precisely matched to a powerful shaded pole motor — available with either oil-impregnated sleeve bearings or precision ball bearings lubricated for life. The recommended operating ambient temperature is -40°C to +55°C with sleeve bearings, and -40°C to +72°C with ball bearings. The motor is mounted to a spider of die cast aluminum which is in turn assembled to a venturi of high temperature resistant black phenolic.

The Centaur will deliver 120 cfm of air, free delivery operating at 115 volts, 60 Hz, or 100 cfm free delivery at 230 volts, 50 Hz making it possible for the design engineer to select a fan to deliver the same cfm on European power sources as Muffin fans or Sentinel fans at 60 Hz power used in the U.S.A.

The Centaur is designed to be physically interchangeable with the Muffin fan or the Sentinel fan.

For complete technical details write today to Rotron Incorporated, Woodstock, N.Y. 12498.
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 unsaturated. 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 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.

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OTHER POWER SUPPLY CAPABILITIES

High Power TWT
Low Noise TWT
Display tube/CRT
Klystron

Chances are that Keltec Florida has the Power Supply design to satisfy your requirements. If not, we can supply custom-designed units for optimum performance in your system. May we be of assistance? Keltec is eager and willing to meet most any challenge.
### High Current Power Supplies

#### Table of High Current Power Supplies

<table>
<thead>
<tr>
<th>Mfr</th>
<th>Model</th>
<th>Range</th>
<th>Output Amps</th>
<th>Load Ripple mV</th>
<th>Price</th>
</tr>
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<tbody>
<tr>
<td>Int Cast</td>
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<td>0.01</td>
<td>0.01</td>
<td>120</td>
</tr>
</tbody>
</table>

#### Notes

- **Range**: The range of the power supply in volts.
- **Output Amps**: The maximum output current in amps.
- **Load Ripple mV**: The load ripple in millivolts.
- **Price**: The price of the power supply.

---

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

INFORMATION RETRIEVAL NUMBER 605
POWER SUPPLY WITH READOUT

Power Supply Specs:
- Voltage Regulation:
  - (Load) 0.01% + 1 mv
  - (Line) 0.005%
- Current Regulation:
  - (Load) 1.0% + 10 ma
  - (Line) 1.0% + 10 ma
- Ripple (RMS): 250 microvolts
- Meters:
  - Voltmeter — 3 ranges
  - Ammeter — 3 ranges
- Plug in I.C. Regulator Cards
- Voltage Resolution (3 mv-15 mv)

Digital Readout Specs:
- Power Supply Output Readout:
  - Voltage — (19.99V-199.9V) Two Ranges
  - Current* (.5-1.0-2.0-4.0A) Single Range
- External Voltage Readout:
  - Voltage — (19.99V-199.9V) Two Ranges
  - To be applied into DVM on front panel terminals.
- Three Digit Display with “1” overrange
- Readout Accuracy 0.1%
  - *current readout will depend on
    max. rating of mated power supply.

FEATURES
- Dial your Output Voltage or Current and Readout on Display.
- Improved Resolution and Voltage/Current Accuracy.
- BCD Signal available for Digital Printout.
- Useable as DVM to read external voltage.

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Voltage</th>
<th>Current</th>
<th>Price(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVC II/DVM 10-2</td>
<td>0-10V</td>
<td>0-2A</td>
<td>$399</td>
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<td>LVC II/DVM 20-1</td>
<td>0-20V</td>
<td>0-1A</td>
<td>$399</td>
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<tr>
<td>LVC II/DVM 50-.5</td>
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<td>0-.5A</td>
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</table>

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Voltage</th>
<th>Current</th>
<th>Price(1)</th>
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<td>0-50V</td>
<td>0-1A</td>
<td>$446</td>
</tr>
</tbody>
</table>

(1) Price includes Digital Readout as described above.

ALSO AVAILABLE WITH 0.01% CURRENT REGULATION (PVC POWER SUPPLY)

NJE CORPORATION
Electronic Development and Manufacture
Kenilworth, New Jersey 07033 / (201) 272-6000 / TELEFAX: FFP • TWX: (710) 996-5967
INFORMATION RETRIEVAL NUMBER 605

Electronic Design 4, February 15, 1970

D25
<table>
<thead>
<tr>
<th>Mfr</th>
<th>Model</th>
<th>Range Volts</th>
<th>Max Amps</th>
<th>Line</th>
<th>Load %</th>
<th>Ripple mV</th>
<th>Price $</th>
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<tr>
<td>*H-P</td>
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<td></td>
</tr>
</tbody>
</table>

**Output Regulation**

- **Line**
- **Load %**
- **Ripple mV**
- **Price $**
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.)
### High Current Power Supplies

<table>
<thead>
<tr>
<th>Model</th>
<th>Range (Volts)</th>
<th>Load %</th>
<th>Ripple %</th>
<th>Price ($)</th>
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<tbody>
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## High Current Power Supplies

### Table 1: High Current Power Supplies

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<th>Line %</th>
<th>Load %</th>
<th>Ripple mV</th>
<th>Price $</th>
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| *Kepco* | K070-20M      | 0-60         | 60       | 0.01   | 0.01   | abcd      | 955     |
| *Sorensen*| SM75-5M     | 0-60         | 50       | 0.01   | 0.01   | abcd      | 525     |
| *Kepco* | JQE75-5       | 0-75         | 75       | 0.005  | 0.01   | abcd      | 625     |
| *Kepco* | TC-80-4M     | 25-80        | 5        | 0.005  | 0.01   | abcd      | 300     |
| *Sorensen*| DC860-5A    | 0-60         | 60       | 0.005  | 0.01   | abcd      | 380     |
| *Techni*| LAB-6M       | 0-25         | 25       | 0.005  | 0.01   | abcd      | 430     |
| *Kepco* | JQE100MA-5A  | 0-100        | 100      | 0.005  | 0.01   | abcd      | 545     |
| *Sorensen*| DC860-10A   | 0-60         | 60       | 0.005  | 0.01   | abcd      | 600     |
| *Kepco* | LAB-12M-18M  | 0-60         | 60       | 0.005  | 0.01   | abcd      | 575     |
| *Sorensen*| DC860-20A   | 0-60         | 60       | 0.005  | 0.01   | abcd      | 530     |
| *Kepco* | JQE75-18M    | 0-75         | 75       | 0.005  | 0.01   | abcd      | 777     |
| *Sorensen*| DC860-30A   | 0-60         | 60       | 0.005  | 0.01   | abcd      | 300     |
| *Trygon*| L3865-6      | 50-80        | 80       | 0.005  | 0.01   | abcd      | 450     |
| *Trygon*| L5865-12     | 50-80        | 80       | 0.005  | 0.01   | abcd      | 545     |
| *Kepco* | JQE100MA-5M  | 0-100        | 100      | 0.005  | 0.01   | abcd      | 625     |
| *Kepco* | RC100-10M    | 40-100       | 100      | 0.005  | 0.01   | abcd      | 625     |
| *Deltron*| SP-100       | 0-100        | 100      | 0.005  | 0.01   | abcd      | 750     |
| *EMC*  | SCR100-100   | 6-100        | 100      | 0.1    | 0.1    | abcd      | 2500    |
| *Trygon*| C910-30      | 110          | 100      | 0.2    | 0.2    | abcd      | 1450    |
| *Kepco* | K5120-5M     | 0-110        | 110      | 0.2    | 0.2    | abcd      | 1979    |
| *Kepco* | K5120-10M    | 0-110        | 110      | 0.2    | 0.2    | abcd      | 1523    |
| *Mid-East*| RA125-3,2    | 0-125        | 125      | 0.2    | 0.2    | abcd      | 425     |

### Table 2: High Current Power Supplies (Continued)

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### Notes

- Remote programming
- Remote sensing
- Price includes meters
- Solid state
- Automatic crossover from constant current to constant voltage
- Multi output type
- Select any voltage by selecting the desired voltage and current
- Constant current models available
- IC Power Supply
- Slot type
- Line & load regulation combined
The Acopian promise of 3-day shipment on orders for industrial or MIL with both single and dual outputs. Every Acopian power module is shipped with this tag. Do you have the latest Acopian catalog? It lists AC to DC power modules for your assurance that whenever you order supplies listed in the Acopian catalog, your order will be on its way to you in 3 days. We guarantee it.

Index by Model Number (continued)

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The Acopian promise of 3-day shipment doesn't apply to just part of our line—or to even 90% of our line. It is your assurance that whenever you order supplies listed in the Acopian catalog, your order will be on its way to you in 3 days. We guarantee it.

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Remember, every Acopian power module is shipped with this tag.
## ELECTRONIC IC DESIGNS

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## Standards

- **Output Voltage (VDC)**
- **Current @ 50°C (mA)**
- **Current @ 60°C (mA)**
- **Current @ 71°C (mA)**
- **Model**
- **Price**

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- **Output Voltage (VDC)**
- **Current @ 50°C (mA)**
- **Current @ 60°C (mA)**
- **Current @ 71°C (mA)**
- **Model**
- **Price**

- **4.0**
- **3.2**
- **2.8**
- **2.6**
- **CP-4P-6P**
- **$125.00**

- **4.0**
- **3.2**
- **2.8**
- **2.5**
- **CP-5P-5P**
- **$125.00**

- **4.0**
- **3.2**
- **2.8**
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- **CP-5P-6P**
- **$145.00**

- **4.0**
- **3.2**
- **2.8**
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- **CP-5P-7P**
- **$180.00**

- **4.0**
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- **CP-5P-8P**
- **$310.00**

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**ELECTRONIC DESIGN 4, February 15, 1970**

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**TECHNIPOWER**

A Benrus Subsidiary • Ridgefield, Conn. 06877 Phone 203-438-0333 TWX 710-450-3631

**INFORMATION RETRIEVAL NUMBER 609**

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**Electronic Design 4, February 15, 1970**
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.

Now you can squeeze your 5V/20A power supply down to fit your microcircuitry.
# Constant Current Power Supplies

<table>
<thead>
<tr>
<th>Model</th>
<th>OUTPUT</th>
<th>REGULATION</th>
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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 ±0.05% 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

for $379.50 complete.
### Constant Current Power Supplies

<table>
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<th>REGULATION</th>
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### Notes

- Remote programming
- Remote sensing
- Price includes meters
- Solid state
- Automatic crossover from constant current to constant voltage
- Dual output
- This model designation covers a series of modular supplies. These supplies are listed in the tables according to their output voltage.
- Control section and high voltage tank enclosed in one unit.
- Reversible polarity.
- Line & load regulation combined
Constant Current Power Supplies

<table>
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<th>Mfr</th>
<th>Model</th>
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<th>Load</th>
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CREATE YOUR OWN POWER SUPPLY SUB-SYSTEMS

with OFF THE SHELF TDM modules

all on a single panel (we'll assemble it for you)

Transistor Devices' famous TDM and TMD modules may be grouped together and bolted on a single 5 1/4" panel to meet your exact requirements in a single package. No expensive cabling, racks, or accessories required. Modules feature front panel voltage and current limit adjustment, test points, and indicator lamps. OV crowbar protection is built in.

SPECIFICATIONS

- Input 103.5 - 126.5 V, 47 - 63 Hz
- Outputs 0 - 305 V, 0 - 60 A
- Transient Response 50 Usec
- Temperature Coefficient .01%/°C
- 0 - 55°C Ambient at full rating

REGULATION | TDM | TMD
--- | --- | ---
LINE | .01% + 5 mV | .1% + 10 mV
LOAD | .01% + 5 mV | .1% + 10 mV
RIPPLE | .001% + 200 µV | .01% + 1 mV

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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
Secretary of Commerce

"Space contributed by Hayden Publishing Company Inc." business press advertising contributed for the public good
### High Voltage Power Supplies

<table>
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<tr>
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<th>Max Volts</th>
<th>Max Amps</th>
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### Notes
- Remote programming
- Remote sensing
- Price includes meters
- Solid state
- Automatic crossover from constant current to constant voltage.
- Dual output

**Reader service numbers for literature and application notes, see page 06**

**Price** $
### Index by Model Number

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<thead>
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**Plastic Capacitors**
- **Power Des.**: 2K10
- **Power Design, Inc.**: 1543A
- **Sorensen**: 1003-200
- **Sorensen**: 1006-100
- **Raytheon**: 1012-60
- **Raytheon**: 1020-30
- **Co.**: 1030-20
- **Co.**: 1061

**High Voltage**

- **Spellman**
  - **Spellman**: High-Voltage

**Univolt**
- **Universal Volttronics**
- **Vector**
- **Vector Engineering, Inc.**
  - **PM-2K-01A**
  - **PM-3K-01A**
  - **PM-5K-01A**

---

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**RACK MOUNTED**
- General purpose and laboratory applications. Both regulated and unregulated models.

**MODULAR STYLE**
- For original equipment manufacturers and cathode ray tube uses.

**MINIATURE ENCAPSULATED MODULES**
- For OEM display supplies and photomultiplier applications.

Write or call for detailed technical literature

**SPELLMAN HIGH VOLTAGE ELECTRONICS CORP.**

**INFORMATION RETRIEVAL NUMBER 614**

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**ELECTRONIC DESIGN 4, February 15, 1970**

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**Our third decade of leadership in high voltage technology.**

**1930 Adee Avenue**

**Bronx, New York 10469**

**212/547-0306**
Switching regulator offers high efficiency

Where space and weight are important factors, the switching regulator has some impressive advantages. Here's why:

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.

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 ($P_T = 110 \text{ W}$)—in an economical TO-3 package. Especially useful in efficient power conversions, the 2N5804 and 2N5805 will find design applications in switching inverters, series regulators, linear amplifiers, deflection amplifiers, and motor controls.

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 lookahead carry capability. The CD4008D combines low quiescent power dissipation—$5 \mu W$ (typ)—with high-speed operation where sum propagation delay is typically 400 ns and carry-in to carry-out delay is 50 ns. This rapid carry feature is especially valuable in assembling multiple adder stages such as a 16-bit full adder where all sum outputs will settle to final values in 660 ns.

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.

Typical operating characteristics:

- Output Impedance: $<0.15 \Omega$
- Line Regulation: 0.03%
- Efficiency: 76.5%
- Rise Time: 1 $\mu$s
- Switching Frequency: 60 kHz
- Output Voltage: 11 V
- Output Current: 400 mA

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.
feeds the "B" register with information from either the Bus line or the SHR/SHL select gate and the "B" register, in turn, passes this information to the four "B" inputs of the adder. The select gate 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 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".

Ultra reliable: RCA's radiation-hard transistors

Reliability was the hallmark of the successful lunar landing of Apollo 12's "Intrepid" and the redocking maneuver with the "Yankee Clipper." One of Apollo's most important systems—the Rendezvous Radar—uses an ultra-high-reliability version of RCA's 2N2857 family of radiation-tolerant, low-noise UHF amplifiers.

For applications demanding radiation-tolerant devices, RCA's pioneering low-noise, ultra-high frequency 2N2857 family has demonstrated its tolerance to a severe radiation environment consisting of steady-state fast-neutron radiation with near-fission spectrum (E > 0.1 MeV); fluence $1.2 \times 10^{14}$ n/cm$^2$ accompanied by reactor gamma radiation (E=1.0 MeV); gamma dose $1.5 \times 10^{10}$ rads. Peak primary photo current (lp) for a dosage rate of 10$^{9}$ rad/sec is about 0.006 ampere.

The following table depicts the survivability of the 2N2857 family:

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<thead>
<tr>
<th>Parameter</th>
<th>Test Condition</th>
<th>Pre-Irradiation</th>
<th>Post-Irradiation</th>
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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.

The following table depicts the characteristics of 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:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>TA7606</th>
<th>TA7608</th>
<th>TA7610</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Radiant Peak Power Output (Watts)</td>
<td>1 (min.)</td>
<td>5 (min.)</td>
<td>10 (min.)</td>
</tr>
<tr>
<td>Source Dimension (Mils)</td>
<td>3</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Typical Threshold Current, $I_{th}$ (Amperes)</td>
<td>4</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Low Drive Current, $I_{MD}$ (Amperes)</td>
<td>10</td>
<td>25</td>
<td>40</td>
</tr>
</tbody>
</table>

Circle Reader Service No. 645.
<table>
<thead>
<tr>
<th>Mfr</th>
<th>Model</th>
<th>RANGE</th>
<th>Volts</th>
<th>Amps</th>
<th>Line %</th>
<th>Load %</th>
<th>Ripple ±</th>
<th>Notes</th>
<th>Price $</th>
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<tbody>
<tr>
<td>*Kepco</td>
<td>ABC2-1M</td>
<td>0-2</td>
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<td>0.05</td>
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<td>131</td>
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<tr>
<td>Int Contr</td>
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<td>3V</td>
<td>3V</td>
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<td>0.25</td>
<td>abcd</td>
<td>321</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
New precision dc power supplies with 0.1% + 1mV accuracy $345.00

The QHS Series is composed of three instruments, each having:
- direct voltage programming to 6 digits
- 11µV resolution
- 0.1% + 1mV calibration accuracy
- constant voltage regulation of 1ppm + 30µV for 20% line voltage fluctuations
- constant voltage regulation of 5ppm + 50µV for 100% load changes
- 100µV p-p ripple (10Hz—500kHz)
- 10ppm + 100µV stability for 8 hours
- reset-ability of 30ppm or 200µV
- optional overvoltage protection
- 250 hour factory pre-aging.

The QHS 20-1 (0-20 Vdc @ 1A), QHS 40-5 (0-40 Vdc @ 5A) and QHS 100-2 (0-100Vdc @ .2A) are available for immediate delivery in a 3½” x 8¼” x 12¾” modular package suitable for rack mounting.

For more information contact your local Sorensen representative or; Raytheon Company, Sorensen Operation, Richards Avenue, Norwalk, Connecticut 06856.
Tel: 203-838-6571; TWX: 710-468-2940; TELEX: 96-5953

Circle 200 on Inquiry Card
48

Laboratory Type Power Supplies
Mfr

Model

Plastic LV36-300
Int Con
*RCA
*H -P
*M idEast
LT
7

LT
8

CPS400- l
WP704A
6204B
PMA40-.5

35.336.7
0. 1-38
0-40
0- 40
0- 40

ABC400 .5M
*H -P
6 ll2A
*Soren- QHS40 -. 75
sen
*Kepco CDT400.5M
*Soren- QHS40-. 5L
sen
*H -P
*ERA
*H-P
*H-P
*Trygan
*H-P

6102A
TR040M
6205B
6202B
HR40-750
6200B
*Kepco CK40-0 . 8M
*Soren - QRD40-. 75
sen
*Soren- ORS40-. 75
sen

6255A

*Soren- QRD40-

0- 40

LT
11

Stan
*N JE
*H-P
*N JE
Power

Des
*N JE
*H-P
Po wer

235

0.0005
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0.05
0.005

0.005
0.01
0.05
0.01

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0.5
0.2

a be de
a be de
e
a be de

300
295
249
269

3

0.00 1

0.01

0.2

abcde

370

LQS48-.67 32-53
LQS48- l. 9 32-53
PMA60-.35 0-60

0.67
l. 9
0 . 35

0.01
0.01
±0 . 01

0.01
0.01
0.02

0.5
0.5
l

abed

139
185
175

CK60--0. 5M 0-60
0-60
6050

0. 5
0.5

0.005
0.01

0.01
0.01

0.5
l

a be de
abed

321
195

0-60
6206B
2-60
RSD-30A
QRD60-. 5 0-60

0. 5
0. 5
0.55

0.01
0.01 0 . 2
20mV
20mV 3
±0.005 ±0. 005 0 . 2

abcde
f
abcdej

169
85
185

QRS60-. 5 0-60

0.55

±0. 01

±0.01 0.4

abcdej

155

305
BP-60D

0-60
0-60

0. 6
0.75

0.01
0.01

o. l
0.01

0. 2
0.25

dep
abcdej

reg
129

*Power/
Mate

BP-60E

0-60

l. 25

0.01

0.01

0.25

abcdej

220

abcdef 445
abcdefj 396

*ERA
*Trygon

0-60
0-60
0-30-60

±0.01
l
l
0. 01
0. 5-1 ±0.005

±0.05 l
0.0 1 0.5
±0.005 0. 2

a be de
440
239
e
abcdefj 205

e
a be de
dev

sen
*H-P
*ERA
AUL
*ERA

SL601 - 2M
SHR60-1 A
QRD60-. 5
-30-1
6294A
SL60-1M
PSD-30
LC Series

0-60
0-60
0-60
4-60

0.01
±0.01
0.01
±0.01

0.0 1 0. 2
±0 . 05 l
0.01
l
0.05 0.8

a be de
abcde
f
abdeg j

116

0-60

l
l
l
112.5
l. 5

0.005

0.01

obcde

3

obdfghj 150

s

Power

l
0.25
0.3
0. 5

0. 05 0. 05 5
20mV 0.5
7mV
0.0 1 0. 01 0.2
±0. 01 0.02
l

t
cd
abcde
abed

395
59
144
175

*Kepco

*N JE
*Trygon
Pree

0.5

0 . 05

0. 05

0.001
l ppm

0-±40

±0. 5

0. 005 0.01

0-40

0.5

lppm

0 . 25

0.00 1 0.04
5ppm o. l

5ppm

a be de

175

abcde
abcdej

375
345

0.25

abcden

399

o. l

abcdej

265

Pree

Stan
*Trygon
*Trygon
*MidEast
*Kepco
Power

o/o

50 15T

0- 50

1.5

0.01

JQE55-2M
PVC-50-2
T50-2
106

0-55
0-50
0-50
0-50

2
2
2
2

11 2

0- 50

Price

s

Des
0-40
0-40
0- 20-40
0- 40
0- 40
0- 40
0- 40
0-40

0. 5
0.5
o. 3- 0.6
0.75
0.75
o. 75
0.8
0.825

0.00 1
±0. 15
0.0 1
0.0 1
0.01
0. 001
0. 005
±0.005

0. 001 0.04
0. 03 0.8
p.2
0.01
0.0 1 0.2
0.05 o. 15
0.00 1 0.04
0. 01 0.5
±0.00S 0.2

0-40

0.825

±0.01 ±0.01 0.4

abcde
abcdeg
obcdef
abcde
e
abcde
abcde
abcde j

265
130
235
169
169
189
281
178

abcdej

145

*H-P
AUL
*Soren-

sen
*Soren-

sen

Be co

*Power/
Mate

0-40
0- 20- 40

l. 5
0.75l. 5

0.01 0. 01 0.2
±0.005 ±0.005 0 . 2

*Soren-

l. 5
1.5
l. 6

0. 01
0.0 1
0.0 1 0. 01
±0.0 1 ±0. 01

l. 6

±0.005 ±0.005 0.5

375

o. 825 -

±0.005 ±0.005 0.2

abcdefj 198

l.65
0 . 5-2
2

0.0 1
0.0 1

f
abcde

2.2

0. 5
0.2
0 . 25

239
2 10
225

Pree

QRD600-30-60
l. 5-30 - 3
ORD60- l .5 0-60

l. 65- ±0.005
3. 3
l. 65 ±0.005

278

sen
*MidEast

HW60-l.5 0-60

1.5

0.01

0.01

*Soren-

QRS60 - l. 5 0-60

l.65

±0.01

±0. 0 1 0.4

abcdej

265

sen
*Power/
Mate

BP-60F

0-60

l. 75

0.01

0.01

abcdej

245

KS60 -2M
TC-602CR

0-60
60

2
2

0.005
0. 0001

0. 01 l
0.0001 0 . 05

abcde
abed

552
1750

HR60-2. 5B 0-60
118
0-60

2.5
2.5

0.01
0.005

0.0 1
0. 01

0.5
0. 24

e
a be de

355
370

BP-60G

0-60

2. 5

0.01

0 . 01

0.25

abcdej

300

6296A

0-60

3

0.01

0 . 01

0.5

a be de

395

HW60-3

0-60

3

0.01

0 . 01

l

0-60
±72
0-75

3
±1.5
1. 5

0. 0 1
O. l mV
0.0005

0 . 01 0.2
lmV
3
0 . 005 0 . 2

acdz

abcde

435
11 25
300

0-75
0. 75

2
2

0.0 1
0.05

0.05
0.05

bcde
a be de

447
175

*Kepco

627 1B
BOP72l. 5M
JQE75l. 5M
SM75-2M
ABC7.52M
JQE75-3M

0-75

3

0. 0005

0 . 005 0.2

abcde

520

*Techni

LA80-l.5M 0-80

1.5

±0.0 1

±0. 15 0. 2%

a be de

325

*Kepco

PR80-2. 5
LAB0 - 3M
LQS65-l.3
RST-30A
6106A
LHS65-2. 8
JQE75-

2.5
3
l. 3
0.5
0.2
2. 8

±1
±0.0 1
0.01
20mV
0.00 1
0. 001

2
±0. 15
0.01
20mV
0.00 1
0.001

cde

357
355
199
125
265
320

*Soren-

0.0 1
0.0 1

0 . 25
l

±0. 005 ±0. 005 0.2

abcdej

249
225

sen
*Soren-

abcdej

255

0- 40
0-40
0-40
0-40
0- 20-40

0.0 1
±0.0 1
0.0 1
0.0 1
±0.005

0. 01
±0. 15
0.0 1
0.0 1
±0.005

0.2
0.2%
0.5
0.5
0. 2

abcde
a be de
e
abcde
abcdefj

350
320
325
350
298

47-49
0-50
0-50

3
3
3
3
2.2 4.4
3
0. 2
0.25

0.05
0.0 1
0.01

0.05
0.01
0. 2

3
0. 2
5

abdfghj 215
cde
90
99
c

North
Hills
*Trygon
Pree
Stan
*Power/
Mate
*H-P

6218A
PSR-12-50
101

0- 50
0- 50
0-50

0.2
0.25
0.4

0.0 1 0.01
0. 0 1 0.0 1
0.005 0.0 1

0.2
100
0.2

cde
c
abcde

11 5
11 0
169

*MidEast
*H-P

LVC ll-50-. 5
6220B
PVC- 50- . 5
5005S

0- 50
0- 50
0-50
0-50

0.5
0.5
0.5
0.5

0. 01
0. 01
0.0 1
0. 005

0.01 0.25
0. 01 0.2
0.01 0.25
0.005 l

abcde
abcdef
a be de
abed

124
250
148
150

LVC ll- 50-1
~228B
~050

0-50
0- 50
0- 50

l
l
l

0.01
lmV
0. 01

0. 01
0.0 1
0.01

a be de
abcde
abed

171
450
195

0.25
0.25
l

0-±50
0- 50
-50 ta +50
5-50
0-50

Jo.

l
l
l
l. 5
1.5

2mV
0. 0 1
0 . 02
0.05
0.0 1

2mV
l
0. 0 1 0.25
0. 02
10
l 5mV 0.25
0. 0 1 0.2

0

a be de
z

cde
abcde

0.24

210
220
120
95225
269

Stan

±0 . 0 1 ±0.0 1 0.4

*H-P
~1 30B
*N JE
PVC-50-1
*H-P
~824A
*Heath l P-27
*H-P
~226B

D46

Load

%

Des

Des

LT
12

Mfr

2.2

6265B
LA40 - 3M
HR40-3B
6290A
*Soren- ORD40-220 - 4
sen
Plastic LV48-300
*H -P
62 17A
*Trygon EAL50-250

Pree

abed

0. 05

Max
Amps

Line

Model

Range
Volts

Price

0-40

sen
*H-P
*Techni
*Trygan
*H-P

*H -P
*EP L

o. 75

0.05

3

0.5
0. 5

. 75-20l. 5
*Trygon SHR40- l. 5A 0-40
*H -P
0- 40
6289A
Wan- MP-40
0- 40
less
Wan - PDC -40
0-40
less
*Soren - QRD40-. 75- 0-20-40
20- l. 5
sen
0-20-40
*Tryga n DL40-l
0-40
*MidHW40-2
East
*Soren - QRD40-2
0-40
sen

*Soren- QRS40-2

LT
10

0.01

Notes

0-40
0- 40

sen

LT
9

Notes

Ripple
mV

Line

REGULATION
Ripple
mV

o/c

Load
%

Max
Amps

Stan

*Kepco

*H -P

Volts

OUTPUT

REGULATION

OUTPUT
Range

150
195
350
BO kit
325

*Kepco

*Kepco
*Kepco
*Kepco
*Kepco

*Techni

*Trygon
AUL
*H-P
*Trygon

0-80
0-80
50-83
3-90
0-100
50- 83

ELLCTRONIC DESIGN

±0. 005 0. 2

abcdefj 305

±0.005 0. 2

abcdej

285

l

0. 25

l
0.25

0.7%
0.2%
0.5
3
0 . 04
0.5

225

310
abcde

obcde

m
abcde

4, February 15. 1970


<table>
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<th>Mfr</th>
<th>Model</th>
<th>OUTPUT Range</th>
<th>Max Amps</th>
<th>Line %</th>
<th>Load %</th>
<th>Ripple mV</th>
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<td>ABC200M</td>
<td>0-200</td>
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<td>0-220</td>
<td>3</td>
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<td>1</td>
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**Notes:**
- Dual tracking
- Digitally Controlled Voltage Source
- 310 series for remote programming and sensing.
- Dual output available
- Multi output type
- Select any voltage by selecting the desired voltage and current after letter series. Constant current models available.
- IC Power Supply
- Line & load regulation combined
- Power supply/amplifier.
more than a power supply

You get more than a power supply when you specify this or any Hewlett Packard power supply. An international network of 220 sales/service offices are at your disposal... the most comprehensive service manuals detailing every aspect of the supply from theory and operation to troubleshooting... protection circuitry including an internal overvoltage "crowbar" to safeguard delicate loads, standard on this Low Voltage Rack (LVR) Series. OUTPUTS: 10V @ 20, 50, or 100A; 20V @ 10, 20, or 50A; 40V @ 3, 5, 10, 30, or 50A; 60V @ 3 or 15A. RIPPLE AND NOISE: typically 200µV rms, 10mV p-p. Remote Programming and lots more. Prices start at $350.

and you can customize it with these options...

- 10-Turn Output Voltage and Current Controls
- Chassis Slides
- 3-Digit Graduated Decadial for Voltage or Current
- 115V, 208V, or 230Vac Inputs
- 50Hz input.
DC POWER

From 10µV to 4000V
From 1µA to 2000A
From $90 to $3,500
From manual to computer controlled.

LOW COST SUPPLIES
Compact laboratory power supplies can be stacked or rack mounted. Choose from 6 well-regulated models: 10V @ 1A; 25V @ .4A; 50V @ .2A. Three Constant Voltage/Current limiting models — $90. Three Constant Voltage/Constant Current models — $115.

Constant Voltage/Constant Current with Automatic Crossover, Remote Programming, Remote Sensing, Auto-Series or Parallel, Optional Internal Overvoltage "Crowbar"

MEDIUM POWER
TRANSISTOR REGULATED
Precisely regulated. Programming speeds as fast as 500µs. 20 models: 7.5V @ 3 or 5A; 10V @ 10A; 20V @ 1.5, 3, 5, or 10A; 30V @ 1A; 40V @ .75, 1.5, 3, or 5A; 60V @ 1 or 3A; 100V @ .75A; 160V @ .2A; 320V @ .1A. $144 to $395.

SCR REGULATED
8 models: 20V @ 15 or 45A, 40V @ 10 or 25A; 60V @ 5 or 15A, 120V @ 2.5A; 600V @ 1.5A. $360 to $550.

HIGH POWER/SCR REGULATED
12 Models: 4V @ 2000A; 8V @ 1000A; 18V @ 500A; 36V @ 300A; 64V @ 150A; 110V @ 100A; 220V @ 50A; 300V @ 35A; 600V @ 15A. $1275 to $3500.

Index by Model Number

<table>
<thead>
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<th>Model</th>
<th>Code</th>
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Now There's A New Design Technique
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INFORMATION RETRIEVAL NUMBER 625

ELECTRONIC DESIGN 4, February 15, 1970 D51
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.

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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.
WEIGHT: Net 3¼ lbs., Shipping 4¾ lbs.
$76.00

UNI-88 0-34 volts, 1.5 amps over entire voltage range. Regulation: Better than ±0.005% or 1 MV for line and load.
WEIGHT: Net 5¼ lbs., Shipping 6¾ lbs.
$99.00

UniTwin-164 0-25 volts, 0.75 amps over entire voltage range. Regulation: Better than ±0.005% or 1 MV for line and load.
WEIGHT: Net 5¾ lbs., Shipping 7½ lbs.
$164.00

SAME DAY SHIPMENT
Series fill all your Power Supply needs.

**UNI-30C**
0-30 volts, 4 amps.
Regulation: Better than ±0.01% or 1 Mv for line and load.

$134.00

5½" W x 3¾" H x 7¾" D
WEIGHT: Net 8¼ lbs., Shipping 10¼ lbs.

---

**UNI-30D**
0-30 volts, up to 6 amps (see chart).
Regulation: ±0.01% or 1 Mv for line and load.

$151.00

5½" W x 3¾" H x 9¾" D
WEIGHT: Net 11½ lbs., Shipping 14 lbs.

---

**UNI-30E**
0-30 volts, up to 12 amps (see chart).
Regulation: ±0.01% or 1 Mv for line and load.

$174.00

5½" W x 5¾" H x 9¾" D
WEIGHT: Net 15½ lbs., Shipping 19 lbs.

---

**UNI-30F**
0-30 volts, up to 15 amps (see chart).
Regulation: ±0.01% or 1 Mv for line and load.

$205.00

7½ " W x 5½" H x 9¾ " D
WEIGHT: Net 20¼ lbs., Shipping 24¼ lbs.

---

**UNI-30G**
0-30 volts, up to 24 amps (see chart).
Regulation: ±0.01% or 1 Mv for line and load.

$265.00

7½ " W x 5½" H x 11¾ " D
WEIGHT: Net 25¾ lbs., Shipping 30¼ lbs.

---

**UNI-30H**
0-30 volts, up to 34 amps (see chart).
Regulation: ±0.01% or 1 Mv for line and load.

$315.00

7½ " W x 5½" H x 16½ " D
WEIGHT: Net 34½ lbs., Shipping 39½ lbs.

---

Also from Power/Mate, the largest line of Bench Pacs ever offered.

All of your laboratory and systems needs are sure to be met by these new, high-performance economical Bench Pacs. Twenty-three different models cover voltages from 0 to 60, and currents up to 15 amperes.

They feature both voltage and current regulation, adjustable current limiting, five-way binding posts, easy-to-read dual meters, and built-in short circuit protection.

Low-cost, versatile, high-performers, these general purpose bench supplies from Power/Mate are worth a lot in money saved and added convenience. Ask for complete literature.

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

SAME DAY SHIPMENT

INFORMATION RETRIEVAL NUMBER 626

ELECTRONIC DESIGN 4, February 15, 1970
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**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.**
Meet JR.
The world's first
Guaranteed Forever
miniaturized power supply.
Five times smaller. 50% better efficiency.
Competitively priced.
Write for complete catalog.
acdc electronics, inc.
2979 North Ontario St.,
Burbank, Calif. 91504.
### Modular dc Power Supplies

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

**Companies advertising in the power supply section are marked by an asterisk.**
## Modular dc Power Supplies

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

Companies advertising in the power supply section are marked by an asterisk.

**Electronic Design**, February 15, 1970
## Modular dc Power Supplies

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*Kepco      | PAR-15           | 15             | 6        | ±0.05  | ±0.05  | 2         | djus  | 05      |
*Power/     | Mate             | RC-15           | 13-16    | 0.05   | 0.05   | 2         |       | 05      |
*Nucor      | D Series         | 13-16          | 0.075    | ±0.025 | ±0.025 | 1         | abdgb | 76      |
*TDI       | TDM+            | 15-16          | 1.7-12   | ±0.001 | ±0.001 | 2         |       | 59      |
*Nucor      | P Series         | 13-17-16       | 3-12     | ±0.05  | ±0.05  | 3         |       |         |
*Power      | UPMF-11          | 0-16            | 1        | ±0.01  | ±0.01  | 1         |       | 199     |

| SCI        | SCI              | 0-16            | 1        | ±0.01  | ±0.01  | 1         |       | 199     |
| SCI        | 371              | 0-16            | 1        | ±0.01  | ±0.01  | 1         |       | 199     |
| SCI        | 371              | 0-16            | 2        | ±0.01  | ±0.01  | 1         |       | 199     |
| Power/     | Mate             | RC-15           | 13-16    | ±0.05  | ±0.05  | 1         |       | 59      |
*Power/     | Mate             | RC-15           | 13-16    | 0.05   | 0.05   | 2         |       | 59      |
*Acopion    | OA12/1500,5      | 14-16           | ±0.05    | ±0.05  | ±0.05  | 2         |       | 199     |
*Acopion    | OA12/1500,1,1,15L| 14-16           | ±0.05    | ±0.05  | ±0.05  | 2         |       | 199     |
*Acopion    | OA12/1500,12,15  | 14-16           | ±0.05    | ±0.05  | ±0.05  | 2         |       | 199     |
*Dynamax   | KH 15/15         | 14-16           | ±0.05    | ±0.05  | ±0.05  | 2         |       | 199     |
*Acopion    | OA12/1500,15     | 14-16           | ±0.05    | ±0.05  | ±0.05  | 2         |       | 199     |

| Deltron    | D                | 4.5-16          | 0.1-1.5  | ±0.02  | ±0.02  | 1         |       | 199     |
| Valcor     | CG15 Series      | 14-15           | 5.6-11   | ±0.05  | ±0.05  | 1         |       | 199     |
| Abbott     | D Series         | 13.5-16.5       | 0.02    | ±0.05  | ±0.05  | 1         |       | 199     |
| Wanlass    | 30-OEM-22        | 9-17            | ±1       | ±1     | ±1     | 1         |       | 199     |
| Wanlass    | 60-OEM-22        | 9-17            | ±1       | ±1     | ±1     | 1         |       | 199     |
| RoseMount  | SPS-2079P        | 13-17           | ±0.04   | 3mV    | 6mV    | 1         |       | 199     |
| RoseMount  | SPS-2098P        | 13-17           | ±0.175  | 2mV    | 5mV    | 1         |       | 199     |
| RoseMount  | SPS-2095P        | 13-17           | ±0.185  | 3mV    | 6mV    | 1         |       | 199     |
| Elasco     | MS155            | 15-17           | ±0.01   | ±0.05  | ±0.05  | 1         |       | 199     |
| Acopion    | 16J Series       | 15-17           | ±0.05   | ±0.05  | ±0.05  | 1         |       | 199     |
| Acopion    | 16J Series       | 15-17           | ±0.05   | ±0.05  | ±0.05  | 1         |       | 199     |
| Acopion    | 16J Series       | 15-17           | ±0.05   | ±0.05  | ±0.05  | 1         |       | 199     |
| Acopion    | 16J Series       | 15-17           | ±0.05   | ±0.05  | ±0.05  | 1         |       | 199     |
| Acopion    | 16J Series       | 15-17           | ±0.05   | ±0.05  | ±0.05  | 1         |       | 199     |
| Acopion    | 16J Series       | 15-17           | ±0.05   | ±0.05  | ±0.05  | 1         |       | 199     |

**Notes:**
- DJU: Regulated
- BDF: Fully regulated
- SC: Switching
- LD: Line are regulated
- DJU: 12V
- BDF: 24V

---

**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

<table>
<thead>
<tr>
<th>Mfr</th>
<th>Model</th>
<th>Range Volts</th>
<th>Max Amos</th>
<th>Load %</th>
<th>Ripple mV</th>
<th>Notes</th>
<th>Price $</th>
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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. 065.
## Modular dc Power Supplies

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<th>Range (Volts)</th>
<th>Max Amps</th>
<th>Line %</th>
<th>Load %</th>
<th>Ripple mV</th>
<th>Notes</th>
<th>Price $</th>
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### Notes

- **Modular de Power Supplies**
- 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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**Table Details**

- **Mfr**: Manufacturer
- **Model**: Model Number
- **Range (Volts)**: Voltage Range
- **Max Amps**: Maximum Amps
- **Line %**: Line Regulation (%)
- **Load %**: Load Regulation (%)
- **Ripple mV**: Ripple Voltage (mV)
- **Notes**: Notes or Remarks
- **Price $**: Price in Dollars

---

**Extra Information**

- **Modular de Power Supplies**
- **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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**Electronic Design 4, February 15, 1970**
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## Modular dc Power Supplies

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

**Companies advertising in the power supply section are marked by an asterisk.**

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Reader service numbers for literature and application notes, see page D66.

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Additional features explained on p. D65.
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<td>0.001%</td>
<td>r</td>
<td>450</td>
</tr>
<tr>
<td>CEA</td>
<td>CE6AC502</td>
<td>80-139</td>
<td>5</td>
<td>0.0005</td>
<td>0.002</td>
<td>0.0005%</td>
<td>r</td>
<td>500</td>
</tr>
</tbody>
</table>

**Reader service numbers for literature and application notes,** see page 06.

**Additional features explained on p. 065.**

---

- **Dynage D Series**
  - 156.1-177.1
  - 0.05-
  - 0.01%
  - 0.01% dsu
  - 156-160
  - 0.15-0.25
  - 5 abdg
  - 145-
  - 145-
  - 25

- **CM Series**
  - 105-140
  - 0.05-
  - 0.05
  - 0.01% su
  - 105-
  - 140-
  - 25

- **Elosco VS Series**
  - 140-160
  - 0.05-
  - 0.05
  - 0.01% dsu
  - 135-

Readers service numbers for literature and application notes, see page 06. Additional features explained on p. D65.

Companies advertising in the power supply section are marked by an asterisk.
### Modular DC Power Supplies

<table>
<thead>
<tr>
<th>Mfr</th>
<th>Model</th>
<th>Range Volts</th>
<th>Max Amps</th>
<th>Line</th>
<th>Load</th>
<th>Ripple mV</th>
<th>Notes</th>
<th>Price $</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jynage</strong></td>
<td>H Series</td>
<td>156-1000</td>
<td>0.1-10</td>
<td>±0.025</td>
<td>±0.1</td>
<td>1</td>
<td>abbgu</td>
<td>161-</td>
</tr>
<tr>
<td><strong>Dynage</strong></td>
<td>D Series</td>
<td>156-1000</td>
<td>0.1-10</td>
<td>±0.025</td>
<td>±0.1</td>
<td>1</td>
<td>abbgu</td>
<td>130-</td>
</tr>
<tr>
<td><strong>CEA</strong></td>
<td>CEA6DZ00R</td>
<td>140-250</td>
<td>0.05</td>
<td>±0.0001</td>
<td>±0.0004</td>
<td>0.003%</td>
<td></td>
<td>275</td>
</tr>
<tr>
<td><strong>CEA</strong></td>
<td>CEA6SZ00R</td>
<td>140-250</td>
<td>0.05</td>
<td>±0.0005</td>
<td>±0.0002</td>
<td>0.005%</td>
<td></td>
<td>205</td>
</tr>
<tr>
<td><strong>CEA</strong></td>
<td>CEA6Z7500</td>
<td>140-250</td>
<td>0.05</td>
<td>±0.0002</td>
<td>±0.0008</td>
<td>0.02%</td>
<td></td>
<td>155</td>
</tr>
<tr>
<td><strong>CEA</strong></td>
<td>CEA6Z500</td>
<td>140-250</td>
<td>0.05</td>
<td>±0.001</td>
<td>±0.04</td>
<td>1</td>
<td></td>
<td>145</td>
</tr>
<tr>
<td><strong>ACDC</strong></td>
<td>BX250N1-0.6</td>
<td>100-240</td>
<td>0.1-0.6</td>
<td>±0.01</td>
<td>±0.1</td>
<td>1</td>
<td>abbkg</td>
<td>156-</td>
</tr>
<tr>
<td><strong>TDI</strong></td>
<td>STR</td>
<td>5-300</td>
<td>0.25-10</td>
<td>±1-3</td>
<td>±0.5</td>
<td>0.7</td>
<td></td>
<td>25-</td>
</tr>
<tr>
<td><strong>Acoplan</strong></td>
<td>SFI Series</td>
<td>1-500</td>
<td>2.8-60</td>
<td>±0.01</td>
<td>±0.01</td>
<td>1</td>
<td></td>
<td>39</td>
</tr>
<tr>
<td><strong>EST</strong></td>
<td>MS Series</td>
<td>0-310</td>
<td>0.05-8</td>
<td>±0.01</td>
<td>±0.1</td>
<td>0.3</td>
<td>abdeg</td>
<td>220-</td>
</tr>
<tr>
<td><strong>EST</strong></td>
<td>SR Series</td>
<td>0-310</td>
<td>0.05-10</td>
<td>±0.01</td>
<td>±0.01</td>
<td>0.3</td>
<td>abdeg</td>
<td>115-</td>
</tr>
<tr>
<td><strong>EST</strong></td>
<td>TR Series</td>
<td>5-310</td>
<td>0.5-8</td>
<td>±0.01</td>
<td>±0.1</td>
<td>1</td>
<td>abbbl</td>
<td>90-</td>
</tr>
<tr>
<td><strong>ACDC</strong></td>
<td>BX300N1-0.6</td>
<td>100-300</td>
<td>0.1-0.6</td>
<td>±0.01</td>
<td>±0.1</td>
<td>1</td>
<td>abbkg</td>
<td>186-</td>
</tr>
<tr>
<td><strong>ACDC</strong></td>
<td>BX500N1-0.6</td>
<td>200-325</td>
<td>0.1</td>
<td>±0.1</td>
<td>1</td>
<td></td>
<td></td>
<td>16-</td>
</tr>
<tr>
<td><strong>Techni</strong></td>
<td>GSA-265-15</td>
<td>0.17</td>
<td>±0.01</td>
<td>±0.1</td>
<td>1</td>
<td></td>
<td></td>
<td>175</td>
</tr>
<tr>
<td><strong>Techni</strong></td>
<td>PMP Series</td>
<td>192-340</td>
<td>0.05-3</td>
<td>±0.5</td>
<td>±0.5</td>
<td>5</td>
<td>su</td>
<td>210-</td>
</tr>
<tr>
<td><strong>Techni</strong></td>
<td>F115 Series</td>
<td>210-340</td>
<td>0.05-1</td>
<td>±0.5</td>
<td>±0.5</td>
<td>5</td>
<td>su</td>
<td>355-</td>
</tr>
<tr>
<td><strong>Techni</strong></td>
<td>PB Series</td>
<td>210-340</td>
<td>0.05-3</td>
<td>±0.5</td>
<td>±0.5</td>
<td>5</td>
<td>su</td>
<td>186-</td>
</tr>
<tr>
<td><strong>ACDC</strong></td>
<td>BX530N1-0.6</td>
<td>240-340</td>
<td>0.1-0.6</td>
<td>±0.01</td>
<td>±0.1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Techni</strong></td>
<td>HR80 Series</td>
<td>225-375</td>
<td>0.03-1</td>
<td>±0.5</td>
<td>±0.5</td>
<td>5</td>
<td>su</td>
<td>186-</td>
</tr>
<tr>
<td><strong>ACDC</strong></td>
<td>BX400N1-0.6</td>
<td>190-410</td>
<td>0.1-0.6</td>
<td>±0.5</td>
<td>±0.5</td>
<td>5</td>
<td>su</td>
<td>210-</td>
</tr>
<tr>
<td><strong>CEA</strong></td>
<td>CEA6DZ100R</td>
<td>260-500</td>
<td>1</td>
<td>0.0001</td>
<td>0.0004</td>
<td>0.003%</td>
<td></td>
<td>690</td>
</tr>
<tr>
<td><strong>CEA</strong></td>
<td>CEA6Z100R</td>
<td>260-500</td>
<td>1</td>
<td>0.0005</td>
<td>0.0002</td>
<td>0.003%</td>
<td></td>
<td>620</td>
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<tr>
<td><strong>CEA</strong></td>
<td>CEA6Z7500</td>
<td>260-500</td>
<td>1</td>
<td>0.0002</td>
<td>0.0008</td>
<td>0.001%</td>
<td></td>
<td>570</td>
</tr>
<tr>
<td><strong>Techni</strong></td>
<td>HF80 Series</td>
<td>250-500</td>
<td>0.025-0.5</td>
<td>±0.5</td>
<td>±0.1</td>
<td>1</td>
<td></td>
<td>140-</td>
</tr>
<tr>
<td><strong>Techni</strong></td>
<td>HF80 Series</td>
<td>600-1000</td>
<td>0.012-0.375</td>
<td>±0.5</td>
<td>±0.1</td>
<td>2%</td>
<td></td>
<td>175-</td>
</tr>
<tr>
<td><strong>EST</strong></td>
<td>SV Series</td>
<td>75-900</td>
<td>0.005-0.2</td>
<td>±1.5</td>
<td>±0.1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Techni</strong></td>
<td>HF80 Series</td>
<td>450-750</td>
<td>0.025-0.75</td>
<td>±0.05</td>
<td>±0.1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Arnold</strong></td>
<td>PHU-1500</td>
<td>1150-1500</td>
<td>1</td>
<td>0.1</td>
<td>±0.1</td>
<td>1%</td>
<td>d</td>
<td>350</td>
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<tr>
<td><strong>Arnold</strong></td>
<td>PHU-2000</td>
<td>1500-2000</td>
<td>1</td>
<td>0.1</td>
<td>±0.1</td>
<td>1%</td>
<td>d</td>
<td>350</td>
</tr>
<tr>
<td><strong>Abbott</strong></td>
<td>HAK-12D-1795A</td>
<td>1800-2000</td>
<td>0.061</td>
<td>±0.5</td>
<td>±0.1</td>
<td>1%</td>
<td>d/h</td>
<td>425</td>
</tr>
</tbody>
</table>

**Notes:**
- 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. Reversible polarity.
- i. Specify BC series for 0.5% line & load regulation or reduced cost.
- j. Triple output.
- k. Model 506/16 power rack adapter will house 10 or 12 units of the type in a standard relay rack.
- l. Select any voltage by inserting the desired voltage after CEA6 plus letter series. Output voltages fixed or adjustable. 5%, 10%, 20%, 30%, 40%, 50%. Constant current models available.
- m. Dual output available.
- n. Select any voltage by selecting the desired voltage and current after letter series. Constant current models available.
- o. Price includes relays.
- p. Status block type.

Reader service numbers for literature and application notes, see page D66.

Companies advertising in the power supply section are marked by an asterisk.
Know the Difference?

Right. One HW power supply is a 10-volt, 8-amp model; the other a 200-volt, 1-amp model. They are two of twenty constant-voltage, constant-current power supplies ideally suited for lab or system. 0.1% load and 0.005% line regulation are standard — as are remote programming and sensing, series/parallel operation, 500µ volt ripple, and separate voltmeter and ammeter. Many other standard and optional features and prices for this and other series power supplies are fully detailed in our color catalog. Send for yours now.

Oh, yes. Another difference is that one costs $205 and the other $355.

Mid-Eastern Industries A Division of Eanco, Inc.
660 Jerusalem Rd. / Scotch Plains, N.J. 07076 / (201) 233-5900

Precise automatic battery charging

... For microwave, communication, telemetering, standby power, starting emergency generators, any unattended battery powered equipment. Use-proven by public utilities.

Ratealco Quality Features

Fully Automatic: Constant voltage ... output current automatically regulated to meet battery demands ... can't overload!

Unaffected by Line Voltage variations: Compensates automatically — output varies less than 1% with line voltage variations of 10%. Exceeds government and utilities requirements.

Simple, reliable: Solid state circuits—no relays or moving parts.

Easy to install: Takes little space, easy mounting, full access to terminals, not damaged if connected with polarity reversed.

May be paralleled: Without special accessories.

Capacities: Up to 20KW available.

Write for more information or phone (206) 624-7770.

ELECTRONICS MANUFACTURERS
612 Pontius Avenue North, Seattle, Washington 98109

INFORMATION RETRIEVAL NUMBER 629

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Trygon Power Supplies D33
Tung-Sol Division, Wagner Electric Corporation D50
Weston Instruments, Inc., Newark Division D8, D9

INFORMATION RETRIEVAL NUMBER 630

"the Voltswagon"

INTRODUCING
The VW Series ... Power supplies providing Economy, Reliability and Performance by NUCOR ...

*Available in 65° C + 95° C Base Temp. Ratings

NUCOR
Nuclear Corporation of America
2 Richwood Place
Denville, New Jersey 07834
(201) 627-4200 (TWX) 710-9878487

INFORMATION RETRIEVAL NUMBER 628

INFORMATION RETRIEVAL NUMBER 629

INFORMATION RETRIEVAL NUMBER 630

ELECTRONIC DESIGN 4, February 15, 1970
When it comes to high voltage dc power supplies, come to the

INNOVATORS

from Hipotronics. Here we are, one of the world's largest suppliers of HV Test Equipment and some people don't know we make HV DC Power Supplies. And we're getting bigger and better all the time: We just expanded our facilities by 150 percent, allowing us to more fully supply the needs of present — and future — customers.

CAPABILITIES:

- EHV DC Power Supplies; i.e., 1 million volts (a 20 ma, with reversible polarity)
- HV "Brute Force" Supplies; i.e., 500 KV @ 100 ma
- HV High Energy Supplies; i.e., 200 KV @ 1 amp or 100 KV @ 2 amps, with reversible polarity
- 100 kw Constant Current Monocyclic Capacitor Charging Supplies
- Power Packs, epoxy and oil filled
- Standard HV Power Supplies; i.e., 100 watts to 200 kw, 1000 volts to 1 million volts

FACILITIES:

- Capacitor manufacturing facility (Corson Electric Division of Hipotronics)
- Transformer manufacturing facility
- Vacuum, varnishing and impregnating system, for coils up to 7 foot diameter
- Advanced vacuum oil processing system
- Indoor high bay assembly and test area for operating units into the megavolt range
- Lift facilities in excess of 25 tons
- 85,000 square feet of modern air-conditioned plant facilities.

Call or send your specific requirements to
Mr. David Spiegelman, Chief Engineer, Power Supplies

High Potential Electronics
BREWSTER, NEW YORK 10509 / (914) BR 9-8091
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)
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

*Optional Distributor Resale Price.
New Products

Four-digit low-cost multimeter checks 5 functions in 30 ranges

Dynasciences Corp., Instrument Systems Div., 9601 Canoga Ave., Chatsworth, Calif. Phone: (213) 341-0800. P&A: $795; 90 days.

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

With 13 pushbuttons and a 100-ms response time, the model DM414 Maxi-Ranger digital multimeter is capable of measuring ac and dc voltages, ac and dc currents, and resistances, all in very wide ranges.

It can measure dc voltages from 1 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 voltages can be measured from 1 nA/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 covers 10 to 10,000 MΩ.

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 counter for $750 logs frequencies from 1.0000 Hz to 1.0000 MHz. p. 98.
- Low-noise S-band MIC flatpack amplifiers can be directly soldered together. p. 108.
- Multi-layer ceramic wiring structure fits four complex ICs in standard DIP. p. 116.
- Modular read/write memory cards feature 10-ns cycle time and 15-ns access time. p. 123.
- Evaluation Samples, p. 150. Design Aids, p. 152.
filter magic?
watch envelope-delay
problems disappear!

High-speed data transmission demands Reeves-Hoffman Hi-Fidelity crystal filters with advanced control of envelope delay combined with optimum selectivity!

Available at most IF frequencies

Our Hi-Fidelity crystal filters minimize envelope-delay distortion, and eliminate the need for discrete equalizers.

Describe your requirement

Reeves-Hoffman designs to your specifications. Call, TWX, or write today for delivery and price.

---

INSTRUMENTATION

Computing $750 counter measures 1 Hz to 1 MHz


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.

---

DIVISION, DYNAMICS CORPORATION OF AMERICA

400 WEST NORTH ST, CARLISLE, PENNSYLVANIA 17013 • 717/243-5929 • TWX: 510-650-3510

INFORMATION RETRIEVAL NUMBER 49
CTS HYBRID MICRO-CIRCUITS

PICK 'EM OFF-THE-SHELF

TRY US!

850/851 Relay Drivers
A single 700ma or dual 350ma driver in a compact TO-8 package can be driven directly or with TTL or DTL inputs. Prices: 1 to 9—$15.00 ea; 100—$11.50 ea.

873 ±15 V Voltage Regulator
Independent +15V and -15V regulators in a TO-8 package. Offers better than .03% line regulation and .05% load regulation. Externally adjustable from 8V to 36V.
Price: 1 to 9—$32.00 ea.; 100—$20.85 ea.

870 5 Volt Regulator
Offers .05% line and load regulation and built in short circuit protection. TO-3 package provides safe and rugged high power operation.
Prices: 1 to 9—$27.25 ea; 100—$17.70 ea.

861 Log I.F. Amplifier
Used in cascade, the 861 Series provides a log video output. It features internal supply decoupling, built in video detector and allows direct JF coupling between stages.
Prices: 1 to 9—$36.00 ea; 100—$26.50 ea.

878/879 Voltage Regulator
A 2 ampere regulator in a TO-3 package which is externally adjustable from 8V to 57V.
Prices: 1 to 9—$20.00 ea; 100—$13.00 ea.

862 Operational Amplifier
Operates from ±6V to ±28V supply and will drive 50 ohm load. TO-5 package.
Prices: 1 to 9—$22.80 ea; 100—$14.80 ea.

Pick your standard CTS microcircuits off-the-shelf. All available for fast, 48-hour delivery from stock and all produced under the same stringent processes as CTS custom hybrid circuits. These precision packages are hermetically sealed and operate over -55°C to +125°C full military temperature range.

Try CTS total hybrid circuits capability for all your requirements. Complete in-house facilities assure you get the package you need to meet your exact requirements.
Ask for our Hybrid Microcircuits Brochure. CTS Microelectronics, Inc., West Lafayette, Indiana 47906. Phone: (317) 463-2565.
AT LAST
a reliable and inexpensive cryogenic refrigerator.

We made the Displex® to meet growing demands for a small system that "runs and runs." Its displacer expander provides controlled cold from 30°K to 300°K and produces 17 watts at 77°K. No refilling and consumables—it's a closed-cycle system, so you get long-term operation with high reliability. Gas cushioned displacer action in the expander results in low vibration and low noise.

Wherever you need a portable or installed unit for cryogenic operations, the Displex Model CS-102 will give months of round-the-clock service. May we help you with cryogenic application engineering for your need?


---

INSTRUMENTATION

Low-cost digital clock has two time modes


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.

Hand-held logic probe detects most levels


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.

Compact oscilloscopes widen response to 7 MHz


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.

Compact panel meters indicate to five digits


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.
## Band-Pass Filters

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center Frequency</td>
<td>10 Khz - 75 Mhz</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>.01% - 3% of C.F.</td>
</tr>
<tr>
<td>Phase Linearity</td>
<td>&lt;= 5%</td>
</tr>
<tr>
<td>Transient Overshoot</td>
<td>&lt;= 40 db</td>
</tr>
<tr>
<td>Shape Factor</td>
<td>&lt;= 1.25:1</td>
</tr>
<tr>
<td>Differential Phase Shift</td>
<td>&lt;= ±2°</td>
</tr>
<tr>
<td>Group Delay Uniformity</td>
<td>&lt;= ±5%</td>
</tr>
</tbody>
</table>

## Band-Reject Filters

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center Frequency</td>
<td>10 Khz - 35 Mhz</td>
</tr>
<tr>
<td>Reject Bandwidth</td>
<td>10% to 80% of C.F.</td>
</tr>
<tr>
<td>Pass Bandwidth</td>
<td>&lt;= 5%</td>
</tr>
<tr>
<td>Shape Factor</td>
<td>&lt;= 3.1</td>
</tr>
<tr>
<td>Notch Rejection</td>
<td>&lt;= 80 db</td>
</tr>
<tr>
<td>Insertion Loss</td>
<td>&lt;= 0.5 db</td>
</tr>
<tr>
<td>Ripple</td>
<td>&lt;= 0.25 db</td>
</tr>
</tbody>
</table>

## Single Side-Band Filters

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center Frequency</td>
<td>10 Khz - 35 Mhz</td>
</tr>
<tr>
<td>Pass Bandwidth</td>
<td>.01% to 2% of C.F.</td>
</tr>
<tr>
<td>Carrier Rejection</td>
<td>&gt;= 70 db</td>
</tr>
<tr>
<td>Shape Factor Carrier Side</td>
<td>&lt;= 1.15:1</td>
</tr>
<tr>
<td>Shape Factor Side-Band Side</td>
<td>&lt;= 1.25:1</td>
</tr>
<tr>
<td>Insertion Loss</td>
<td>&lt;= 0.5 db</td>
</tr>
<tr>
<td>Ripple</td>
<td>&lt;= 0.25 db</td>
</tr>
</tbody>
</table>

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.
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**INSTRUMENTATION**

**DPM with 3-1/2 digits adjusts its own zero**

*Digilin, Inc., 6533 San Fernando Rd., Glendale, Calif. Phone: (213) 246-8161. P&A: $169; stock to 3 wks.*

Featuring 3-1/2 digits and low cost, a new digital panel meter eliminates the need for zero adjustment. The model 330 automatically zero-adjusts itself by grounding its input amplifier, comparing its output to ground, and using the difference signal to generate a zero-correction signal. Its input amplifier features a technique that eliminates circuit loading.

**CIRCLE NO. 256**

**Wideband variable filter attenuates in 4 slopes**


Spanning the range of 0.02 Hz to 20 kHz, a new variable filter offers four selectable attenuation slopes. The model 3750 is a low-pass, high-pass, band-reject and bandpass filter with attenuation slopes of 6, 12, 18 or 24 dB/octave. Its passband gain is unity (0 dB) or ten (20 dB) and it attenuates more than 80 dB for the 24-dB/octave position.

**CIRCLE NO. 257**
the trouble with stepping switches isn't anymore

You no longer have to fight a fist-full of spaghetti when you service a stepping switch. Exclusive Clare Quick-Mount lets you pull out the old switch and plug in the replacement—in less downtime than it takes to install the simplest device.

Clare Quick-Mount is available on all spring-driven stepping switches, using 15, 22 or 28-pair connectors. You can get up to 416 switching points in less space than most other hard-contact devices.

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.

<table>
<thead>
<tr>
<th>Type 20 and 26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bracket Mount</td>
</tr>
<tr>
<td>Card Cage Mount</td>
</tr>
</tbody>
</table>

LOOK TO CLARE FOR STEPPING SWITCHES
a GENERAL INSTRUMENT company
INSTRUMENTATION

**Tri-function generator outputs within ±0.05 dB**

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.

**Phase-angle voltmeter measures six quantities**


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.

**Tiny function generator supplies 3 waveforms**


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.
RESOLON® CONDUCTIVE PLASTIC ELEMENTS UP TO 36" LONG.....
UP TO 3" DIAMETERS

Duncan Electronics full line of RESOLON® single-turn, non-wirewound potentiometers now encompasses rectilinear and sector elements, as well as proven conductive plastic rotary elements.

New rectilinear elements are provided with standard electrical travel of 1/4" to 16", or custom designed up to 36" on special order.

Single-turn/servo-mounted, rotary pots are available in 1/4" to 3" diameters.

Either linear or non-linear functions may be provided by these potentiometers.

CP elements can be designed in any irregular configuration and can be ordered as separate segments or in custom housings engineered to your requirements. Write today for full information.

RESOLON® CP
HIGH PERFORMANCE FEATURES:

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- Low output smoothness: maximum of 0.1% of total applied voltage.
- Low temperature coefficient: -300 ppm/°C max.
- Wide temperature range: -65°C to +125°C.
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  Closer tolerances available.

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PHONE: (714) 545-8261 ☐ TWX 910-595-1128

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In these days of guarantees, zero-defects and fail-safe performance, Stalwart custom compounds elastomers to meet customers' critical performance requirements. Important requirements like resistance to heat aging, radiation, flame, and compression set—to mention only a few. What's more, Stalwart offers design assistance to make sure molded, extruded, and calendered rubber parts conform to precise tolerances. Ask your Stalwart representative for an objective analysis of your design problems. Or, send today for your copy of the 18-page "Stalwart Rubber Selector."

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Bedford, Ohio 44146 Subsidiary of Blasius Industries, Inc.
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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.

Here are a few more conservative characteristics. Maximum permeability, 6900. Typical. Saturation flux density, 4100 gauss and residual magnetism of 850 gauss. If curie point is significant to your operation, how about one of 175 °C. Then there's temperature coefficient. Ceramag® 24H goes +0.700%/°C at -25°C to 25°C and -0.450%/°C at 25°C to 75°C. And all of this with a disaccommodation factor of 1.4 x 10^{-6}.

Ceramag® 24H is ready. Are you? Drop us a line and we'll send you some even more interesting facts about this fantastic new material. And the charts to prove it. Stackpole Carbon Company, Electronic Components Division, St. Marys, Pa. 15857. Ph: 814-834-1521

STACKPOLE
Electronic Components Division

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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.


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.
When You Choose An AC Meter
Best Isn’t Always Most Expensive

So you’re going to buy an AC meter. You want the best meter for your job—at the best price. Right? You have a problem! Let’s talk about it.

We have AC meters, lots of AC meters. We have AC meters that sell for more than $4500—and for their job, they can’t be beat.

But how about the engineer who doesn’t have a big production problem or need 5-digit resolution? How about the engineer who is making only two or three measurements a day...or week? We have a series of meters for him, too.

A series that has built a solid reputation for accurate performance and reliability—most of you have used them in the past. About three years ago, Hewlett-Packard updated with three redesigned, solid-state instruments—the 400 E/EL for broad frequency, 10 Hz and 10 MHz; the 400 F/FL for high sensitivity, 100 µV to 1000 V; and the 400 GL for broad dB range, −100 to +60 dB, 100 µV to 1000 V sensitivity.

These instruments are packed with convenience features. Two of these meters have a built-in 100 kHz low-pass filter to take out unwanted high frequencies for low-level audio measurements. You get fast response—a reading in less than 2 seconds after turn-on, and <2 seconds overload recovery. These instruments have an internal wideband ac amplifier, with an 80 dB gain—so we put an output on the back. With all these you can have the log scale uppermost for greater resolution in dB measurements.

Each HP-made taut-band suspension friction-free meter movement is individually calibrated to its scale for accurate readings over the entire range. Elimination of friction gives these meters excellent repeatability.

These, and more, are the features that assure reliable, day-in, day-out performance that gets the job done on time. If your problem is in sonar, acoustics, audio response, communications, calibration, ac to dc conversion and amplification—or any other application where precision ac voltage measurements are a must—then consider the HP 400 series carefully. They will fit your measurement requirements, leave your wallet fatter, and make your job easier and faster.

Check your HP catalog, starting on page 201, and choose the meter that best meets your measurement needs. Order today by calling the nearest HP order desk. For data sheets, write to Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland. Price: $300 to $390.
McLEAN'S NEW SOLID STATE CONTROLLER SOLVES THE PROBLEM OF NOisy COOLING

YUP! IT AUTOMATICALLY SLOws DOWN BLOWER SPEED SO YOU GET QUIETER OPERATIoN AND JUST THE RIGHT AMOUNT OF COOL AIR!

THAT'S GREAT!

THAT'S COOL!

FURTHERMORE THE SLOWER BLOWER SPEED RESULTS IN LONGER LIFE FOR COMPONENTS AND BLOWERS! — THAT’S REAL ECONOMY!

Yes, a transistorized control and modulating thermostatic probe sense the temperature of your components, or outlet air temperature. The preset system regulates airflow between 80°F and 90°F. For instance, if it senses outlet air temperature at 90°F it operates at full volume and, as it cools the equipment, it gradually decreases output. The slower blower speed results in more peace and quiet plus big savings in blower and component life.

MICROWAVES & LASERS

Directional coupler lowers cost to $49


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


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

To build a conventional panel you'll:
Buy, stock and inspect . . . 60 indicators
Punch . . . . 60 panel holes
Engrave . . . . 60 legends
Mount . . . . 60 indicators
Wire . . . . . 120 terminals
Inspect . . . . 120 connections
TOTAL STEPS . . . . 480

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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.


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.
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American Electronics Inc.
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Fullerton, California 92634

INFORMATION RETRIEVAL NUMBER 63

IMPATT OSCILLATORS SPAN 8 TO 18 GHZ


Four series of high-Q impatt oscillators with low a-m and f-m 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


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


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, 213 Fairchild Dr., Mountain View, Calif. Phone: (415) 962-3563. P&A: $58 per kit.

A kit of three compatible npn power transistors form a vhf amplifier system with 25-W outputs from a 12-V supply. It consists of the MSA8506, MSA8507 and MSA8508 transistors. Connected serially, they provide a power gain of 24 dB over the range of 150 to 175 MHz. Full outputs are achieved with inputs of 125 to 500 mW.

CIRCLE NO. 271
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and Much Less in OEM Quantities

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MICROWAVES & LASERS

Tiny spdt coaxial relay takes 50 W at 1.2 GHz

Dow-Key Co., Box 348, Broomfield, Colo. Phone: (303) 466-7303.

Measuring approximately $2 \times 2 \times 3/4$ in., a new single-pole double-throw magnetic-latching coaxial relay handles 50 watts of cw power at frequencies up to 1200 MHz. The #181-2307 relay has a maximum VSWR (voltage standing-wave ratio) of $1.3:1$ at 1200 MHz and requires a coil-voltage of 26 V dc for operation. It is fitted with type TM coaxial connectors and consumes very little power.

CIRCLE NO. 272

Rf power transistor gives 60 W at 150 MHz

Solitron Devices, Inc., 1177 Blue Heron Blvd., Riviera Beach, Fla. Phone: (305) 848-4311. P&A: $66'; 3 to 4 wks.

Operating at a collector-to-emitter voltage of 28 V, a new rf power transistor delivers 60 W at 150 MHz with a minimum gain of 6 dB. Known as the SRD54117, it also can deliver 50 W at 175 MHz with a minimum gain of 6 dB. The device has a VSWR (voltage standing-wave ratio) of 3:1 and is packaged in a TO-128 power tower.

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We build 8 different data sets for dependable high-speed data communications. They work. Even with line conditions that lick other modems.

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Telephone 305 + 691-1220  TWX 810-848-6588

a milgo company

In Europe -

Reading, Berks, England
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.

Multi-lox ceramic wiring structures are a new development in IC packaging technology that satisfy the current design need for speed and complexity on a single substrate. The new structures consist of high-alumina ceramic parts containing one or more layers of buried high-conductivity hermetic wiring. Hermetic risers connect the buried wiring to the top and bottom of the assembled structure. The various layers are then assembled, stacked on top of each other, and fired together as a single unit.

The short interconnections made with the buried lines permit high chip density on the same substrate. This, in turn, provides minimum signal delays in high-speed circuits, and very low line resistance (typically one ohm per inch for buried runs and 0.5 ohms per inch for surface conductors).

Another advantage of the Multi-lox 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 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
*PROVEN—The industry standard. Units in use by the largest manufacturers and users (names on request);

ECONOMICAL—Costs far less than any other testing method, including black boxes;

DELIVERABLE—Normal shipment in 45 days;

VERSATILE—Can be programmed in less than 15 minutes for almost any type array (LSI-MSI-MOS), IC, digital PC board, or functional chassis . . . without punched cards, paper tape or magnetic tape.

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North American Electronic Systems
DIVISION OF EDUCATIONAL COMPUTER CORPORATION
Sicklerville, N. J. 08081 Tel. 609-629-4141

THIS PROVEN* TEST CONSOLE takes problems of LSI testing off your mind!

Features of The TC4100 System:

- a word generator capable of 40 outputs, each 100 patterns deep, bit rates from DC to 2.5 MHz. (options: adjustable depth, split-phase advancement);
- a four channel clock generator with adjustable frequency, sequencing, positioning, inhibiting, and leveling of clock pulses;
- a 16 channel comparator with adjustable strobe width and position, 1 and 0 level windows, don't care inhibits, and error overrides;
- a 40 channel converter with every word adjustable for 1 and 0 levels;
- a work area with quick connect fasteners for different array socket carriers;
- word toggling capability for words up to 800 bits.

Functional Components:
Clocks, comparators, converters, word generators, and automatic wafer probing interface accessories are separately available.
Looking for an economical system building block?

REDCOR 720 MUX/A-D CONVERTER

REDCOR's Model 720 Multiplexer/A-D Converter is an economical and versatile system-building block that accepts up to 32 channels of analog data. Time-shared multiplexing and successive approximation analog-to-digital conversion are utilized to process the analog input data into a format suitable for inputting directly into a computer. The basic 720 contains modular multiplexers, high-input impedance buffers, a sample and hold, an ADC, power supplies, and a voltage reference.

The 720 Multiplexer/A-D Converter offers distinct cost-performance advantages for a wide variety of data-acquisition problems where high resolution and attendant accuracy must be compared to system cost and throughput rates. The 720 is available in 8 to 12 bits binary, with system throughput rates ranging from 40 KHz to 20 KHz. Either single-ended or differential inputs are provided, with full-scale input ranges from 5v to 20v in bipolar or unipolar configurations.

The 720 is completely self-contained in a forced-air-cooled 19-inch chassis that requires only 1½ inches of panel space. Modular concepts are employed throughout the instrument, with all circuitry contained on plug-in circuit modules that are removable from the master interconnect mother PC board. All test points required for system test calibration and maintenance are available from the swing-out front panel. The modular structure of the 720 ensures ease of maintenance and simplifies field expandability of channels.

Simplified operation, low-cost, ease of interfacing, and guaranteed system performance specifications make the Model 720 Multiplexer/A-D Converter attractive for any computer-controlled data-acquisition or process-control application.

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.

Flat-ribbon coax cable handles fast signals

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

Meeting the need for high-speed signal transmission in data processing and communications applications is a new sub-miniature coaxial cable in a flat-ribbon configuration. FRC-Fab-Ri-Cable's drain wire and center conductor have a silver-plated alloy for greater strength and higher conductivity. The drain wire is helically applied in a flexing situation for maximum life.
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't ratings available in this size device. Including the avionics and hydraulic landing and control surface systems of tomorrow’s electrifyingly changed aircraft.

Our six new high voltage 40RCS devices are metal-cased and glass-sealed for superior 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.
PACKAGING & MATERIALS

**PC transistor socket lowers its profile**

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

Developed to meet the changing needs for larger devices that are capable of being wire-wrapped are two new 36 and 40-pin sockets for dual-in-line components. These sockets are the only receptacles that will accept any width center (0.5, 0.6, or 0.8 in.). They can be designed in any custom configuration and can be wire-wrapped for maximum versatility and performance.

**Wire-wrapped sockets accept dual-in-lines**


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.

**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.

**Cable for computers has 32 wire pairs**
Dynamic variety in subminiature switches. Our SM and 1SX switches. Take our SM series with a complete variety of integral or auxiliary actuators, bifurcated gold contacts for improved reliability and quick-connect detent terminals. It's temperature resistant and meets Military Specification 8805. And if our SM won't fit your needs, try our tiny 1SX. It's the smallest of the snap-action switches, and has low differential — .001 inch max. And it has all the features of the SM.

For more information on these dynamic subminiatures, contact your MICRO SWITCH Branch Office, Authorized Distributor or write for Catalog 50.

HONEYWELL INTERNATIONAL: Sales and service offices in all principal cities of the world.
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.
EECO'S LOGIC-WARE.
It's a full service system for the logic designer.

Computer automated design aid — logic simulation, error checking exception reports, string list and documentation.

Computer automated production system — wire routing, component placement and wire wrapping.

Hardware — boards, chassis, cards, connectors, power supplies, IC's, racks, frames, sockets, panels and drawers. Final assembly and checkout.

DATA PROCESSING

Modular memory cards boast 10-ns cycle time


Model 14-521 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.

Parallel data modem takes 8-level inputs


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 $10^8$ 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.

Advanced Memory Systems, Inc., 1376 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.

Desktop CRT calculator shows memory contents

General Data Comm Industries, 537 Newtown Ave., Norwalk, Conn. Phone: (203) 847-2445.

Designated as the GDC-402C, a parallel-input simplex modem accepts 5, 6, or 8-level tape reader inputs (paper or magnetic) and converts the data to parallel tones for transmission over the public telephone network. The modem transmits nine tone channels in parallel, eight data channels, and one timing channel. Operating speed is 75 characters per second.

Fast graphics plotter prints electrostatically
Now, without sacrificing compact size, you can get high torque even at higher speeds—from 1 to 900 RPM. Synchron 900 Series has thick, wide gears, specially designed to give the added gear strength that makes full use of its power increase. Highest quality instrument gear train for all speeds below 900 RPM.

The new self-starting hysteresis motor has positive direction of rotation—right or left hand. Plus extra heavy phenolic first gear for low noise level. It can be stalled continuously without electrical or mechanical damage.

Added strength in both the rotor and gear train enables 900 Series to handle your toughest timing and control jobs. Because of its compact dimensions, it is often interchangeable with motors of lower torque. To find out what 900 Series can do for you, write or phone today to have a representative contact you.

HANSEN MFG. CO., INC.
Princeton, Indiana 47570


EXPORT DEPARTMENT: 2200 Shames Drive, Westbury, N.Y. 11590

INFORMATION RETRIEVAL NUMBER 75

DATA PROCESSING

Cassette demagnetizer keeps heads in tune

Built into a compact cassette case, the model TD-10 demagnetizer removes excessive magnetic buildup 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.

Small disc memories store 145,000 bits

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.

Cassette circulator stretches playback

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.

Fast graphic terminal digitizes hard copy

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.
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.


See us at IEEE.
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.

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.

Acoustic data sets expand telephone use

Electronic Voice Inc., 2059 E. 223 St., Long Beach, Calif. Phone: (213) 830-6161.

Three new devices make up a set of acoustic data couplers for use in the switched telephone network. Model 101A is for two-way transmission between EIA-interface terminals; the 102A provides half- or full-duplex transmission in either direction. Both models have an error of less than 1 bit in $2 \times 10^6$ bits. Model 102B is for operation through type 80 telephones.
there is only one rapid-charger

BREAKTHROUGH! Now nickel-cadmium batteries can be safely recharged in 15 minutes or less! RAPID-CHARGE, the new energy source system from McCulloch Electronics brings fully discharged sealed nickel-cadmium batteries up to rated capacity in 15 minutes or less. Conventional systems take 14 to 20 hours!

Design opportunities are limited only by imagination. The utility of existing battery-powered products can be increased many times with RAPID-CHARGE. Entire NEW concepts are now possible for portable-power products for home, business and industry.

The RAPID-CHARGE system can be adapted to any nickel-cadmium power-pack configuration or capacity. And McCulloch engineers will assist in the development of RAPID-CHARGE applications to meet your design requirements.

Write today for additional information.
ICs & SEMICONDUCTORS

Twelve-bit ladder fits on single chip

Motorola Semiconductor Products Inc., P.O. Box 20924, Phoenix, Ariz. Phone: (602) 273-6900. P&A: $2.75; stock.

Requiring only the addition of a miniature bulb, a new monolithic tuning indicator circuit, which costs only $2.75, indicates proper fine tuning of color TV and FM receivers. When the receiver is correctly tuned, the circuit’s two input voltages are equal and the lamp is turned ON. Model MC1335 has a typical standby current of 5.5 mA.

CIRCLE NO. 293

Monolithic $3 circuit indicates fine tuning


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

Hy Comp, Inc., 146 Main St., P.O. Box 250, Maynard, Mass. Phone: (617) 897-4578, P&A: $175; stock to 2 wks.

Cramming 12 bits on a single chip for digital-to-analog conversions, a new thin-film resistor ladder network features an accuracy of one-half the last significant bit from -55 to +125°C. Model HC100 is supplied in a 24-lead flatpack (1/4 x 3/8 in.) or in a 24-lead DIP, either hermetically sealed or epoxy encapsulated.

CIRCLE NO. 294

Dual matched FETs occupy same chip

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

Supplied in chip form for hybrid applications, a new line of silicon planar power transistors include 2, 5, 10 and 20-A devices in npn, pnp and npn high-voltage families. The npn and pnp chips are offered as complementary pairs with sustaining voltages up to 100 V; the npn high-voltage chips have sustaining voltages up to 300 V.

CIRCLE NO. 296
Feel a time code coming on? If you’re tagging analog data for correlation and indexing, Datatron timing instrumentation can catch coding problems before they start.

Problems like the chronic congestion caused by enormous equipment. Or acute inaccessibility for maintenance. Or even progressive “inflexibilitis rigor mortis.” And finally irritating costs.

Now there’s fast, round-the-clock relief. Datatron timing instrumentation goes right to work with its proven 4-way action: Flexibility, ease of maintenance, size and cost.

To begin with, unparalleled versatility is afforded by Datatron’s exclusive “main frame” construction. This approach features identical logic, power supply and chassis for both the time code translator and generator.

What’s more, Datatron generators handle up to five time codes simultaneously. And the translators change codes by the flick of a switch or by changing a printed circuit card.

Equipment maintenance is facilitated by a unique “pancake” design that permits simultaneous accessibility to all circuitry.

And when it comes to size, Datatron isn’t a tough pill to swallow. Dosage is concentrated in only 3½” of vertical rack space.

Datatron’s fast-acting ingredients? Dual in-line DTL and TTL integrated circuits. Wide dynamic range AGC Amplifier. And precision oven controlled crystal oscillator.

As for cost, just consider this one fact: Features that Datatron offers as standard are usually optional on more expensive competitive equipment.

So at the first sign of timing aches and pains, take one Datatron 16-page brochure. It completely details the Datatron timing family, including Tape Search Units, DC Code/Failsafe units and Remote Display units.

Send for it today. It won’t hurt a bit.

Datatron Inc.
1562 Reynolds Avenue
Santa Ana, California 92705
(714) 540-9330
Or combine power any way, N-ways. There's an ANZAC answer in our complete family of power dividers/combiners. Precise outputs, broad bandwidths and high-power handling capability for telemetry, receiver and transmitter applications. These connector types and our plug-in versions provide frequency and performance compatibility which makes them usable with the entire broad band of ANZAC signal processing devices.

Representative of over 80 ANZAC N-way power dividers/combiners are:

**MULTI-WAY**

<table>
<thead>
<tr>
<th>Model</th>
<th>Outputs</th>
<th>Freq. (MHz)</th>
<th>Isol. (db)</th>
<th>Loss (db)</th>
<th>Phase (°)</th>
<th>Unbalance Ampl. (db)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS-30</td>
<td>30</td>
<td>10-500</td>
<td>30</td>
<td>4.0</td>
<td>3.0°</td>
<td>±0.2</td>
</tr>
<tr>
<td>DS-45</td>
<td>45</td>
<td>10-300</td>
<td>35</td>
<td>4.5</td>
<td>3.0°</td>
<td>±0.2</td>
</tr>
</tbody>
</table>

**BROADBAND (compact)**

<table>
<thead>
<tr>
<th>Model</th>
<th>Outputs</th>
<th>Freq. (MHz)</th>
<th>Isol. (db)</th>
<th>Loss (db)</th>
<th>Phase (°)</th>
<th>Unbalance Ampl. (db)</th>
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</thead>
<tbody>
<tr>
<td>3H-50</td>
<td>3</td>
<td>2-200</td>
<td>30</td>
<td>0.75</td>
<td>2.0°</td>
<td>0.2</td>
</tr>
<tr>
<td>4V-50</td>
<td>4</td>
<td>20-200</td>
<td>30</td>
<td>0.75</td>
<td>2.0°</td>
<td>0.2</td>
</tr>
</tbody>
</table>

† Also available in standard "plug-in" packages.

**ULTRA-BROADBAND — 10 OCTAVES**

<table>
<thead>
<tr>
<th>Model</th>
<th>Outputs</th>
<th>Freq. (MHz)</th>
<th>Isol. (db)</th>
<th>Loss (db)</th>
<th>Phase (°)</th>
<th>Unbalance Ampl. (db)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS-4</td>
<td>4</td>
<td>2-2000</td>
<td>25</td>
<td>0.5</td>
<td>3.0°</td>
<td>0.5</td>
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<tr>
<td>DS-8</td>
<td>8</td>
<td>2-2000</td>
<td>25</td>
<td>0.75</td>
<td>3.0°</td>
<td>0.5</td>
</tr>
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</table>

**HIGH-POWER (1,000 W & higher)**

<table>
<thead>
<tr>
<th>Model</th>
<th>Outputs</th>
<th>Freq. (MHz)</th>
<th>Isol. (db)</th>
<th>Loss (db)</th>
<th>Phase (°)</th>
<th>Unbalance Ampl. (db)</th>
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</thead>
<tbody>
<tr>
<td>DS-134</td>
<td>4</td>
<td>50-200</td>
<td>30</td>
<td>0.5</td>
<td>5.0°</td>
<td>0.4</td>
</tr>
</tbody>
</table>

**PRECISE OUTPUT, LOW-LOSS (microstrip)**

<table>
<thead>
<tr>
<th>Model</th>
<th>Outputs</th>
<th>Freq. (GHz)</th>
<th>Isol. (db)</th>
<th>Loss (db)</th>
<th>Phase (°)</th>
<th>Unbalance Ampl. (db)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS-160</td>
<td>2</td>
<td>1.25-1.75</td>
<td>20</td>
<td>0.1</td>
<td>0.5°</td>
<td>0.1</td>
</tr>
<tr>
<td>DS-161</td>
<td>3</td>
<td>1.25-1.75</td>
<td>20</td>
<td>0.1</td>
<td>1.0°</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Typical specifications listed.

ANZAC Electronics • 39 Green Street • Waltham • Massachusetts 02154 • Tel: (617) 899-1900

**ICs & SEMICONDUCTORS**

**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—2\(\frac{1}{2}\) times more powerful.

This added power means this type 3SBS, 2PDT, 1 amp relay gives you higher contact forces, larger contact gaps, and greater overtravel to minimize mechanical shifts. Shifts which usually increase early-in-life failures.

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

So don't cut corners on your next transistor-size relay application. Specify GE’s square Type 3SBS. For full details, write General Electric, Section 792-45, Schenectady, New York 12305.
DIVERSIFIED Power Supplies... OUR CAPABILITY SUPPORTS YOUR LINE

From Diversified Electronics...low cost, custom-engineered OEM Power Supplies—based on imaginative new ideas in designing Power supplies for particular needs! Design-proven circuits are combined to achieve the power performance you require and the packaging flexibility needed. All this with off-the-shelf cost and delivery advantages plus custom-engineered OEM reliability.

TYPICAL PRODUCT DESIGNS

DIVERSIFIED EXPERIENCE... engineered supplies for: BWO-VTM-TWT • Photomultipliers • Storage and Display Cathode Ray Tubes • Discrete and Integrated Solid State Devices • Swept Power Supplies • Solid State Pulse Modulators.

For answers to all your power conversion needs—call or write:

DIVERSIFIED ELECTRONICS CO. INC.
718 EAST EVELYN AVENUE
SUNNYVALE, CALIFORNIA 94086
(408) 738-3911

ICs & SEMICONDUCTORS

Tuning diode for $5.95 has ratio of 14 at 1 MHz


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.

High-voltage thyristor handles up to 2000 V

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

Three new monolithic bipolar/MOS driver switches include the DG122 two-channel differential switch with driver, the SI3001 special-function driver switch and the SI3002 spdt switch with driver. All the devices can be used as multiplexers or d/a converters. They can handle analog signals up to 20 V pk-pk. Their inputs are compatible with 5-V DTL, TTL and RTL.

Driver switches are bipolar/MOS ICs

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.

Power transistors take 300 W at 100 A

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

Said to be the highest-voltage commercially available thyristor, a new thyristor has a peak forward blocking voltage as high as 2000 V without trading-off other important characteristics. It can handle surge currents up to 6000 A. Type 286-Y30 contains an integral heat sink, while type 270-Y30 is a stud-mounted design.

CIRCLE NO. 334

CIRCLE NO. 335

CIRCLE NO. 336

CIRCLE NO. 337
Tips on cooling off hot transistors

See how circuit designers use IERC heat dissipators to protect semiconductors...improve circuit performance and life.

Fan-top dissipators for TO-5 and TO-18 cases drop temperatures dramatically; cost just pennies. T-shape adds almost nothing to board height; allows components to snuggle close to transistors. Spring fingers provide fast, press-on installation.

To cool off low-to-medium power transistors in TO-5 and TO-18 cases, use IERC's efficient LP's. Patented, staggered-finger design maximizes radiation and convection efficiency, radiates heat directly to ambient. Available in single or dual mounting for thermal mating of matched transistors.

IERC Therma-Link Retainers provide efficient thermal links between transistors and chassis or heat sinks. (Also, excellent dissipation when used on p-c boards.) Integral BeO washers reduce capacitance up to 2/3. Fast, no-snap installation; transistors are firmly held.

New! Dissipators and retainers for plastic and epoxy transistors. 3 new series for RO-97A, RO-97 and X-20's. Permit a jump of 10% to 33% in operating power.

Free 8-page short form catalog discusses IERC's complete line of dissipators, retainers and tube shields. Gives specifications, prices, how to order. Send for your copy today.

Special insulating coating — Insulubc 448, a special non-hygroscopic finish developed by IERC, combines excellent dielectric properties, 50 K meg insulation resistance, and high heat emissivity. Also protects against salt spray, fungus, etc.

Tough heat dissipating problem? IERC engineers welcome your letterhead inquiry for specific information or assistance in selecting heat dissipators.

International Electronic Research Corporation • A corporate division of Dynamics Corporation of America • 135 West Magnolia Ave. • Burbank, Calif. 91502

Electronic Design 4, February 15, 1970
Victoreen's rare specimen!

Our MOX-1125. A rare specimen made only by Victoreen. With rare qualities in the 1-10,000 Megohm range. Rated at 1.00W @70°C. 5,000 volts maximum. Yet it's just .130” in diameter by 1.175" long.

It's one of Victoreen's Mastermox metal oxide glaze resistors. About one-half the size of competitive resistors of similar power handling capacity.

All Mastermox resistors are rare performers. Excellent stability: As little as 1% drift under full load in 2000 hours — with more than 40 watts power dissipation per cubic inch, ±0.5% tolerance. 10K ohms to 10,000 Megohms resistance range. Voltage and temperature cycling leaves no permanent effect. And Mastermox stays potent on the shelf — less than 0.1% drift per year.

Get Mastermox. Rare resistor performance.

<table>
<thead>
<tr>
<th>Model</th>
<th>Resistance Range</th>
<th>Operating Power Rating @ 70°C</th>
<th>Max. Oper. Volts</th>
<th>O.D. ± .010</th>
<th>L.D. ± .010</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOX-400</td>
<td>1 - 2500 megohms</td>
<td>25W</td>
<td>1.000V</td>
<td>.420 ± .050</td>
<td>.130 ± .010</td>
</tr>
<tr>
<td>MOX-500</td>
<td>1 - 5000 megohms</td>
<td>50W</td>
<td>2.000V</td>
<td>.790 ± .050</td>
<td>.130 ± .010</td>
</tr>
<tr>
<td>MOX-125</td>
<td>1 - 10,000 megohms</td>
<td>1.000V</td>
<td>5.000V</td>
<td>1.175 ± .050</td>
<td>.130 ± .010</td>
</tr>
<tr>
<td>MOX-1</td>
<td>10K - 500 megohms</td>
<td>2.50W</td>
<td>2.50V</td>
<td>.682 ± .060</td>
<td>.284 ± .010</td>
</tr>
<tr>
<td>MOX-2</td>
<td>20K - 1000 megohms</td>
<td>5.00W</td>
<td>5.00V</td>
<td>2.062 ± .060</td>
<td>.284 ± .010</td>
</tr>
<tr>
<td>MOX-3</td>
<td>30K - 1500 megohms</td>
<td>7.50W</td>
<td>7.50V</td>
<td>3.062 ± .060</td>
<td>.284 ± .010</td>
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<tr>
<td>MOX-4</td>
<td>40K - 2000 megohms</td>
<td>10.00W</td>
<td>10.00V</td>
<td>4.062 ± .060</td>
<td>.284 ± .010</td>
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<tr>
<td>MOX-5</td>
<td>50K - 2500 megohms</td>
<td>12.50W</td>
<td>12.50V</td>
<td>5.062 ± .060</td>
<td>.284 ± .010</td>
</tr>
</tbody>
</table>

MINITAN is the first choice in size and reliability for Spacetac heart pacers.

Now ... more microfarads per millimeter with MINITAN!

MINITAN ... the world's smallest, proven microminiature solid electrolyte capacitor gives you the capacitance-to-volume ratios you've been searching for.

75% Smaller than equivalent CS13 Sizes! With Minitan you solve high density hybrid or thick film packaging problems without sacrificing performance. Polar and non-polar types from .001 to 220 uf, 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 uf — 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 1500.

COMPONENTS INCORPORATED
BIDDEFORD, MAINE 04005
If you don't find it here, give us a call.

SILICON RECTIFIERS

Ask about our many types of custom rectifiers and rectifier assemblies.

<table>
<thead>
<tr>
<th>FULL WAVE BRIDGE RECTIFIERS*</th>
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<tbody>
<tr>
<td><strong>50V</strong></td>
</tr>
<tr>
<td>W 111</td>
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<tr>
<td><strong>100V</strong></td>
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<tr>
<td>VE 18</td>
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<tr>
<td>VS 148</td>
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<td>WH 148</td>
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<td><strong>200V</strong></td>
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<td>VH 648</td>
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<tr>
<td>IN 4438</td>
</tr>
<tr>
<td>VT 600</td>
</tr>
</tbody>
</table>

Available with fast recovery characteristic

Mercury-film relay undersizes TO-5 can

| Ladder filter sells for $5.50 |

| Resistor modules are 8-lead DIPS |

| Eight-segment readout is a low-power device |


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

Murata Corp. of America, 2 Westchester Plaza, Elmsford, N.Y. Phone: (914) 592-9180. P&A: $8.50; 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


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

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

SEMICONDUCTOR DIVISION, 1000 N. SHILOH ROAD, GARLAND, TEXAS 75040 (214) 272-4551

INFORMATION RETRIEVAL NUMBER 87
Revisions are easier with KODAGRAPHER Wash-Off Films.

Here's a real bonus for draftsmen.

You don't need to retrace an entire drawing that needs only revision. A beautiful reproduction on KODAGRAPHER Wash-Off Film can be made that includes only the unchanged areas. You merely draw the new details.

The improved drafting surface on these ESTAR Base Films takes pencil or pen nicely—holds up under repeated erasures. Photographic lines are wet erasable. Resulting diazo prints will be sharp and clean.

Ask your local Kodak Technical Service Representative to show you all the drafting shortcuts possible with Kodak Photo Drawing Systems. Or write Eastman Kodak Company, Business Systems Markets Division, Rochester, New York 14650.

DRAWING REPRODUCTION SYSTEMS BY KODAK
Prepared especially for designers who need information on vaneaxials, the most efficient and sophisticated of all air movers. Versatile in application—for cooling electronic enclosures, ECM, klystrons, high-power tubes, and also for inflating shelters, dispensing chaff, refrigeration equipment, dust precipitators, and many others.

The 32-page catalog presents 40 different vaneaxial air movers ranging in size from one to 15 inches in diameter, from 6.5 to 3450 cfm in output. Ample technical notes precede the detailed presentation of performance parameters, dimensions, and other specifications.

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.

Hy-Cal Engineering, 12105 Los Nietos Rd., Santa Fe Springs, Calif. Phone: (213) 698-7785.

Designed for making accurate surface temperature measurements, series TC 2345 patch-type thermocouples feature an unusual zig-zag configuration to compensate for normal temperature losses through lead wires. They are supplied encased in H-Film for protection, and with a special pressure-sensitive silicon adhesive backing for quick and easy mounting.
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:

<table>
<thead>
<tr>
<th>Price: (1 to 9)</th>
<th>ECL Compatible</th>
<th>TTL Compatible*</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 x 8</td>
<td>$768.00</td>
<td>AMS 0328E</td>
</tr>
<tr>
<td>32 x 9</td>
<td>$845.00</td>
<td>AMS 0329E</td>
</tr>
</tbody>
</table>

*Delivery on TTL—one month.

ADVANCED MEMORY SYSTEMS, INC., 1276 HAMMERWOOD AVENUE, SUNNYVALE, CALIFORNIA 94086, TEL. (408) 734-4330

INFORMATION RETRIEVAL NUMBER 90
SOLVING electro-optical problems is OPTRON's ONLY business....
SO, WE HAVE TO BE GOOD!

You can count on Optron for high interest and undivided attention to your most exacting optoelectronic device requirements. And, you'll get product design, development and manufacturing benefits that only Optron experience can offer.

For example, through continuous process monitoring made possible by the use of diffusion lot traceability, Optron maintains the highest possible reliability. Still other special Optron manufacturing techniques make possible optimum device performance in variable light and temperature conditions. You get sensors with a lens/device relationship previously thought impossible.

Versatile OP 600 Series NPN planar silicon light sensors eliminate cross-talk and are ideally suited for high density arrays. In addition, these small, rugged devices will satisfy virtually any application requirement in optical character recognition. But, if your application isn't standard, you'll especially like Optron's fast reaction to your custom programs, too.

Write today for Optron product technical data and the name of your nearest sales representative.
Our new dry test bath is getting a great reception

This should give you a pretty clear picture of what Fluorinert® Brand Electronic Liquids are all about.

They give you a dry test bath for temperature and gross leak testing of electronic and microelectronic units and integrated circuits. They detect flaws and leaks with great accuracy... and are efficient over a wide range of temperatures.

Fluorinert Liquids have high dielectric strength... which means you can safely test on-circuit. They do not react with the most sensitive of materials... which means you can test about anything.

Fluorinert Liquids drain clean, dry fast and leave no messy residue. You can use and ship units directly out of the test bath, without cleaning.

In fact, Fluorinert Electronic Liquids are now approved for the MIL-Standard 883 and the MIL-Standard 750A gross leak tests for microcircuits.

We have lots more information about this remarkable new test bath. The coupon will bring it all or call your local 3M representative.

Fluorinert® Electronic Liquids

3M 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

Electronic Design 4, February 15, 1970
Small wonder!

New air variable capacitors only 0.310" in diameter for vertical or horizontal tuning.

Johnson introduces these new Type "T" subminiature air dielectric capacitors for trimming applications that call for small size (0.310" diameter), high Q (greater than 1500 at 1 mHz), low TC, and low cost. Mounting dimensions of vertical mount "T" are identical to common 3/8" diameter PC mount ceramic disc trimmers.

Nominal capacities available range from 1.3 pF minimum to 15.7 pF maximum. Minimum voltage breakdown is 250 VDC. End frame is 95% alumina, grade L624 or better, DC200 treated. Metal parts are silver plated and Iridited to inhibit discoloration.

Plates are precision machined from brass extrusions and offer exceptional uniformity, stability, and absolute freedom from moisture entrapment. Temperature coefficient is plus 30 ± 15 ppm/°C. Retrace characteristics are excellent. Outstanding stability during vibration from 10 to 2000 Hz. These new capacitors meet or exceed EIA-RS 204 and MIL Standard 202C Methods 204A and 201A.

□ Please rush a sample of your new Type "T" capacitors, detailed specs and prices.
□ Include Catalog 701 covering the entire E. F. Johnson component line.

NAME______________________ TITLE______________________
FIRM______________________ ADDRESS____________________
CITY______________________ STATE______ ZIP____________________

E. F. JOHNSON COMPANY
3302 Tenth Avenue S. W., Waseca, Minnesota 56093
Providing nearly a half-century of communications leadership

MODULES & SUBASSEMBLIES

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 UPM15-50 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


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

Electronic Design 4, February 15, 1970
TWO NEW BELL RINGERS FROM DELTA

DELTA ALERT... Your night watchman for pennies a month!

Delta introduces its all new ultrasonic silent sentry, the total motion detection, intrusion and monitoring alert system. The system plugs into any wall outlet. It also features variable sensitivity control and adjustable timing which provides the most advanced sentry system on the market.

SPECIFICATIONS:
- Ultrasonic Frequency: 35 KHz
- Area Coverage: 15-30 feet (depending on shape of area)
- Controls: On-Off Switch; Built In Timer; Variable Sensitivity Control
- Output: 110-130V at 1 Amp
- Power Requirements: 110-130V, 80 HzAC
- Dimensions: 10"W x 3½"H x 3¾"D
- Finish: Walnut designer finish

For Complete Unit, Ready to Use...ONLY $59.95

DELTA PRODUCTS, INC.
P.O. BOX 1147 • GRAND JUNCTION, COLORADO 81501
PHONE: (303) 242-9000

HIGH VOLT ANALYST Tune your car like a pro.

Delta's new concept in automotive tune-up, The High Volt Analyst, is a unique and complete auto analyzer which provides all the primary advantages of a scope and is completely portable.

SPECIFICATIONS:
- Accuracy - Tachometer ±2% of full scale (all ranges) • Dwell Meter ±1% (both ranges) • OHMS Scale ±5%
- Low Voltage ±2% of full scale • High Voltage ±5% of full scale
- General - Fully protected meter circuit
- Size: 6½"W x 8½"H x 3½"D
- Weight: 3½ lbs
- Ranges - DC Volts 0-15V, 15KV and 45KV • OHMS: 0-1 Meg
- Batteries (8 Type AA cells) included.
- Comes complete with standard lead set, a special probe, and high tension lead.

Meg. (10K center scale) • Dwell: 4, 6 and 8 cylinders • Tachometer: 0-1500 RPM, 6000 RPM

$79.95 / $59.95

Assembled Kit Form

DELTA: Please send me literature immediately.
I am enclosing $______ for items checked.

☐ DELTA ALERT
☐ High Volt Analyst, Assembled
☐ High Volt Analyst, Kit form

Please ship immediately.

Name

Address

City / State    Zip
and you'll specify Johanson.

Look at the obvious... Johanson craftsmanship — 24 Kt. gold plating, watchmaker's precision machined parts and handcrafted assembly and soldering just not available in other trimmers. This built-in quality means you get superior performance characteristics... 16 pF in a 10 pF package, Q greater than 5000 at 100 MHz, a temperature coefficient of 0 ± 15 PPM /°C, with tuning stability and long life.

Why settle for ordinary trimmers when the best is available — send today for our new catalog sheet on our 5200 series... and start comparing.

MODULcES & SUBASSEMBLIES

D/a converters are plastic DIPs


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.

Digital counting unit can be seen for 150°

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 x 2 x 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.

Accurate data amplifier selects gain and band

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

A new digital counting unit, which can be incorporated into any digital system, uses a readout tube that displays the accumulated count as a green high-visibility numeral, which can be read at angles up to 150°. 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.

Modular power supply measures only 0.8 in.³


Series UM-1400 Moduline digital-to-analog converters are packaged in a modified plastic dual-inline 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-1400 is a set of three Moduline assemblies which gives an over-all accuracy of one-half the least significant bit at 12 bits.


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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?

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?

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

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.

EASTERN DIVISION: 21 HIGH STREET, WEST NYACK, NEW YORK 10994
WESTERN DIVISION: 944 LONG BEACH AVE., LOS ANGELES, CALIF. 90021
INFORMATION RETRIEVAL NUMBER 96
REGULATED and UNREGULATED DC POWER SUPPLY ENCAPSULATED MODULES

Here's a sampling:

**REGULATED**

3.6 VDC @ 250 MA to 180 VDC @ 10 MA

PM 529B  5V @ 250 MA — $33.95*
PM 551  ±15V @  65 MA — $34.95*
PM 555  ±15V @ 100 MA — $43.95*

Single and dual output

Typical line/load reg. ±0.04%
Typical temp. coeff. ±0.02%/°C

**UNREGULATED**

5 VDC to 45 VDC up to 440 MA output current

PM 810  5V @ 400 MA — $13.40*
PM 830  16V @ 165 MA — $12.40*
PM 836  25V @ 100 MA — $12.40*

* 10-29 Quantity Prices

Computer Products, Inc., P.O. Box 23849, Ft. Lauderdale, Fla. 33307
Phone: 305/565-9565

---

**Tools & Engineering Aids**

**Precision drafting unit is completely portable**


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) 212-6800.

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 x 49-3/4-in. reference desk which can be pulled out to a length of 11-1/2 in.

CIRCLE NO. 425
Alternate Action – 1,000,000-cycle reliability!

Push-on, push-off! Two circuit dri-reed switch for controlling separate circuits. When button-lens is depressed, one circuit is closed, the other opened. Button stays down until pressed again.

Has front-replaceable midget flanged base incandescent lamp. Match-mated with other TEC-LITE indicators for panel design harmony. Available in 14 lens colors. Rear Mounts in ¾” hole on centers as close as ¼”. Contact rating: 12 volt amp. As low as $4.90 in quantities of 100 - 499.

For more information on ABL-ABS switch/indicators—or any part of our complete line of display/control products and systems—write: TEC, Incorporated, 6700 So. Washington Avenue, Eden Prairie, Minnesota 55343. (612) 941-1100.
TOOLS & ENGINEERING AIDS

Solder/desolder tool accepts up to 85 tips


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 off, or move, since it works by melting a fine cut through the material.

CIRCLE NO. 426

Foam cutting machine multiplies its uses


Two connector tool kits insert/remove contacts


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. 428

Lighted-probes QC kit enhances inspections

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.
What do you need in Multi-Conductor Cable?

Victor will make it.

Get exactly what you need in multi-conductor cable. We'll design and produce multi-conductor cable to meet just about any individual requirement.

We have the plant, the equipment, the personnel and the know-how to solve your particular problem.

YOUR WARRANTY SHOULD PROTECT YOU... AS WELL AS YOUR CUSTOMER

And a calendar can't do this!

A calendar is an old-fashioned and extravagant way of warranting your product. It's usage that counts—and we count usage.

An ENM elapsed time indicator records actual hours of usage—from minutes to thousands of hours. And it can do this for as little as $6.00 a unit. (Think of what this can save you!)

One customer's week could be another customer's year.

INFORMATION RETRIEVAL NUMBER 102

ELAPSED TIME INDICATORS IN STOCK

Model T4B — Miniature use-time indicator. Scale to 9999.9 hours, with tenths in red. Non-reset. 110 V, 60 Hz. Panel or bracket mount. 1.59" wide.

Model T5BB—Economical use-time indicator. Scale to 9999.9 hours, with tenths in red. Non-reset. 110 V, 60 Hz. Panel mount. 2.88" dia.

T30A—Choice of hours, minutes or seconds scale—4 or 5 digits—tenths in red. Push button reset. 115 V, 60 Hz. Universal bracket mount. 3.0" wide.

T3B—Double scale use-time indicator—99,999.99 hours total time and reset time. Tenths in red, hundredths with sweep hand. Reset scale knob resettable. 115 V, 60 Hz. Panel mount. 1.87" square.

Many other standard elapsed time indicators carried in stock. Specials to fit your requirements. OEM discounts available. Also complete lines of electrical, mechanical and predetermined counting devices. Send for new 4-page Condensed Catalog and Price List 69A.

WRITE OR PHONE FOR DETAILS.
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 x 0.21 in. and will replace the old 0.23 x 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

The original miniature ALCOSWITCH® has been the engineer's 1st choice for contemporary front panel designs.

When most every one was working with conventional switches of the 1930's, ALCOSWITCH® introduced the concept of mass-produced switches compatible with the new technology of miniaturization.

Ultra-miniature in size, the original ALCOSWITCH® combines high current capacity and exceedingly long life into a ½" size case. Contacts are solid silver and the phenolic body has high voltage barriers between terminals and contacts.

Since its introduction the original ALCOSWITCH® has withstood the test of time, where today it is the "most-asked-for" miniature switch.

This broad line of miniature switches includes toggles, push buttons and rotaries, all available in one, two, three and four pole in a single case construction.

Read all about it in this 20-page catalog!

ALCO ELECTRONIC PRODUCTS, INC.
Lawrence, Massachusetts 01843

INFORMATION RETRIEVAL NUMBER 104
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.
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.

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.
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.

Typical attenuation (band center)

<table>
<thead>
<tr>
<th>Tunable frequency range (MHz)</th>
<th>Model</th>
<th>Power (W)</th>
<th>Insertion loss (dB)</th>
<th>Isolation (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100–200</td>
<td>CU311A</td>
<td>30</td>
<td>&lt; 1</td>
<td>&gt; 20</td>
</tr>
<tr>
<td></td>
<td>CU312A</td>
<td>50</td>
<td>&lt; 1</td>
<td>&gt; 20</td>
</tr>
<tr>
<td>200–400</td>
<td>CU321A</td>
<td>30</td>
<td>&lt; 1</td>
<td>&gt; 20</td>
</tr>
<tr>
<td></td>
<td>CU322A</td>
<td>50</td>
<td>&lt; 1</td>
<td>&gt; 20</td>
</tr>
<tr>
<td>300–600</td>
<td>CU331A</td>
<td>30</td>
<td>&lt; 1</td>
<td>&gt; 20</td>
</tr>
</tbody>
</table>

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.

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

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

INFORMATION RETRIEVAL NUMBER 109
Electronic Design 4, February 15, 1970
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.

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

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.

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 \times 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.

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.

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.

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.

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.

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.
That's our Molex Mini-Connector. It's doing big things. Like saving assembly steps. And time. And money. Getting wiring in place with greater production efficiency and operational integrity than you might think possible. Our business is creating these mini-devices to meet your system requirements. We take it seriously. And have the facilities, design capabilities, know-how and everything it takes to produce economical connections . . . fast!

If you would like a free sample of our Mini-Connector, please write. If you would like a sample of performance, you can make connections by calling (312) 969-4550.
New Literature

Resins and epoxies

A new series of illustrated technical bulletins enable the user to choose the best resin-catalyst combination for his application. Typical applications include large embeddings 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

Thyrists

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
antennas anyone?

from P-band through K-band frequencies

VEGA antennas meet and surpass the transmission needs of most airborne vehicles. More and more project engineers and technicians are looking to VEGA for high performance at extreme environmental conditions. See VEGA-for: Slotted Blades, Quartz Cavity-backed Helixes, Stubs, Loop-Vees, Bi-conicals, Power Dividers, and Variable Power Dividers. Picture a VEGA antenna in your next airborne vehicle. In every way VEGA fits into the picture. Contact: VEGA PRECISION LABORATORIES, INC. 239 Maple Avenue, Vienna, Virginia 22180 (703) 938-6300

New Oak Versatility

OAK ECONO-LINE
PUSHBUTTON™
JUST 25¢ A BUTTON*

*For most applications

We've got the button... throws from 1 PST to 8 PDT per button; sizes: .388" sq., .388" x .585" or .388" x .782"; legends engraved to your specifications; black or white buttons are standard, other colors on special order.

Push Rod Stroke... ¾" plus ¾" overtravel; push rod lengths optional at ½", ¾" standard length, ¾", ¾" and 1".

Easy to wire... clips are Oak-pioneered double-wiping. For printed circuit boards or wire-soldering, PCB terminals are ¾", ¾", ¾" standard length, ¾" and ¾" shoulder to tip. Choose terminals for wiring only or P.C. dual-purpose which have the wire hole in addition to the P.C. lug.

Compact Convenience... more buttons per area—24 on .394" centers, 16 on .591" centers, 12 on .788" centers. Any switching—momentary, push-push, interlock, or blockout or combinations. For full details, write today for Bulletin SP-346.
Rendez-vous
in Paris
Port de Versailles
April 3 - 8, 1970

100,000 technicians are expected to attend

SALON INTERNATIONAL DES COMPOSANTS ELECTRONIQUES
Scientific, Technical and economic problems from April 6-10, 1970. - Paris - Conference Room of UNESCO Program, schedule and registration on request.

INTERNATIONAL CONFERENCE ON ADVANCED MICROELECTRONICS
Under the supervision of the National Federation of Electronic Industries. 16 - Rue de Presles - PARIS (15°) - Tel. 273.24.70+

NEW LITERATURE

Torque motors
A comprehensive guide to a line of brushless dc torque motors is now available. It includes moving-coil torque motors, dc tachometers, dc torquer/tachometers, and dc torquer amplifiers. The brushless concept and its benefits and applications are given a concise definitive evaluation. Shown are specifications of typical types of motors, related performance curves and a table of conversion factors. Aeroflex Laboratories Inc.

CIRCLE NO. 454

Relays
A six-page brochure summarizes the specifications of TO-5 and solid-state ac relays. It presents specifications and drawings for several lines of relays including basic and hybrid military TO-5s, industrial TO-5s, and industrial solid-state relays. Lines include magnetic latching spdt, dpdt and 4p4t, 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

leaver lock
flatted toggle
rt. angle mtg. (horiz.)
pushbutton
rocker switch

We’d rather switch than fight.
And have we ever switched! If you put any one of these 8 new subminiature switches on your “whatever”, you’ll have a better performing “whatever.” All C&K switches are competitively-priced and Made-in-America. How’s that for a switch?
Ask for our new catalog.

C&K COMPONENTS, INC.
103 Morse Street, Watertown, Massachusetts 02172
Tel: (617) 926-0800

INFORMATION RETRIEVAL NUMBER 114

Fast-Connect PC BOARDS
SAVE YOU MONEY!

If latest developments of your products indicate use of PC boards, contact us BEFORE designing expensive etched terminals, custom connectors and costly new wiring harnesses!

Our technique of combining PC boards with STANDARD FAST-CONNECT TERMINAL TABS does the job inexpensively and well, and permits use of existing equipment for wiring.

We supply money-saving PC board SUB-ASSEMBLIES with solid state components wave or hand soldered, and basic boards with fast connect terminals of 0.110, 0.187, 0.205 and 0.250 in. from stock tooling — ready for immediate use with standard quick-connect style plug-ons.

FREE Catalog and Designer’s Guide

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CINCINNATI, OHIO 45225

Write or call NOW!
TELEPHONE (513) 681-5424

INFORMATION RETRIEVAL NUMBER 115

Electronic Design 4, February 15, 1970

on small REED RELAYS

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

WHEELOCK SIGNALS, INC.
273 Branchport Ave.
Long Branch, N. J. — 201-222-6880

INFORMATION RETRIEVAL NUMBER 116
Syntronic engineers and manufactures the most extensive line of deflection yokes available...and continually develops new designs to satisfy the ever increasing requirements of the display industry. For large production or custom applications get the engineering control and production experience that only SYTRONIC, the yoke specialists, can provide.

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.

Connectors

Two connector lines, qualified to MIL-C-83723 (USAF), are shown in a new catalog. They meet military aircraft needs for upgrading environment-resistant connectors. Shown are threaded-coupling connectors that are intermateable and interchangeable with MIL-C-5015 connectors, and bayonet-coupling connectors that are intermateable and interchangeable with MIL-C-26482 connectors. Both connectors operate in temperatures from −55 to +175°C and can be made to operate from −55 to +200°C. ITT Cannon Electric.
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 x 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.


Proven: Your most efficient circuit board heat sink . . . .

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 HC18 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.
The capacitor manufactured with close control process insures long-term reliability to the telephone communication industry standards. S&E capacitors are utilized in many telephone line card and repeater circuits, with special purpose circuits for outlying areas that require modified apparatus. Our service to you makes available versatility of design capabilities, quick action on prototype and production needs, with process controls to assure you the confidence of utmost reliability to complement your design criteria. We invite you to call or write to give us an opportunity to demonstrate our service.

S&E Manufacturing/Capacitors
18800 Parthenia Street, Northridge, California 91324
P.O. Box 832 • (213) 349-4111 • TWX 910-493-1252

NEW LITERATURE

Precision components

Hundreds of new precision components are listed in a supplementary 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.

Transistor testers

Descriptions and specifications of four transistor-testing instruments are included in an eight-page bulletin. One model measures dc parameters of npn and pnp transistors on a go/no-go basis. It also tests many types of diodes, SRCs, and other semiconductors. A second model tests medium and high-power transistors under variable-duty cycle conditions. A third model measures transistor gain under high frequency operating conditions. A fourth model tests basic transistor parameters. Baird-Atomic, Inc.

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. Eleco Corp.
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.

BUCKBEE-MEARS COMPANY
245 E. 6th St., St. Paul, Minn. 55101 / (612) 227-6371

INFORMATION RETRIEVAL NUMBER 124

ENGINEERS
Telecommunications
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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 functions.
Responsibilities include electrical design and development of commercial telecommunications products as they apply to microwave radio, trunk and subscriber systems. BS or MSEE required.

- TRANSFORMER & INDUCTOR DESIGNER
Responsibilities include trouble shooting factory problems as well as writing test specifications for components designed. BSEE (or equivalent) required plus a minimum of 2 years experience.
LENKURT IS THE LEADER in the manufacture and development of communications systems for the Telephone, Industrial and Government markets. We offer stable employment with excellent opportunity for advancement...exceptional benefits...liberal vacation policy...in addition to spacious, modern Engineering Laboratories.
Applicants are invited to send complete resume, in confidence, to: Barrett D. Johnson, Employment Manager

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an equal opportunity employer

INFORMATION RETRIEVAL NUMBER 901
Electronic Design 4, February 15, 1970

DISPLAY
CIRCUIT MODULES

DYNAMIC FOCUS FUNCTION GENERATOR
FG100
Converts X and Y deflection current samples into parabolic voltage wave forms to maintain beam focus anywhere on the CRT face.

LINEARITY CORRECTOR
LC101A
Gives on-axis linearity correction for geometric distortion occurring when a flat-faced CRT is used. Ideal for line-scan applications.

CENTERING COIL CURRENT REGULATOR
CR200
Supplies highly stable constant current to two axes of centering, alignment or static astigmatic correction coils in CRT, storage tube or vidicon systems.

VIDEO AMPLIFIER
VA105
Linear, featuring high output capability, fast rise and fall time, excellent full power output and bandwidth. Unique damping control.

STATIC FOCUS CURRENT REGULATOR
SR1000
Provides a fully adjustable constant dc current supply to the static focus coil in magnetically focused systems. Low ripple, adjustable.

INFORMATION RETRIEVAL NUMBER 125

163
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.

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.

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.
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.

**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.

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

**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.

The National Cash Register Company
ELECTRONICS DIVISION
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An equal-opportunity employer

INFORMATION RETRIEVAL NUMBER 902
BASIC programming

A new BASIC-plotting software brochure attempts to standardize the software required by the user of Complot plotting hardware. It describes in detail the latest version of the BASIC plotting software plus two new subroutines in addition to extensive changes made to existing subroutines. An initialize routine has been added to the BASIC software to accomplish the task of setting the routines to handle the desired computer, plotter, and communications configuration. Houston Instrument.

CIRCLE NO. 465

DC components

A four-page short form catalog contains a list of digital panel meters, galvanometer drivers and dual dc power supplies. It also includes dc data, differential and voltage-to-frequency converters. Covered are over 50 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
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).
ANTENNA ENGINEERS

Antenna design, development and test including large aperture unfurlable antennas. Background in electromagnetic theory, with experience in the design and development of sophisticated, broadband feed systems. Knowledge of computer programming and applications of computer techniques to antenna problems is desirable. For more information write to Mr. H. W. Bissell, Professional Placement Manager, P.O. Box 504, Sunnyvale, California 94088. Lockheed is an equal opportunity employer.

NEW LITERATURE

Cooling devices

Analyzing and explaining fan-selection criteria is a six-page two-color short-form catalog and engineering-data bulletin for cooling devices for industrial and scientific equipment. Three of the six pages are devoted to a technical exposition of how and why certain design features of a fan affect its reliability and effectiveness as a cooling device. Selection criteria are developed from this theoretical exposition. Also covered is an entire line of subminiature, miniature, and larger fans, grouped according to size, volume of air-flow, or special application. Pamotor Inc.

CIRCLE NO. 469

Magnetic tape heads

A detailed and comprehensive 24-page catalog presents specifying information for a line of magnetic heads for a number of applications. In addition to detailed technical data and full physical and electrical specifications, it provides comprehensive ordering information and other head selection aids. Design helps incorporated in the catalog include a new cross-reference between OEM and distributor part numbers and a convenient chart of recording track configurations that is suitable for wall hanging. Nortronics Company, Inc.

CIRCLE NO. 470

Nuclear equipment

A new 16-page catalog contains a wealth of nuclear instruments and materials for sale. It includes such items as nuclear detectors, foils, gloves and boots, isotopes, lead products, license-exempt products, monitors, pipettes and planchetts. 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
Free Career Inquiry Service  
Absolutely Confidential

Respond to the career opportunities advertised in this issue. Fill out and send us this handy resume. 
Electronic Design will do the rest — neatly typed copies of this form will be mailed to the companies of
your choice, indicated by the circled Career Inquiry Numbers at the bottom of this page.

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NEW LITERATURE

Thermistors
Specifically designed for electronic engineers, designers and purchasers is a condensed 12-page thermistor catalog. It includes a selected list of a wide variety of solid-state thermistors, varistors and related components. Tables of characteristics, dimensioned outline drawings, product discussions and operating curves are thoroughly detailed. Victory Engineering Corp.

CIRCLE NO. 472

Counters
A complete line of electrical impulse counters, accessories and drivers is described in a new six-page catalog. It consolidates information formerly contained in 14 separate technical bulletins. Included is such information as illustrated counter photographs with complete case dimensions, a listing of counters with model numbers, and pertinent technical descriptions. Kessler Ellis Products Co.

CIRCLE NO. 473

Equipment installation
The sound benefits of protection derived from an installation and erection service for electrical power equipment is shown in a new four-page bulletin. It explains the advantages offered by this service such as technical familiarity, assurance of approved assembly, apparatus inspection and on-site updated modifications. Westinghouse Electric.

CIRCLE NO. 474

Modular program system
The characteristics of an advanced modular programming system are described in a four-page brochure. It contains a complete outline drawing and dimensional information about the individual module. Included are a rendering of system buildup, and diagrams of the shorting pins and diode holders which can be used interchangeably with it. Programming Devices Div. of Sealectro Corp.

CIRCLE NO. 475
Coding keyboard
A no-bounce coding keyboard that requires no circuit boards or soldered connections is described in a new brochure. The brochure contains a discussion of the keyboard's operating principles, its applications, detailed specifications, features and available options. It also contains photographs and an exploded mechanical view of the keyboard. Mechanical Enterprises, Inc.

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 16-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.

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.

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

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.
425 Union Boulevard
West Islip, L.I., N.Y. 11795

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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Design Data from

1970 Electronic Components Drafting Aids Catalog


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7300 Radford Avenue
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(213) 982-2000 Telex: 674672

Clamp or Tie Wire Bundles
In Seconds!

Six-page catalog contains complete ordering information for CAB-L-TITE® clamps and BUND-L-TITE® straps, devices which provide a fast and reliable means of securing wires and wire bundles. Units withstand loadings greater than 50 G’s, are removable in seconds for re-routing wires, and are self-locking—no tying, no knots, no hitches to come loose. Lightweight Du Pont Zytel meets MIL-P-17091 and MIL-P-20693. Proved in aircraft and missiles. Photos, dimensional drawings, tables, physical properties, specifications, price list. Request catalog A.

Dakota Engineering, Inc.
4315 Sepulveda Blvd.
Culver City, California 90230

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PEM miniature self-clinching fasteners are made for permanent mounting on thin panels. Dimensioned to fit into minimum space, they provide strong, self-locking threads equal to MIL-N-25027C. Available in four types for panel thickness as thin as .020”, they are always flush with one surface when squeezed into pre-punched or drilled holes. They are offered in thread sizes from #0-80 to 1/4-20 in 303 stainless steel for optimum hardness to imbed into most panel materials coupled with good ductility for smooth, non-galling self-locking characteristics.

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SiliKromes® are silicon rubber colored filters that instantly change the color of clear miniature lamps. Capable of operating in extremely difficult environmental conditions, SiliKromes serve, for example, at 500°F for 1000 hours or more without color fade or degradation of the elastomer properties. Interchangeable and reusable, the filters come in any color, meet MIL-S-22885 and other applicable Mil-Specs, and are ideally suited for switch indicators, lighting panels, instrument lighting, automotive radios and dash panels and many other military and commercial applications. Write today for free SiliKrome samples, and detailed information.

APM Hexseal Corporation
44 Honeck Street, Englewood
New Jersey 07631 (201) 569-5700

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.

Curtis Development & Mfg. Co.
3236 North 33rd Street
Milwaukee, Wisconsin 53216

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.

Hayden Book Company, Inc.
116 West 14th Street
New York, N.Y. 10011
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12 Different Silicone (HL) and Vitreous (VL) Models

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<td>1 ohm</td>
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