These engineers design laws. They are the only seven of their profession in Congress. Why did they trade their slide rules for campaign buttons? And has an engineering education helped or hindered their work as legislators? For the views of this elite group of U. S. Congressmen, turn to the story that starts on page 60.
Today, fast, low-cost pulses with variable rise and fall — tomorrow, a system!

HP’s new, all-solid-state 1900 Pulse System gives you the best of two worlds. For only $1195, you can get a 7 ns variable rise and fall generator, right away. Then, as your needs and or funds increase, plug-in capability allows you to get additional features, without having to buy a whole new generator.

Our basic package consists of a rate generator, a pulse shaping output, and a mainframe.

The 1917A pulse shaping output provides 10 V pulses with variable rise and fall times as short as 7 ns, reversible polarity, and dc offset. It takes up only half of a mainframe, and can handle rep rates of up to 25 MHz. A unique external-width function allows the 1917A to be used as a pulse amplifier, also, maintaining width and spacing of externally-supplied pulse trains.

The 1905A Rate Generator ("clock") is a quarter-size plug-in. It provides output triggers at repetition rates from 25 Hz to 25 MHz in six decade ranges. Rep rate can be determined internally, by external triggering, or by single-pulse push-button. Gating feature allows pulse bursts. The 1901A Mainframe is a standard rack size unit, and contains power supplies that can be used to power other 1900-series plug-ins. Built-in EMI and RFI shielding are standard.

Price of this three-part package (including a blank plug-in) is only $1195. As your needs change, available plug-ins include a 350 ps output, a 16-bit (RZ, NRZ) word generator, variable delay generators, fan-in and fan-out generators, and optional analog programming — plus a high power pulse-shaping output (1 A, 500) and mainframe.

Call your local HP field office for ordering. For further information on the HP 1900 Pulse System, see pp. 254-261 in your 1970 HP catalog, or send for our new free brochure on pulse generators. Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.
The new GR 1808 AC Millivoltmeter is so plain it's almost ugly. The beauty of the 1808 lies in the engineered features that give it the plain look. First of all, there's only one voltage scale and it's as easy to read as a yardstick. You can't read the wrong scale!

Look at the range switch — only six positions! Most voltmeters have twelve ranges and panels so cluttered they look like they belong in an SST, not on the bench. That's because most voltmeters have only a 3:1 meter range. The GR 1808 has a 10:1 range which halves the amount of range switching and means faster, easier, error-free readings for you. The meter is big, too — 6 inches of scale as compared to the usual 4½-inch varieties.

A point about stability — line-voltage variations cause absolutely no meter jitter or change of reading on any range.

Voltage measuring range is from 100 µV to 150 V from 10 Hz to 10 MHz. Basic accuracy is ±1% of reading, and input impedance is 10 MΩ shunted by 10 pF. A floating dc output is available for recording or for using the GR 1808 as an ac to dc converter for DVM's.

The features may be fancy, but there's nothing fancy about the price; only $295 in U.S.A.

For complete information, write General Radio, West Concord, Mass. 01781; Telephone (617) 369-4400.

In Europe: Postfach 124, CH 8034, Zurich, Switzerland.
Which 5-digit multimeter is your best buy?

The new S-D 7005 offers five-digit resolution and accuracy. Designed for top performance in actual laboratory use.

Price: $1,295.

S-D just introduced it.

Prove it to yourself. Ask these questions in evaluating any competitive DVM:

- Does the basic DVM include four dc ranges from 1 V full scale to 1,000 V full scale?
- Can all optional functions be added by means of individual cards at any time? (Auto-ranging, AC volts, DC millivolts, ohms, DC current and digital outputs?)
- Is the input impedance greater than 10,000 megohms on 1 V and 10 V ranges? Is feedback noise at the input terminals less than 1 mV? Is full scale response time less than 400 milliseconds?
- Does the unit use dual slope integration for max noise immunity at line frequencies? Are plug-in cards used for easy maintainability of all measurement circuitry?
- Does it have an annunciator to remind you what measurement you’re making? Are its digital outputs compatible with both IC logic and discrete component logic?
- The S-D 7005 offers all these features and more for just $1,295. Request technical data or a demonstration from your local Scientific Devices office or contact: Concord Instruments Division, 888 Galindo St., Concord, California 94520. Phone: (415) 682-6161. TWX: 910-481-9478.
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Information Retrieval Service Card inside back cover

Cover: Designed by Art Director Clifford M. Gardiner and photographed
by Henry Ries.
Low-power astable and monostable oscillators

COS/MOS IC’s offer unique advantages in low-power astable and monostable oscillator circuits.

A new RCA Application Note (ICAN-6267) describes how COS/MOS IC’s in multivibrator circuits:

- offer large time-constants without the use of large capacitors
- operate at frequencies up to 1 MHz
- provide excellent frequency-stability over a broad operating-temperature range (-55°C to +125°C)
- permit simple circuit design—only two external components required
- consume only 10 nW @ V_{DD} = 10 V, f = 10 kHz

The schematic diagram (Fig. 1) is taken from the referenced application note and shows a typical astable multivibrator circuit using a CD4001 COS/MOS Gate. This circuit is implemented through the use of two of the gates in the COS/MOS IC plus the external capacitor and resistor incorporated to establish timing. Typical operation of the circuit is: multivibrator period approximately 0.6 ms with R_{E} = 0.4 MΩ, C_{1} = 1000 pF @ \( V_{DD} = 10 \text{ V} \).

The voltage waveform for the circuit is shown in Fig. 2.

Application Note ICAN-6267 provides data on multivibrator frequency as a function of temperature and supply-voltage variations and includes information on nine circuits for astable and monostable oscillators built around COS/MOS IC’s.

Thinking industrial applications? Think RCA Thyristors

There’s good reason why RCA thyristors in stud and press-fit packages should be foremost in your mind, where industrial controls or power switching systems are your concern. Simply, RCA’s broad line of SCR’s and triacs provide the winning combination of quality, reliability, performance and availability for a myriad of key industrial applications. RCA has the right thyristor for the job—available now!

When you look closer, you’ll find RCA is a key industrial supplier of SCR’s and triacs for numerous types of industrial control equipment, motor controls, computer power supplies, heating controls, lighting controls, and power switching systems.

A broad line it is, when you consider, too, the wide selection of current ratings available from stock:

- SCR’s—10, 20, and 35 A
- Triacs—10, 15, 30, and 40 A

Each unit is available in press-fit, stud, or isolated-stud packages. Families of RCA SCR’s are rated 25 to 600 volts, and triacs are rated from 100 to 600 V—depending upon type and your requirements.

Circle Reader Service No. 152.
purchased in unconnected form. Access is provided to the terminals of each internal device—permitting complete versatility in developing circuitry. These interconnections can readily be manufactured by RCA to fill your volume requirements. Circle Reader Service No. 153.

IC Triac control circuit with built-in protection

An IC Thyristor Trigger, RCA's CA3059, offers the power circuit designer significant advantages:

(a) Switching transients and RFI are reduced since the IC permits switching to occur only at zero supply voltage

(b) Built-in protection against sensor failure

In the heater application shown here, the protection circuit removes power from the load if the sensor shorts or opens. To utilize the protection circuit, connect terminal 13 to terminal 14, as shown, and then:

Set the value of $R_p$ and sensor resistance ($R_x$) between 2 kΩ and 100 kΩ. Hold the ratio of $R_x$ to $R_p$ within 0.25 and 4. If the ratio falls outside these limits, a resistor must be added, in series with the sensor or across the sensor, to provide a resistance ratio within this allowable range.

For Triacs specifically intended to operate with the CA3059, check RCA's 2.5- to 40-ampere, 100-600 volt series, Types 40693-40734. Circle Reader Service No. 154.

VERSATAW: the stereophile's choice

Many "top-of-the-line" stereo manufacturers are studying the RCA 2N5494 silicon transistor—and other transistors of the VERSAWATT family—for use in their high-fidelity solid-state equipment.

VERSAWATT TYPES FOR AUDIO APPLICATIONS

<table>
<thead>
<tr>
<th>Transistor</th>
<th>Power (watts)</th>
<th>Amperes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2N5296</td>
<td>4</td>
<td>1.0</td>
</tr>
<tr>
<td>2N5298</td>
<td>9</td>
<td>1.5</td>
</tr>
<tr>
<td>2N5490</td>
<td>16</td>
<td>2.0</td>
</tr>
<tr>
<td>2N5492</td>
<td>26</td>
<td>2.5</td>
</tr>
<tr>
<td>2N5494</td>
<td>35</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Using the 2N5494 in the output of a quasi-complimentary symmetry circuit, one manufacturer finds this low cost, 3 A n-p-n transistor especially suited to audio amplifier applications. It has a low thermal resistance rating, and its current and voltage capability contribute to high performance. An added bonus:

VERSAWATT transistors employ Hometaxial-base construction to provide freedom from second-breakdown problems.

VERSAWATT transistors are available in three basic configurations—straight lead (JEDEC TO-220 AB), TO-220 AA (direct replacement for TO-66) and a package with leads shaped for easy PC board mounting. Circle Reader Service No. 155.

High power GaAs Lasers for portable range finding devices

When a helicopter lands in a swirl of dust, the aircraft's safety may depend upon the pilot's ability to gauge distance between copter and ground. A laser altimeter is only one device in which RCA TA7705 and TA7787 gallium arsenide (GaAs) lasers find application. They may be used in ship-docking instrumentation, anticollision devices, and many other portable ranging systems.

Since these GaAs laser diodes have short pulse duration and fast rise time ratings, equipment accuracy of a few inches is possible over a measured distance of a few feet to several hundred feet...allowing vital range resolution.

The TA7787 is unique! It is the largest single lasing chip available—55 mil source dimension. Minimum radiant power output is 60 watts at 100 PPS. The TA7705 is identical to the TA7787 except that its output is 40 W min. Drive current for both types is 250 A (typ); output pulse is 100 ns. Both units radiate at a center wavelength of 9050 angstroms.

The TA7705 and TA7787 are available in OP-12 coaxial stud packages. Why not design them into your portable ranging equipment?

Pulsing circuit diagrams for these lasers are available upon request. Circle Reader Service No. 156.

For price and availability information on all solid-state devices, see your local RCA Representative or RCA Distributor. For specific technical data, write RCA, Commercial Engineering, Section 57G-5/UM5, Harrison, N. J. 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Liévre, 1227 Geneva, Switzerland.
You've got to see our solid state displays to believe them.

New alphanumerics and numerics shown actual size.
So here's our "You've got to see them to believe them" sample offer.

HP offers very big rewards in numeric and alphanumeric solid-state displays:
- IC compatibility — 5 volts or less eliminates the need for a separate high-voltage power supply.
- Human-factor engineered to make false readings virtually impossible.
- Long operating life — conservatively rated to give you a minimum of 10 years (MTBF) of brilliant service.
- Rugged construction — units are hermetically sealed and can withstand severe environmental conditions.
- Small size — allows for the compact presentation of digital data.
- Human-factor engineered to make false readings virtually impossible.
- Long operating life — conservatively rated to give you a minimum of 10 years (MTBF) of brilliant service.
- Rugged construction — units are hermetically sealed and can withstand severe environmental conditions.

For a limited time, our alphanumerics are available in a 3, 4, or 5 character package for just $20.00 per character; limit of one package per customer. The numerics are available for the low cost of $25.00 each; limit three per customer. These are the regular volume prices.

Fill out the coupon completely and mail it with a check or P.O. You'll be in for the brightest surprise any display ever gave you.

HEWLETT PACKARD
SOLID STATE DEVICES

Tear out and mail to: Hewlett-Packard, HPA Division, 620 Page Mill Road, Palo Alto, California 94304

NAME_________________TITLE_________________
COMPANY__________________________ZIP_________
ADDRESS__________________________

☐ 3 character unit, $60.00 ☐ 4 character unit, $80.00 ☐ 5 character unit, $100.00
(7100 Series)
☐ Please send me_____ numeric indicators at $25.00 per unit. (Limit 3.)
(7100 Series)
☐ Please send me complete information on your solid state displays.

Offer expires September 30, 1970 / Coupon must accompany order.

ELECTRONIC DESIGN 14, July 5, 1970
The Sweet Heart Of The MODEM System

One call does it all

Dial Motorola for complete data about the industry’s most complete line of “Dial-for-Data” MODEM circuits. There’s an IC for every stage; and they’re all available at cost-saving system prices.

RS-232C Line Drivers and Receivers ... the first and only monolithic quads in the industry to meet this stringent EIA spec. They’re designated MC1488L and MC1489L.

More importantly, because there’s four in one package, you get more board space, lower package count. And, they’re directly compatible with MDTL and MTTL logic circuits. Both types are available right now in the 14-pin dual in-line ceramic package.

Op Amps for Active Filters ... to select specific audio tones from telephone lines. A dual op amp is the ideal element; and, your ideal choice would be the MC1437L (a dual MC1709C) or the brand new MC1458G (a dual MC1741C). The latter is internally compensated for frequency response. Both devices cost considerably less than two single-package op amps and compare favorably with mechanical resonators or reed systems ... and, of course, are much more reliable!

Tone Generators ... The MC1550G is a high-frequency differential amplifier that makes an ideal, ultra-stable oscillator with built-in bias circuitry at little more than the cost of a transistor.

Digital Logic ... MDTL or MTTL can be used to control the frequency-shift keyer and to perform other MODEM logic functions. Motorola offers a complete line in both families.

There’s a Motorola IC for every MODEM stage; and, they’re all available “off-the-shelf” ... at cost-saving system prices:

<table>
<thead>
<tr>
<th>Type</th>
<th>Function</th>
<th>Price (100-up)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC1488L</td>
<td>Quad RS-232C Line Driver</td>
<td>$7.00</td>
</tr>
<tr>
<td>MC1489L</td>
<td>Quad RS-232C Line Receiver</td>
<td>$6.00</td>
</tr>
<tr>
<td>MC1437L</td>
<td>Dual (MC1709-type) Op Amp</td>
<td>$3.25</td>
</tr>
<tr>
<td>MC1458G</td>
<td>Dual (MC1741-type) Op Amp</td>
<td>$4.00</td>
</tr>
<tr>
<td>MC1445G/L</td>
<td>Dual-input F.S.K. Switch</td>
<td>$3.95</td>
</tr>
<tr>
<td>MC1550G</td>
<td>Differential Amplifier</td>
<td>75¢</td>
</tr>
</tbody>
</table>

If you’re interested in complete data about integrated circuits for the complete MODEM system, simply Dial-for-Data ... (602) 962-3161. Or write: P.O. Box 20912, Phoenix, Arizona 85036.

* MDTL, MTTL trademark of Motorola Inc.
NEW NAME IN THE OP AMP GAME

There's a new name in the game for the best low-cost general-purpose IC op amp. Sprague 2139. Available now.

Plug the new Sprague 2139 into sockets where you've had the 1539, 741, 101 or the 709. Improved performance! Available now!

The Sprague 2139 comes in 8-lead TO-5 (TO-78) cans, and in chip form for building hybrids. Available now. And it's coming soon in plastic DIP.


SPRAGUE 2139

THE SPRAGUE 2139

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAST SLEW RATE</td>
<td>34 V/µs @ 100 gain</td>
</tr>
<tr>
<td>LOW NOISE</td>
<td>20 nV/(Hz) 1/2</td>
</tr>
<tr>
<td>VERY LOW TEMP. DRIFT</td>
<td>± 0.2 nA/°C</td>
</tr>
<tr>
<td>HIGH COMMON-MODE REJ. RATIO</td>
<td>20 V p-p @ 20 kHz</td>
</tr>
</tbody>
</table>

SPRAGUE ELECTRIC CO., SEMICONDUCTOR DIV., WORCESTER, MASS. 01606 (617) 853-5000


INFORMATION RETRIEVAL NUMBER 821

ELECTRONIC DESIGN 14. JULY 5, 1970
No other 28-lb. data recorder can make that statement.

Now available, our new 417 WB speaks wideband to the tune of 374.5K Hz at 30 ips. Of course it’s not the only recorder that meets IRIG specs for wideband Group II. But it’s the only one that weighs less than 50 lbs. (The 417 WB’s 28 lbs. also includes its carrying case and self-contained battery, by the way.) And it’s the only one small enough to fit under an airplane seat.

So, when you have to hit the trail for data, let the new 417 WB take a load off your back. And off your mind. It needs less maintenance and fewer adjustments than any other portable recorder. It ignores bumps, jolts, vibrations and odd mounting angles. It normally draws only 25 watts of power. It records on seven channels. And it matches large rack machines for accuracy.

But that’s just a taste. For the full 417 WB story and spec sheet, write Mr. Fred Romer, Dept. 412-10, Lockheed Electronics Company, Plainfield, New Jersey 07061. Or call him at (201) 757-1600. He, too, speaks wideband.

Lockheed Electronics
A Division of Lockheed Aircraft Corporation
Trading off performance for cost in conversion equipment?

Stop!

Raytheon Computer just cut prices 33%

Now you don't have to make any cost/performance trade-offs in A-to-D and D-to-A conversion or interface equipment. We've taken the best price/performance ratio in the industry and made it even better. With price reductions from 15% to 50%.

So now you can pick from the industry's broadest line of conversion equipment. With ADC's. DAC's. Multiplexers. Sample-and-holds. All at new low prices. All available now. Off-the-shelf.

Take our 12-bit, multiplexed ADC. Case-mounted with 32 channels, this unit was a good buy for $3,640. The new price is only $2,300. Want more capacity? It's available with up to 256 channels. With savings to match.

Or choose our high performance 0.05% sample-and-hold amplifier card. It's yours for only $125. And that's a savings of more than 33%.

And we'll throw in wiring lists, test results, and technical manuals. Free. We'll deliver your conversion equipment and documentation cheaper and faster than you could do it yourself.

And, if your systems need computer power, try one of ours. Choose from a family of 16-bit machines. With cycle times from 900ns to 1.75μs, including our new 1.0μs 704 mini for under $10,000. All are software compatible with over 400 proven off-the-shelf programs.

Get the best price/performance bargain in the industry for your system, today. Call or write and ask for Data File E-188.

Raytheon Computer, 2700 S. Fairview Street, Santa Ana, California 92704. Phone (714) 546-7160.

The only thing Raytheon Computer does is your job. Cheaper.
For further information on meetings, use information Retrieval Card.

Aug. 25-28

CIRCLE NO. 460

Aug. 30-Sept. 2

CIRCLE NO. 461

The Model 92A has been designed as the definitive rf millivoltmeter. Accuracy at all frequencies and voltage levels is the best ever offered by Boonton Electronics, long a leader in the rf millivoltmeter field.

Fast warm-up, high reliability, long intervals between calibrations, plug-in PC boards for ease of servicing, light weight, and no heat, are characteristics of the Model 92A’s solid state design.

STANDARD FEATURES
- Accuracy 1% fs + 1% rdg.
- Programmable
- Measures 100 µV to 3 V* from 10 kHz to 1.2 GHz
- True RMS response to 30 mV**
- Convenient push-button ranging and half-rack packaging
- Fast, high level dc output
- High input resistance, low input capacitance
- Overload protection to 400 V dc, 10 V ac
- VSWR less than 1.15 up to 1.2 GHz

Price: $750 Standard Unit
*To 300 V, up to 700 MHz with accessory 100:1 divider
**To 3 V, up to 700 MHz with accessory 100:1 divider

Call or Write for Details or Demonstration
It's true.

After helping a jillion feet of paper tape wind and unwind its way through communications systems everywhere, Teletype announces the addition of magnetic tape data terminals.

There are some basic advantages in both mediums. But as you are well aware, the medium that's right for a system depends a lot on the application criteria.

The new magnetic tape data terminals have many operational features that make life less complicated for the operator.

For example, take a look at the tape cartridge, which was specifically designed for reliability required for data transmission.

Its vital statistics are: 3" x 3" x 1".

It contains 100 feet of ½" precision magnetic tape.

It will hold 150,000 characters of data, recorded at a density of 125 characters per inch. The equivalent of a 1000 foot roll of paper tape.

This means that your data is easier to store, easier to handle, easier to work with than ever before. And it's reusable.

Teletype is a trademark registered in the U.S. Pat. Office.
The units have a "fast access" switch which will move tape forward or reverse at a speed of 33 inches per second. A digit counter provides a reference point to help locate various areas of the tape.

Four ASCII control code characters can be recorded in the data format to aid character search operations. When the terminal's "search" button is pressed, tape moves at the rate of 400 characters per second until the control code selected is detected. Then the terminal stops the tape automatically.

A "single step" switch is also provided which enables you to move the tape forward or backward one character at a time. In editing or correcting tape, you can send a single character using this feature.

Also magnetic tape adds high speed on-line capability to low speed data terminals. You can zip data along the line at up to 2400 words per minute. For example: Take a standard speed Teletype keyboard send-receive set, and a typical typist. Add a new magnetic tape unit to this combination and the on-line time savings can pay for the magnetic tape terminal in short order.

You can take better advantage of voice grade line speed capabilities. An operator can prepare data for magnetic tape transmission using the keyboard terminal in local mode. Then send it on-line via the magnetic tape terminal up to 2400 words per minute.

These new modular magnetic tape data terminals offered by Teletype are perfectly compatible with model 33, model 35, model 37 and Inktronic® keyboard send-receive equipment.

You can send or receive at high or low speed. Or can be used independently as stand-alone terminals on-line.

If you would like to know more about this new line of Teletype magnetic tape data terminals, please write Teletype Corporation, Dept. 89-15, 5555 Touhy Avenue, Skokie, Illinois 60076.
Built-in flexibility lets you choose:

- Arbitrary filter characteristics
- Single or multichannel processing
- Recursive structures (poles with or without zeros) or non-recursive (zeros only)
- One channel at 500 kHz sampling rate or 500 channels at 1 kHz (or anything in between)
- Optional word lengths in 4 bit increments — 16 or 24 bits standard
- Interface with computer, paper tape, or keyboard
- Internal A/D and D/A conversion
- Programmable characteristics with read-write memory
- Fixed characteristics with read-only memory (ROM)

Rockland's Series 4000 Lineup of Digital Filters Includes . . .

*SERIES 4100:
General purpose digital filters for laboratory-scale data analysis, simulation and testing applications in such areas as communications, sonar and geophysics.

*SERIES 4300:
Narrow band-pass/band-reject filters for applications in wave/distortion analysis.

*SERIES 4400:
Programmable comb filters for spectral analysis with primary applications in data analysis, vibration testing, radar.

*SERIES 4500:
Speech synthesizers to produce natural-sounding speech in real time for voice communications systems including computer voice response.

*SERIES 4600:
Variable low-pass, high-pass, band-pass, and band-reject filters as digital complements to Rockland's analog filters.

*SERIES 4900:
Variable all-pass filters for phase equalization and variable delay approximations.

PRICES START AT $5,000.
These new digital filters, along with Rockland's full line of analog filters, offer you a single source for all your signal processing requirements.

Rockland Systems Corporation
131 Erie Street East,
Blauvelt, New York 10913
For Instant Information Telephone

(914) 359-1818
The MAN 1:
A seven-segment light-emitting all-semiconductor alphanumeric 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, L, O, P and U. Available now. Any quantity.

- Brightness: 350 foot-Lamberts @ i=20 mA, 3.4V, per segment.
- Pulsed forward current=100mA, 10% duty cycle/segment.
- Compatibility: directly interfaces with off-the-shelf IC decoder/drivers.
- Price: 1,000 quantities, $11.00 (all prices are suggested resale figures).

The MAN 2:
An alphanumeric display made up of 36 discrete LEDs which can form 64 ASCII characters and a decimal point.
The IC-compatible 5 x 7 X-Y array gives you a bright red (peak emission 6500Å), high contrast display suitable for keyboard verifiers, avionics or computer terminals or other displays. Since the 36 dots can make 2⁶ bits available, the MAN 2 can be very useful in film annotation work.

- Per-diode brightness: 300 foot-Lamberts @ i=10 mA, 1.7 volt per diode.
- Pulsed forward current (50 µsec 20% duty cycle) 100 mA
- Light turn-on and turn-off 5 ns typical
- New reduced price: 1–9 quantities, $40.00.

GaAsLITEs are in stock world wide.
You know that all of our products are available in the U.S. through Schweber (516) 334-7474; Semiconductor Specialists (312) 279-1000; K-Tronics (213) 685-5888; or Kieruff. You can get them overseas as easily:

United Kingdom: SEMICONDUCTOR SPECIALISTS, West Drayton 6415
France: YOUNG ELECTRONIC, 604-10-50
West Germany: Alfred Neye, ENATECHNIK, (04106) 4022
Denmark: SCANSUPPLY, AEGIR 5090
Belgium: TECHMATION, 384078
Netherlands: TECHMATION, 020-173727
Norway: ARTHUR F. ULRIKSEN A/S, 21 6510
Switzerland: OMNI RAY A.G., 051-478200
Italy: SILVERSTAR LTD., 46.96.551
Sweden: GP-INGENIOERSFIRMAN, 08/930280
Japan: NEW METALS AND CHEMICALS LTD., (201) 6585-7
Australia: HAWKER DE HAVILLAND AUSTRALIA PTY., LTD., 93-0221
Israel: MONSEL

For additional technical information write Monsanto Electronic Special Products, 10131 Bubb Road, Cupertino, California 95014. (408) 257-2140.

The MAN 3:
The world's first commercially available planar monolithic display. Low cost, besides!
The MAN 3 is a small (.125" high) bright red GaAsP seven-segment display that gives you extremely good visibility with high density packing; 16 digits need only 3 inches on your display. And since the MAN 3 interfaces with our standard IC drivers and uses as little as 10 mW per segment, it's simple to design numerical readouts into desk calculators, truly portable battery-operated instruments, even timepieces.

- Brightness: 200 foot-Lamberts @ i=5 mA, 1.7 volt, per segment.
- Total cont. forward current: 80 mA.
- Pulsed forward current=50 mA, 10% duty cycle per segment.
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Circuit designers and suppliers hassled over the relative advantages of wire vs multilayer printed-circuit connections at the IEEE Eastern Electronics Packaging Conference. But amid the unresolved arguments, two new techniques were described that combine the features of multilayer with the fast turn-around and flexibility of wire interconnects.

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News Scope

Magnetic domain memory going into production

The magnetic domain memory, an experimental computer development for several years, is moving out of the R&D stage to the production line.

Hughes Aircraft Co., developer of the Dynabit magnetic domain memory, has assigned an exclusive license for the manufacture of the device to Digital Development Corp. of San Diego.

Hughes announced the business arrangement at the annual conference of the IEEE's Computer Group, held in the Washington Hilton Hotel. The conference, titled "The Challenge of the 70's," was devoted almost entirely to an exploration of the fast-growing computer peripheral field. Dynabit fits into this area as one of the newest entries in the auxiliary memory category.

Dynabit is a static, random-access memory based on controlled magnetic domain wall motion through a fine wire. According to John V. DiMatteo, public relations spokesman for Digital Development Corp., it is not suited for use as a main memory because it is too slow (1.0-ms typical cycle time), but it can compete with disk and drum auxiliary memories that require 5 to 100 ms.

DiMatteo says that Dynabit is very reliable because it is a completely static device. It can withstand high shock, vibration and temperatures from -80 to 200 C. No pricing has yet been announced, but the cost per bit is initially expected to be greater than that for disc or drum memory.

Dynabit can be used to store any number of bits, because it is a modular device that can be cascaded indefinitely. Production units are expected to be available during the last quarter this year.

The IEEE computer conference had a registration in excess of 1100 engineers—more than double the number attending the inaugural meeting last year in Minneapolis. Exhibitors were very impressed with the high technical qualifications of those who attended.

Dr. Lee DuBridge, science adviser to President Nixon, delivered the welcoming address at the conference luncheon.

21,000-W solar array being built for NASA

The largest solar-cell-array system for generating electric power on a spacecraft is being developed by engineers at NASA's Marshall Space Flight Center in Alabama.

The array will consist of two "wings," which will fold during launch and be exposed after the satellite reaches its orbital altitude. Each wing will contain 1200 square feet of solar-cell surface area, and together they will provide 21,000 W for about one hour during each orbit. This is enough power for five average houses, says NASA.

The power will be used to operate the Saturn Workshop and the Apollo Telescope Mount—the major components of the Skylab cluster.

A power-conditioning system will regulate Skylab's power to a nominal level of 28 V dc at about 4000 W.

The 18 solar cell panels of the Apollo Telescope Mount array will weigh 4000 pounds and charger-regulator-battery modules—one for each panel—will weigh 1980 pounds. While the final design of the Saturn Workshop has not been specified, NASA says that its solar panels will be wired to provide eight separate power sources.

The telescope component will orbit the earth at 250 miles—high enough above the atmosphere to give scientists a clear look at the sun.

The Saturn Workshop will contain 10,000 cubic feet of living and working space. Both components of the Skylab cluster will be launched separately in late 1972, according to the space agency.

Pacemaker users warned of radiation hazards

Electromagnetic interference put out by microwave ovens, electric shavers, auto ignition systems and TV sync generators may be serious enough to stop the hearts of persons with electronic pacemakers, the U.S. Bureau of Radiological Health and industry sources, have reported.

Industrial types of microwave ovens, such as are used by airlines and restaurants, can stop pacemakers at distances of up to 100 feet, according to James Fiala, president of the Microwave Heating Div. of EAS, Inc., Minneapolis. Other, less powerful equipment, he says, may cause malfunction and faintness of operation of pacemakers.

The problem with microwave ovens was spotlighted recently by a letter in the Journal of the American Medical Association, signed by five physicians. They pointed out in the May 18 issue that one patient had fainted near a microwave oven and that experiments had shown that the radiation caused the pacemaker to go into erratic action.

The problem involves both the type of pacemaker used as well as the condition of the rf seals on the microwave oven door. Edward Cheatham, engineering manager of pacemakers for Medtronics, Inc., Minneapolis, explains that there are two basic types of pacemakers: demand and asynchronous (constant beat).

The demand pacemaker, which increases the heartbeat with physical exertion, is the popular type. It has ac-coupled, high-impedance, sensitive amplifiers, which are more susceptible to electromagnetic interference than the electronics in the asynchronous units.

These pacemakers pick off a con-
Tough tape from Texas made of polymer alloys

By using high-performance polymer alloys instead of the common polyvinylchloride makeup of most magnetic tapes, a Texas company says it has achieved greater toughness than the best competitive product available.

The new magnetic tape, called Epoch 4, is also said to have better adhesion of the tape coating to its backing and improved recording characteristics. The developer, Graham Magnetics of Graham, Tex., is offering users a 20-year warranty against defects in the tape's materials and workmanship.

Mini-calculator rivalry intensifies in Japan

At least three Japanese electronics concerns have begun producing miniature calculators this year. The latest announcement comes from Sanyo Electronics, Ltd., in Osaka. Its new unit, which weighs 2.2 pounds and is smaller than a cigar box, not only can add, subtract, multiply and divide; it also can perform chain multiplication and division, mixed calculations, raising to a power and calculations by a constant.

The unit, called Sacom-Mini, has four MOS/LSI circuits that were developed by Sanyo through a technical agreement with General Instrument Corp. of Hicksville, N. Y. Other mini-calculators are being manufactured in Japan by the Micro Compt Div. of the Sharp Corp. and by Canon, Inc.

Honeywell a 'partner' in Japan's space effort

Honeywell, Inc., one of the first American companies to participate in the 1969 U. S.-Japan agreement for interchange of space technologies, has formed a company with Nippon Electric Co., Tokyo, to perform for the Japanese equivalent of NASA—the Japanese National Space Development Agency.

The first program expected to be undertaken by the new company is the development of guidance and stabilization systems for rockets that will launch Japanese communications satellites by 1975.

Honeywell and Nippon Electric have had cooperative arrangements for several years, with the Japanese company producing Honeywell avionics for the Japanese F-104 as well as Honeywell computers.

New wafer is expected to cut IC product costs

The availability of silicon on spinel epitaxial wafers has been announced, with predictions that it will lower the costs and improve the performance of MOS and other IC products.

Union Carbide Corp.'s Crystal Products Dept. in San Diego, developer of the new wafer, says it is a significant advance in semiconductor-on-insulating-substrate technology. David J. Valley, general manager of the department, predicts that spinel, a magnesium aluminate mineral, will replace silicon and sapphire as a substrate material in many applications. In addition, he says, spinel substrates will lead to new devices that are present are either economically or technically not feasible.

Potential applications include high-speed memories, precision thin-film monolithic devices and new photosensitive and thermal sensors.

The desirable properties of spinel as an insulating substrate include structural compatibility with the silicon film and high resistivity.

James J. Beeman, national sales manager for the Union Carbide department, reports the new wafers are available in development quantities. Made by the Czochralski, or pulled-from-melt process, the wafers are 1.25 inch in diameter by 0.020 inch thick, with a 2-micron single crystal silicon film. Union Carbide will sell spinel products in other forms—as grown boules and as cut wafers and polished wafers.

Beeman says a circuit combination of silicon on spinel epitaxial film active devices, with sputtered tantalum RC elements, would provide precision and stability. At the same time it would obviate the high cost and poor reliability associated with applied chips in hybrid circuits.

With present silicon ICs, high-precision resistors and capacitors of 0.1% or even 1% tolerance are not attainable because of their very high temperature coefficients.

Automated packaging seen on rise at Nepcon

An increased trend among component manufacturers toward automation was apparent at the National Electronic Packaging and Production Conference—Nepcon East—held last month in New York's Coliseum.

Conference Chairman Milton S. Kiver said, "Computer-aided packaging design is moving along with computer-aided circuit design." Another trend, Kiver noted, is that more companies are looking at in-house facilities for making their own ICs and hybrids. And, he said, job-shops are being set up to handle whatever part of the IC process that companies cannot do on their own, for example, masking.

Total attendance at the conference was better than 17,000 with about 350 companies occupying nearly 600 booths. Had economic times been normal, there would have been at least a third more attendance, Kiver said.
They're new, Molex edge connectors. For printed circuit boards. Terminals crimped to wires automatically. We have straight-in and right-angle types. With and without mounting ears. It's another giant step by Molex in helping create high-speed, low-cost devices that simplify circuitry. Reliable? You bet. The connector has bifurcated terminals that provide solid contacts. Yet you can slip the connector on and off many times without damaging printed circuits. And it's not a preloaded unit. Carries only contacts required. From nine to twenty-two.

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Major advances in interconnection promised

Two techniques described at IEEE conference blend best features of multilayer and wire-wrap

John N. Kessler
News Editor

Circuit designers and suppliers hassled over the relative advantages of wire vs multilayer printed-circuit interconnections at the IEEE Eastern Electronics Packaging Conference. But amid the unresolved arguments, two new techniques were described that combine the features of multilayer with the fast turn-around and flexibility of wire interconnects.

Ronald Morino, manager of manufacturing research at Photocircuits Corp., Glen Cove, N. Y., told conferencees at the Massachusetts Institute of Technology in Cambridge that his company was “in the last stages of developing a Multiwire system for commercial use.” The new technique consists of a numerically controlled machine that spits out 0.007-inch-diameter insulated wire with a built-in solder mask onto a circuit board.

A computer-generated punched paper tape drives the numerically controlled machine that plots the paths and dispenses the wire. After the interconnection paths are plotted, termination points are formed by automatic drilling and metallization of holes through the wire paths. Components are soldered into these holes.

The polymide film insulation on the wires permits crossovers without danger of breakdown voltages. According to Morino, Multiwire circuits will provide the lowest cost when ordered in lots of 250 to 3000 parts with interconnection complexity of about 20 pins per square inch. The product looks much like a printed-circuit board.

3-tier multilayer system

The second new technique is being developed by Loral Electronics, New York City, and is based more on multilayer than on wire interconnect technology. Alan Chertoff, assistant chief engineer, and James J. Foti, manager of micro-minimizeratization at Loral, described a three-tier multilayer system consisting of printed-circuit boards, substrates and chips. Each tier is topographically structured—multilayered in itself. The interconnect system is called QTA—Quick Turnaround. It is based on standardizing the internal layering of each multilayer tier and customizing the two outer layers.

“We have sorted out the interconnections that remain the same for all designs from those that change for each design,” Chertoff said. In this way we can batch-process the internal interconnections and produce thousands of them. The only thing that remains to do is to etch the outer surfaces.”

Chertoff emphasized that the QTA system is highly adaptable for large-scale integration. What Loral calls the “master logic chip”—MLC—contains up to 150 elements and can be interconnected to higher-order assemblies, such as multilayer substrates and multilayer printed-circuit boards. “This three-tier packaging system is a viable alternative to the discretionary wiring approach to LSI,” Chertoff said.

Foti, who presented the paper as co-author with Chertoff, described QTA as a “custom-universal interconnection network.”

“With QTA,” Chertoff explained later, “the design engineer can specify the number of printed-circuit boards he needs, the number of substrates, the number of chips. He reaches up on the shelf and takes what he needs. All the boards are pre-drilled. The etching of the outer surfaces can be done in two weeks.”

Chertoff contended that if this were done for a conventional multilayer system, it would take “four months to get the boards, four to six months to get the substrates and about the same time to get the chips.”

“In two weeks you can get a full LSI system with a price factor one-tenth of what it would normally cost,” he said.

Two different animals

It is difficult to compare Multiwire with QTA. Morino emphasized that the two “are different animals.” Chertoff pointed out that Multiwire is essentially a series operation, appropriate for relatively small numbers of systems. And Morino agreed, but he also pointed out that in instances where fast turnaround is most needed, the number of systems is most often going to be small.

Multiwire, if it fulfills its promise, will be highly adaptable for wiring together small components for relatively small runs, while QTA seems appropriate for LSI systems where the turnaround time is short.

From the standpoint of tooling and art work, Multiwire should reduce costs. “When you have high volumes,” Morino said, “you usually have the lead time you need to prepare a production line. But when you want to put up a custom system and you have a three, four or five-week lead time, and you start at that time to design the board, the chances are that you need only a few of them.”
Morino pointed to two factors in determining which technique to use: one is quantity, the other is complexity.

"When you have a very simple interconnection where there are no stringent space requirements, the printed-wiring techniques—even in small quantities—are probably more economical," he said. "But when you have a very dense pattern, and you have to resort to a very precise artwork preparation to generate the interconnection you need, the cost of preparing the artwork may run from several hundred to a few thousand dollars. If this is the case, if you need only a few pieces, it will pay to go Multiwire. Now let's say you have the same complex part, but you have to generate 10,000 pieces. In this case, if you amortize the artwork costs—say $2000—over 10,000 pieces, the cost is only 50¢ per piece."

**Multilayer vs wire debated**

The question of multilayer vs wire for interconnections was discussed without resolution by a panel at last month's conference. Both techniques have been used to interconnect logic systems for such high-reliability projects as Apollo, according to L. David Hanley, deputy associate director of the Charles S. Draper Laboratories at MIT. He emphasized that both techniques were successful after many problems were worked out.

George Messner, director of research for Photocircuits, favored printed wiring. "Is there, after all, anything more efficient—in terms of volume, weight and cost—than a hole?" he asked.

Jack Fidian, eastern regional manager for Iotran International Inc., Sunnyvale, Calif., vouched for wire interconnects on the basis of economy. He said wire interconnections were the best way to make economical changes in a short time.

**Future trends outlined**

Design trends for tomorrow's electronic systems, as envisioned by another panel of experts at the conference, included these:

- There will be more sophisticated linear ICs. But the hitch here is cost: the use of such ICs cannot be justified unless the price goes way down. It is expected that cost competitiveness will be achieved by making linear ICs as replacements for complex circuitry.
- Hybrid forms will play an increasing role, especially in consumer applications, where, according to William Moyers, president of Microtronix Technology Inc., Mountainside, N. J., there will be a 1000% increase in communications needs in the next 10 years. The big advantage of hybrids is that they can be tailored to specific applications, and design changes can be made at much less cost than with monolithic ICs and multiple chip forms.
- Some of the first consumer ICs will be turning up in new cars this September, Moyers said. But the future market will also include ICs in appliance timing controls and in low-power (2-5 W) audio.
- The ancient art of weaving is being updated to make woven controlled impedance harnesses of cables, twisted pairs and single conductors. Edward Ross, vice president of the Southern Weaving Co., Mauldin, S. C., showed how various types of wire could be mixed and conductors "broken out" to connect to individual components or packs.

**Evolutionary changes seen**

The over-all technological trends in packaging in the 70s will be evolutionary Moyers told the conference, with solder and thermocompression bonds continuing to be used for a while.

The main interconnection techniques for ICs will continue to be beam leads, flip chips and the raising of conductor paths off the substrate by means of etching, Moyers said.

As the need for higher and higher packaging densities continues, and LSI systems become more widely used, the need for cooling systems will become more critical, the conference was told. In a paper on cooling techniques, Stanley A. Casazza of Raytheon Missile Systems Div., Bedford, Mass., explained that hot-spot power densities of 100 to 1000 W per cubic inch have become commonplace in advanced electronics.

Since such semiconductors as germanium tend to degrade at about 120° F, cooling must be incorporated into the packaging design. Casazza outlined four basic cooling methods.

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**QTA—Quick Turnaround—a three-tier system** developed by Loral Electronics. Each tier of printed circuits, substrates and chips is topologically structured—that is, multilayered—in itself.
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Disposable battery slated for Army manpacks

Soon Army field troops will be able to power their manpack radio transceivers with lightweight batteries that have twice the energy of batteries of comparable size and are cheap enough to throw away when they wear out.

Zinc-air units activated by water, the batteries are under development at the Army Electronics Command's Electronic Components Laboratory at Fort Monmouth, N. J. Companies that have contributed to their development include the Yardney Electric Corp., New York, N. Y.; American Cyanamid Co., Stamford, Conn.; the Electric Storage Battery Corp., Yardley, Pa.; Leesone Corp., Great Neck, N. Y.; and Gould Batteries, Inc., in St. Paul.

Particular progress has been made on two units: one a 10-ampere-hour 24-V, four-pound battery and one of twice that capacity weighing six pounds. The nominal energy densities are 60 watt-hours per pound for the smaller battery and 80 watt-hours for the larger.

High quality production costs would be in the $25 to $30 range, according to Carl A. Nordell, of the laboratory's Power Sources Div. To keep costs down, he says, noble metals are not used. Instead, a carbon-Teflon type of low-cost cathode is substituted. Compensation for the poorer voltage characteristics is made by the use of extra cells—22 instead of 20 for a 24-V battery.

Water starts the action

The battery is activated by pouring water into a tray—a container built with a filling slit for each of its 22 cells. Approximately 330 cubic centimeters of water, or 15 cm³ per cell, is absorbed in 10 minutes or less. Air enters the battery through three rows of air intake and exhaust holes provided on each side. The unit cell stack is completely wired and slipped into the plastic battery box with a polyurethane foam lining.

KOH can substitute for water

"The design has shown promising electrical performance capability in two variations," Nordell says. "In one the anodes are impregnated with potassium hydroxide (KOH) as required for water activation, and in the other, the anodes are not impregnated and the battery is activated by adding a 35% solution of KOH.

"Although our present goal remains activation with water, we realize that KOH activation is practical and offers real advantages in terms of simplifying manufacturing, lowering cost, and eliminating the problem of supplying water at freezing temperatures."

Nordell adds, "The main deficiency of the present KOH design results from the impregnation of the anodes after cell stack assembly. The voids in the cells become choked with solid KOH, and the subsequent absorption of water is slowed appreciably. Additional anode development could correct this problem and provide impregnated anodes which could be fully activated in the 10-minute period the Army requires."

Two-pound unit is under way

Work on a two-pound water-activated zinc-air battery has just been started for Fort Monmouth. Internally the battery consists of thirteen 11.6-ampere-hour cells, with the terminal connector assembly on one end and a combination reservoir and activation water-measuring device on the other.

Intercell spacers provide cell support in addition to maintaining the required spacing necessary for air access.

The unit will be tested with the AN/PRC-25 radio.
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Tiny network employs novel thick-film design

For the designers of $15 radios—who may think they have crammed just about everything feasible into their sets—Sprague Electric Co. has come up with an irresistible extra: an adjustable frequency/loudness network in a package no bigger than a volume control, but one that is reported to give the performance of the expensive and much more bulky Fletcher Munson network used in $1000 hi-fi sets.

J. H. Fabricius, manager of ceramic product development at Sprague in North Adams, Mass., says the new variable networks are combinations of thick films on a ceramic substrate. Prototypes produced by Sprague have adjustable capacitors of 0.01 and 0.02 µF, fixed capacitors of 0.022 and 0.006 µF, plus a 20 kΩ variable and a 25 kΩ fixed resistor (see figure)—all in the small package. The variable capacitances and variable resistance change with shaft rotation.

To develop this network, two problems were solved. First, high capacitances were provided on a 3/4-inch-diameter substrate area.

Second, a heretofore unachieved variation in capacity—from a few picofarads to 0.01 or 0.02 µF—were produced by a half turn or less of the control shaft.

The development effort began with the design of a 10 pF-to-0.01 µF variable capacitor. State-of-the-art thick-film technology, Fabricius says, readily provided enough capacity when dielectric materials, with constants ranging from 30 to 100 and capable of forming defect-free layers as thin as 0.0005 inch, were used. The capacitor element was formed on an alumina substrate by depositing films of metal, dielectric and metal—in that order.

But the tough problem was to obtain the incremental variation of capacitance. It was solved in two steps. First, the exposed, or top, metal layer of the capacitor was deposited as some 1600 discrete metal “islands,” 5 to 10 mils on a side and with dielectric separation of 1 to 2 mils. For this segmented layer, a sweeping, sector contact had to be created.

It was here that the greatest contribution was made: A contact system was developed with negligible electrical resistance and with low shaft torque (3 to 4 inch ounces).

The contact element was formed of a fine-woven metal mesh backed by a silicone rubber pad and a spring-loaded washer. The fine weave provided several contact points for each island. Angular rotation of the contact sector varied the number of islands connected, as well as the output capacitance.

These same techniques were then applied to produce the variable networks of Sprague’s design. (See figure and photo. The resistive elements appear black in the photo.)

Capacitors fabricated with the thick-film techniques used here are currently of low voltage and suitable for applications of from about 20 Hz to 100 kHz.

Computer troubleshoots as it automates a process

Most automatic industrial control systems monitor only the input and output of a controller; so if there’s a malfunction in some part of the system, the entire process must be shut down to allow troubleshooters to go to work. A new computer feature being offered by General Automation of Orange, Calif., gives operators real-time access to a memory register inside the computer. Switching, sequencing, positioning, timing and other parts of the total process can be checked while the system is in operation. Troubleshooting can be performed and preventive maintenance scheduled without shutting down the manufacturing process.

This feature, called the Autovue system, is being offered in General Automation’s SPC-16, a 16-bit, 480-nanosecond minicomputer. The system requires an oscilloscope.
Real-time examination of machine tool travel, the way Autovue might show it. Under normal conditions, the X and Y rate of travel would be the same (solid trace). Improper lubrication, a faulty bearing or dirt might cause the travel to be reduced (dashed line). Maintenance personnel could observe this and schedule service. The computer interrupt would stop the process automatically if the operation degraded to that point.

or other time-based display instrument to be connected to the console display register through a digital-to-voltage converter. The operator inserts digital patterns from memory (corresponding to the process under computer control) and displays the patterns on the scope. Thus portions of the process under control of the computer are viewed as time-based displays.

As Neal Young, product manager at General Automation puts it: "The Autovue allows a visual correlation between the process, program and computer without taking the computer off line or interrupting the process."

For example, in a computer-controlled chemical process plant, the opening and closing of valves might be indicated on the display. A template matching the ideal scope display pattern can be compared to the display representing the process. Extension of the time-base could indicate a faulty valve.

In a computer-automated machine tool, the scope display might be used to note time-based irregularities in X and Y travel while the machine is in operation. Any irregularities that exceeded an out-of-tolerance limit could trip a computer interrupt and stop the process.

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Frictionless transducer uses Hall Effect

A transducer that operates on the Hall Effect principle produces an output voltage directly proportional to a small rotary shaft displacement. Since the output is electrical rather than mechanical, wear and tear on components is said to be drastically reduced.

The transducer was developed by an aerospace technologist, David Smith, at the National Aeronautics and Space Administration’s Langley Research Center in Hampton, Va.

The principle of the transducer is applicable to any meter with a rotary shaft that responds to changes in physical magnitude.

The transducer transmits its output, as does any conventional mechanical-to-electrical transducer, by wire or telemetry to a terminal for display, storage or computer processing.

As shown in the schematic, a Hall probe (a plate of an appropriate conductor or semiconductor) is rigidly suspended between the poles of a permanent magnet fixed to the meter output shaft. With a constant control current supplied to contacts at the ends of the probe, the output voltage generated between contacts on the sides of the probe is directly proportional to the sine of the angular displacement of the meter shaft.

"Since the sine of the angle and its measure in radians rapidly approach equality for small angles, the voltage output and meter shaft rotation for angles ranging from 0 to 6° may be accepted as being directly proportional," NASA says.

"A voltmeter connected to the Hall transducer output can then be calibrated to give direct readings of meter shaft rotation on a linear scale extending over about ±6°."

With proper shaping of the magnetic field between the magnetic poles, or the use of a specially designed Hall probe, the voltage output linearity of the transducer can be extended to a much larger range of shaft rotations—approximately ±30°.

Where nonlinearity outputs are acceptable, the transducer can be used for measurement of angles up to ±90°.

A prototype has been built and tests are under way at the Langley Research Center.

Information on the rights for the commercial use of the transducer are being offered by NASA, Code GP, Washington, D. C. 20546. • •

Direct sunlight can't damage new color TV camera

A color television camera that moon explorers can point directly toward the sun without damage and that is also sensitive to dim light has been developed by RCA’s Astro-Electronics Div., Princeton, N. J.

The camera uses RCA’s new Silicon Intensifier Tube, which, the company says, "has a brightness magnification never before achieved in a color TV camera."

Most TV tubes have a smooth imaging surface of photoconductive material that can be burned by bright light or damaged by vibration. The imaging surface of the Silicon Intensifier Tube consists of almost 400,000 individual silicon diodes, making it immune to extreme sunlight.

The camera has a passive thermal control system that permits continuous operation on the moon. It operates from -250°F to +250°F.

Two cameras will be delivered to NASA this summer under a $196,600 contract. Each camera weighs 10 pounds and measures 4 by 6-1/2 by 16-1/2 inches, including the lens. The camera will transmit a 525-line picture at 30 frames per second.

The tube’s low-light-level performance is better than that of silicon vidicon, RCA says. In fact "it is the best now available." • •
Chicago Miniature's new low current, fine wire lighting bugs need only a fraction of the current normally required for sub-miniature lamps. These T-1 and T-3/4's have an average current drain of only 8-21 ma., and are specifically designed for applications requiring illumination from low current level circuits. A new process developed by Chicago Miniature gives our bugs well shaped, stress free fine wire filaments which result in superior reliability and life performance.

Their ability to be driven directly from low output integrated circuitry eliminates the need for separate driver circuits. And, all of these lamps are aged for a minimum of 16 hours to insure long lamp life and dependable operation.

For complete information on these low current, fine wire Lighting Bugs, circle the reader service number or write for catalog CMT-3A.

For application assistance contact your Chicago Miniature Sales Representative. For off-the-shelf delivery, contact your local authorized Chicago Miniature Electronic Distributor.

THE LIGHTING BUGS

This bug feeds on practically nothing.
This fiberglass case, designed and manufactured by H. Koch & Sons to house the instruments shown in front of it, was shipped from Dayton, Ohio, in October, 1951, and arrived back in Dayton in June, 1952. During this eight months it travelled a total of 19,000 miles by rail, air, boat and truck including three months storage in Panama. (The route is shown on the map.) At the end of the odyssey, both the instruments and the case were in perfect condition.

Koch fiberglass cases for delicate instrumentation have been designed to withstand high impact...to be watertight...to serve as an operating cabinet for the instruments...to register humidity, temperature and pressure inside the case. And they do all this in handsome, durable fiberglass that doesn’t dent, scratch or lose its finish because fiberglass color permeates throughout.

Write today for our “H” brochure or call Ray DuYore about your immediate requirements for cases protecting valuable, delicate instruments.

STORAGE TRANSIT OPERATIONS

Koch fiberglass cases for delicate instrumentation have been designed to withstand high impact...to be watertight...to serve as an operating cabinet for the instruments...to register humidity, temperature and pressure inside the case. And they do all this in handsome, durable fiberglass that doesn’t dent, scratch or lose its finish because fiberglass color permeates throughout.

Write today for our “H” brochure or call Ray DuYore about your immediate requirements for cases protecting valuable, delicate instruments.

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A Systems Division of Gulf + Western Industries

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INFORMATION RETRIEVAL NUMBER 25

Electonic Design 14, July 5, 1970
Now read this...

32C

14 digits in 14 centimetres with the new Philips PANDICON*!

Putting numbers into electronic calculators, computers and data terminals isn’t so difficult these days. But getting numbers out — legibly and economically — can be another matter. Unless, of course, you’ve heard about Philips’ new PANDICON fourteen-decade integrated readout tube, type ZM 1200. Its legibility you can see for yourself. No more unnatural spaces between digits. Decimal points and punctuation marks where you expect them to be. Coherent numbers instead of 14 separate digits — all in a space less than the width of this page.

But there are other advantages too. Economy for example. All 14 digits in one and the same tube. To provide this display with ordinary single tubes, somebody would have to make 168 external connections. The PANDICON needs only 27. Interconnections are inside — protected from damage. You save on drive components because only one decoder-driver is needed for the full 14-digits display. You save on power too — it consumes only 1.5 to 2 W.

Best of all is the reliability. We’re not ready to quote Mean-Time-Between-Failure figures yet, because, after hundreds of thousands of life-test hours, we haven’t had enough failures to make statistically significant conclusions. It may take some time yet, as we anticipate an MTBF of 500,000 hours.

Meanwhile, we’ve given you a full one-year guarantee on this tube — with the strong suspicion it will live 10 times as long! After all we have over 60 years experience in gasdischarge physics.

If 14 digits are too much, we can offer you 8, 10 and 12-digit tubes soon.

Our engineers have also developed a Dynamic Drive Module type DDM 14 to go along with the PANDICON. Everything is described in our new PANDICON data file, which is yours for the asking.

Philips Electronic Components and Materials Division, Eindhoven, the Netherlands.

Distributed and sold in the U.S. by: Ampex Electronic Corporation, Providence Pike, Slatersville, R.I. 02876.

* Registered trade-mark of N.V. Philips’ Gloeilampenfabrieken, Eindhoven, the Netherlands.
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G. W. A. DUMMER, Formerly Superintendent Applied Physics
Royal Radar Establishment, British Ministry of Technology

Written by an internationally recognized authority, this volume satisfies the need for a comprehensive, application-oriented reference on conductive, superconductive, contacting, and resistive functions. It is exceptionally broad and detailed in coverage, setting forth the basic phenomena for each specific function, describing how the materials for each are used in component parts, and providing sufficient basic data to prepare the reader for problems which may be met in specific applications. In cases where combined materials are part of the design, such as cables and wires, brief data is given of dielectrics, etc. in order that reasonably complete coverage is available. More than one-hundred-forty charts, tables, and diagrams provide rapid access to properties of materials for a specific requirement. Extensive references are included to facilitate further study.

Thorough descriptive coverage...more than 140 charts, tables, and diagrams.


G. W. A. Dummer, author and co-author of scores of books on all aspects of electronics, presently devotes all his time to writing and consulting activities. A pioneer in reliability, thin-film circuits, and semiconductor integrated circuits, he initiated much of the British Government's research in microelectronics. His earlier contribution to the development of radar and radar synthetic trainers earned him Britain's award, Member of the British Empire, and America's Medal of Freedom. Mr. Dummer is a Fellow of the I. E. E., the I. E. R. E.

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The best power supply for driving operational amplifiers is one specifically built to drive operational amplifiers. We make it. We call it our OA series.

(In case you missed the connection, that's short for operational amplifier.)

When you're designing a power supply that will only be used to drive op amps, there are a lot of things you can do to make it better than "general purpose" dual output power supplies. You can start by "zeroing-in" on ±12 and ±15 VDC and offer 0.01% regulation at either of those voltages. You can build in a common reference to assure absolute tracking of both the positive and negative outputs so they won't drift independently. You can design a 0.5 amp unit that weighs a mere 4 pounds and measures only 5.0" x 2.8" x 4.38".

(acdc electronics inc.
Oceanside Industrial Center, Oceanside, California 92054, (714) 757-1880)
## OA Dual Output Power Supply Modules for OP Amps / Specifications

<table>
<thead>
<tr>
<th>Nominal Output Voltage (VDC)</th>
<th>Output Voltage Range (VDC)</th>
<th>Maximum Current Rating (Amps)</th>
<th>Maximum Dimensions (inches)</th>
<th>Weight approx. (lbs.)</th>
<th>Case Size</th>
<th>Model (Add -1 for Overvoltage Protection)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>±12</td>
<td>11-13</td>
<td>0.350 @ 71°C 0.425 @ 55°C 0.500 @ 40°C</td>
<td>5.00 2.50 4.38</td>
<td>4</td>
<td>J2</td>
<td>OA12D0.5</td>
<td>119.00</td>
</tr>
<tr>
<td>±15</td>
<td>14-16</td>
<td>0.750 @ 71°C 0.900 @ 55°C 1.1 @ 40°C</td>
<td>5.00 3.12 4.37</td>
<td>5</td>
<td>A1</td>
<td>OA12D1.1</td>
<td>149.00</td>
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<tr>
<td>±12</td>
<td>11-13</td>
<td>3.0 @ 71°C 3.5 @ 55°C 3.7 @ 40°C</td>
<td>5.00 5.25 6.00</td>
<td>11</td>
<td>C1</td>
<td>OA15D3.7</td>
<td>195.00</td>
</tr>
</tbody>
</table>

*See also new IC line of 5 volt power supplies

### Input
- 105-125VAC, 47-63Hz ( usable also to 400Hz — consult acdc for derating).

### Output
- Voltage range shown in table is continuously variable between limits by externally accessible screwdriver adjustment of multiturn pot. Output is floating. Current: zero to full load as shown in tables.

### Regulation
- 0.01% or 0.001 volt for line changes of 10%, 0.01% or 0.002 volt for NL to FL changes.

### Ripple
- 0.5mV or 0.001% max. RMS (whichever is greater).

### Stability
- Maximum 0.1% or 10mV for eight hour period after initial warmup.

### Transient Response
- Output voltage returns to within regulation limits within 50µsec in response to a 50% step change in load current.

### Remote Sensing
- Terminals are provided to maintain regulation at the load, compensating for the DC voltage drop in the load cable.

### Ambient Temperature
- Operating: Full rated output at operating temperatures of 0° to 71°C without forced air or heatsinking. Storage: -55°C to +85°C.

### Mil Specs
- The listed catalog models are constructed with the highest quality components and have MTBF ratings in the neighborhood of 50,000 hours per MIL-HDBK-217. acdc will also build supplies to meet specific MIL specs such as MIL-E-4158A, MIL-E-16400, MIL-T-21200, and meet environmental requirements such as MIL-E-5400, MIL-E-5272, MIL-E-4970, and RFI specs MIL-I-26600 and MIL-I-6181. acdc’s own environmental laboratory is able to perform qualification testing when required and is used extensively to prove out designs. In order to provide the most efficient design, customer inquiries are invited, outlining exact specifications and environmental conditions required for the end product.

### Weight
- See table.

### Mounting
- Unit can be mounted in any position on either one of two sides. Mounting faces have threaded mounting holes.

### Dimensions
- H-W-L dimensions for individual models are given in the table.

### Overload Protection
- All models are inherently protected against overload and short circuits of any duration. No fuses or reset buttons are used — automatic recovery is electronically accomplished.

### Overvoltage Protection (Optional)
- Overvoltage protection “crowbars” both voltages to near zero in the event of a rise of one or both of the voltages of 20% or 4 volts (whichever is greater).

### Connector
- Solder hook terminal header.

### Construction
- Modules are constructed of heavy gage aluminum with integral extruded heatsinks; color is black. Removable covers of perforated steel have a light gold enamel finish. Regulating circuitry is mounted on a PC board.

### Output Impedance
- DC — 1kHz 0.0001 R, or 0.001 ohm max. 1-10kHz 0.0003 R, or 0.01 ohm max. 10-100kHz 0.006 R, or 0.3 ohm max. (whichever is greater). 
- R = rated load.

### Temperature Coefficient
- Maximum 0.15% or 1mV/°C.
Technology Abroad

Rapid growth reported in Israeli electronics

After Japan, what industrial country has one of the fastest growing electronics industries in the world? Answer: Israel.

Figures just released by the Government of Israel reveal that since 1960 the tiny industry there has been growing at an average annual rate of 17%. (The Japanese are out of sight, enjoying a 44% increase in factory sales in 1968 over 1969.)

Even more impressive is the fact that Israel's electronics output accounts for 8% of its Gross National Product—about $4.6-billion. In the advanced countries of the world, the electronics industry's share of the GNP is usually 2 to 3%.

Avner Tal, scientific consultant to the Government of Israel Investment & Export Authority, notes that most of the country's electronics output goes for defense needs. There's little left for export. There are now 4000 workers in the Israeli electronics industry, he said.

Electronic 'eyes' help run new supertanker

A 227,000-ton supertanker launched earlier this year at the GötaVerken shipyard in Sweden has an advanced electronic system that continuously monitors 160 of the engine room's vital parameters. The parameters include engine pressures, temperature and propeller speed.

Developed jointly by GötaVerken and Saab, the aircraft and car manufacturer, the equipment provides for indication, alarm and recording. Analog signals for all parameters are displayed on a compact central panel. By pressing one of the 160 buttons, the operator can read the desired parameter instantly in the appropriate units, kg/cm², degrees C, etc. Alarm signals are provided for parameters that do not require constant monitoring. A printer-readout for selected analog signals is also available.

Parisian movie camera runs on solar power

A solar-powered movie camera, with batteries that are recharged by built-in, flexible cadmium telluride solar cells, has been developed by La Radiotechnique Compelec of Paris. Several panels, each containing from 20 to 24, 15 x 18 mm solar cells, are attached to the surface of the camera housing. With normal sunlight of 1 kW per square meter, about 7 to 8 V and 30 mA is supplied by the solar cells—sufficient for recharging the movie-camera batteries.

'Noiseless' lamp built

Conventional discharge lamps, including fluorescent and mercury, sometimes create static that interferes with television and radio reception. Now Toshiba, in cooperation with the Japan Broadcasting Corp., has developed what it calls the world's first "noiseless" mercury lamp. The noise level has been reduced to 1/20th that of conventional lamps, Toshiba says.

ATS-1 telephony tested

The Australian Post Office and NASA are concluding tests this month with the ATS-1 satellite over the Pacific to determine the feasibility of using satellites for telephone service to thousands of subscribers in the remote "outback" regions of Australia.

InformatIon Retrieval number 26

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ANALOGIC's new Modupac™ line is the first complete "building block" family of signal conversion modules. We've engineered them with fifth-generation techniques to handle virtually all A/D and D/A applications. They're available as independent single units, or in any combination. And they're easily interconnected to form all or part of a limitless range of systems. However you specify them, Analogic Modupac™ modules offer you the following advantages:

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INFORMATION RETRIEVAL NUMBER 27
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constant, constant, constant, constant, constant, constant, constant...

Send in this coupon for free bulletin giving complete details on GE AC Voltage Stabilizer features, ratings and application data; or see your GE sales representative today.  

* Output voltage is stabilized in less than 2 cycles for transient line drop of 30%.
Honeywell’s versatile line of precision meters.

Now that versatile line of precision meters is Jewell

Same plant. Same people. Same meters that were made popular by superior styling, design and quality. Only now they’re Jewell. Everything else is the same—including the compact, frictionless movements and self-shielded, low-cost construction. So, when you need a meter for your application, the best place to find it is still Manchester, N.H. Write for our spanking new catalog... or get in touch with our nearest sales representative, distributor or mod-center.
**B-1 avionics expected to be off-the-shelf systems**

The $1.4-billion B-1 bomber contract has gone to North American Rockwell, but the half-billion-dollar avionics contracts for the airplane are still very much up for grabs. Although the Air Force has not said what it wants yet, an effort to cut cost overruns and hold the line on prices may be pointing the way to off-the-shelf electronics, updated to fit the needs of the bomber. This is expected to hold total spending for electronics at or below early estimates.

**FAA tightening procurement procedures**

While the Federal Aviation Administration will remain a lucrative market for R&D contracts (an estimated $600-million in the next 10 years) don't look for procurement contracts to follow R&D awards automatically, as in the past, unless the equipment performs well. Successful R&D bidders will have to prove that their production electronic equipment will work as well as that built under the R&D programs. Recent Congressional hearings and press criticism of the agency have stressed the poor delivery records of contractors whose costs have exceeded the original procurement contracts, and the agency is getting shy of such criticism.

**Congress weighs entry into the computer age**

The computer is going to Congress, but the how and when of its arrival will be determined by politics. The proposed Legislative Reorganization Act of 1970, scheduled for floor action soon, carries a provision in Title IV that would establish a Joint Committee on Data Processing. Practically every member of Congress agrees that computers are needed to handle the ever-increasing mountain of legislative data, files, mailing lists, federal grants and contracts, voting analyses, Congressional documents and scores of other jobs. But the disagreement is over who will run and control the system. The act calls for a joint House-Senate committee. Many members of the House feel that it should have its own system, because of the difference in scope of the two bodies; other members think the entire process should be run by the Library of Congress's Legislative Reference Service. Many Republicans are likely to oppose any computer system for at least two years, believing that installation of the machines would give the Democratic majority a leg up on the 1972 elections. The proposed Reorganization Act, while setting up the joint committee, would also establish a director of data processing at $40,000 a year—or just $2,000 less than a Congressman's salary. His assistant would be paid $36,000. Meanwhile the Clerk of the House of Representatives is proceeding with plans to let a contract for the study of just how House members would use computers. There are other undertones in the bill: Congressional committees and individual members would
no longer be at the mercy of such executive agencies as the Bureau of the Budget for information and research on which to base policy decision. And there is some belief that a properly equipped Appropriations Committee could take back the job of drafting the Federal Budget, something it gave up 50 years ago. While the argument boils, the old time-consuming, laborious and ineffective practices continue—the Senate, for instance, still pays its 4,500 employees in cash.

NASA moves toward establishing a moon base

The National Aeronautics and Space Administration has awarded a $320,000 contract to North American Rockwell Corp.'s Space Division in Downey, Calif., to study all aspects of establishing a base on the moon. The company was one of 18 aerospace contractors invited to submit bids on the 11-month study.

The North American team will define and analyze the kinds of lunar exploration missions that are desirable and possible. It will establish the major requirements for the missions and develop conceptual descriptions of the base itself.

Moon bases with and without orbiting lunar vehicles will be described, plus mobile systems for the moon's surface, both roving and flying.

NASA's Marshall Space Flight Center, Ala., will monitor the study.

Western Union bids to supply computer services

The Western Union Telegraph Co. has asked the Federal Communications Commission for permission to sell computer services to data-processing suppliers when the company's computers are not being used to switch messages.

Permission would result in FCC's waiving its preliminary determination that required companies furnishing data-processing services to do so through separate affiliated corporations.

Full utilization of its computers, Western Union contends, will permit lower costs to users of both communications and data processing.

In another move to expand, Western Union has already scored. FCC has granted it permission to buy the Bell System's Teletypewriter Exchange (TWX) Service. Cost of the system is approximately $90-million. Working capital will bring Western Union's total TWX investment to about $118-million.

DCA to get 15 computer systems instead of 34

The Defense Communications Agency’s long-awaited authorization for 34 new standardized computing systems—with an option to buy 53 more—has been cut. DCA will now get 15 systems for sure, with an option to buy 20 more at a later date.

Software, which is now handled locally at each of the agency’s 16 IBM/360 computer centers, will be provided by a newly-created centralized office called the Joint Technical Support Activity in Washington, D.C.

Requests for proposals to bid on the computer contract will be issued soon by the Air Force Systems Command’s Electronic Systems Div., Hanscom Field, Bedford, Mass.
tektronix® expands the 7000 series

New Three-Plug-In Mainframe
New Dual Time Base Plug-In

A third mainframe and a fifth time base are added to the growing 7000-Series. The NEW 7503 THREE-PLUG-IN OSCILLOSCOPE offers bandwidths up to 90 MHz, depending on the plug-in selected. The NEW 7B52 Dual Time Base features four sweep modes: Main, Intensified, Delayed, and Mixed. The Mixed Sweep is CALIBRATED, allowing you to MEASURE... not just MONITOR.

Simultaneous measurements can be made by multiple plug-ins with widely different features. Some of the features of the fourteen plug-ins currently available are: dual-trace, 75 MHz at 5 mV/div (four-trace, 75 MHz with two units) • differential, 100,000:1 (100 dB) CMRR at 10 µV/div • differential comparator, 75 MHz at 1 mV/div and comparison voltage accurate to 0.1% • random or sequential sampling, 25-ps risetime (depending upon the sampling head) • two single-trace amplifiers, 90 MHz at 5 mV/div • current amplifier, 75 MHz at 1 mA/div.

For faster and easier measurements, Auto Scale-Factor Readout, which is exclusive to Tektronix, labels the CRT with time/div, volts or amps/div, invert and uncal symbols, and automatically corrects for 10X probes and magnifiers. All the data is on the CRT, where you need it, for faster measurements with fewer errors. And, looking into the future, the readout system is designed to meet needs other than of today's plug-ins.

The CRT display above is just one example of the flexibility and measurement ease that is YOURS when you use an oscilloscope that features Auto Scale-Factor Readout and dual vertical amplifier plug-ins. Pulse width, period, amplitude, and aberrations are all quickly measured in ONE display by applying the same signal to both amplifiers. With the 7B52 Time Base in the MIXED mode, two different sweep speeds are displayed simultaneously—the first 4 div at 100 µs/div, the last 6 div at 10 µs/div (the delay time multiplier control can be rotated to start the faster sweep at any point on the main sweep). The DC offset feature of the 7A13 Differential Comparator Amplifier is used to obtain the bottom trace. With a deflection factor of 100 mV/div, the pulses are effectively 100 divisions high, giving the resolution needed to detect aberrations and precisely measure pulse amplitude of -9.91 V (accurate to 0.1%).

For even greater versatility, 2 four-plug-in mainframes are available, the 7704 (150-MHz) and 7504 (90-MHz) Oscilloscopes. The 7000-Series does not require a full complement of plug-ins, you can start with only one horizontal and one vertical plug-in and add more as your measurement requirements change. When your plans call for the purchase of a new oscilloscope, evaluate the Tektronix 7000-Series... it's EXPANDABLE.

Your Tektronix field engineer will gladly demonstrate the complete VERSATILITY of the New Tektronix 7000-Series Oscilloscope System, in YOUR lab with YOUR signals. Contact him locally or write: Tektronix, Inc., P. O. Box 500, Beaverton, Oregon 97005. See your 1970 Tektronix catalog for complete specifications.

Prices of instruments shown: 7503 — 90-MHz, Three-Plug-In Oscilloscope $1775 7A16 — 90-MHz, Single-Trace Amplifier 600 7A13 — 75-MHz, Differential Comparator Amplifier 1100 7B52 — Dual Time Base 900 U.S. Sales Prices FOB Beaverton, Oregon Available through our new leasing plan.
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:
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**THE FINEST IN VARIABLE ELECTRONIC FILTERS**

New multifunction Tunable Filter, Model 3750.
Once upon a time there was a little electronic bug. "I can flip-flop, I can gate, and do a lot of miraculous little numbers," he said modestly. "You see, however, people have a tendency to bend and break my arms and legs. Unintentionally, of course." "I see," said the Wizard. "I.C. is, in fact, what they call me," said the bug. "Ouch!" cried the bug, as the kindly Wizard broke one of his 14 arms. Unintentionally, of course. "Thanks Dummy, you just rendered a tiny, but vital portion of my electronic function useless."

"Sorry," said the Wizard, waving his magic wand. "I shall devise a magic carrier to protect you and the millions like you on your travels across the land. And a magic 'contactor' to see you safely through burn-in and test equipment. The cost is exceedingly low, too."

"Sensational!" cried the bug. "You've saved my life. How can I ever thank you?" "Easy," said the Wizard, taking out his order pad.
VIDEO SOURCE FOLLOWER

Problem: You want a zero offset source follower, operating from DC to 100 MHz.

Solution: One Siliconix 2N5912 and two matched resistors as shown.

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SIDELIGHTS

Our Management man goes to Washington

Have you ever visited your Congressman in Washington? Or taken a ride on the Congressional subway to the Capitol Building? Or had your lunch at next to wholesale prices in the Old Senate Building? Our Management Editor, Dick Turmail, hadn't until he took part, recently, in a series of interviews in the nation's capital.

To gather data for the cover story on p. 60, Turmail talked to a number of Congressmen located in various House office buildings, including the Rayburn, Longworth, and Cannon.

"To locate a legislator," Turmail says, "all you really need is his name. The building lobby guards supply the rest of the data—offhand."

"Congressman Ed Foreman of New Mexico moved yesterday, sir. He is now in Suite 1721," a Longworth Building guard replied to Turmail's query. He had neither paused in his answer nor checked a list. He has simply memorized the names, states, and suite numbers of 435 U. S. Representatives.

Although Congressional suites are similar in size and basic floor plan, each one displays the personality of its occupant. While some offices are festooned with state pennants and sports trophies, others might be mistaken for the local library. Most of the offices are staffed by pleasant people who seem happy to serve you.

A secretary on Sen. Mansfield's office staff was unhappy, however, when she was unable to supply a campaign button that Turmail had requested. "Oh," she said, "I'm sorry, but the Senator hasn't used a campaign button in his 28 years in Congress."

Management Editor Dick Turmail keeps posted on capital news while waiting for an interview in Washington.
Resistance networks for A/D and D/A conversion, digital volt meters and numerical control systems demand extreme precision. Allen-Bradley can deliver. Precision that starts with a patented chromium-cobalt resistive material vacuum deposited on a substrate made to Allen-Bradley specifications. Precision based on exclusive computer drawn grids. Precision backed by extensive design and testing facilities. Precision on a continuing basis assured by Allen-Bradley's 14 solid years of experience.

Add the reliability of a single substrate, uniform temperature characteristics, much lower attachment costs and you see why Allen-Bradley thin film networks are the logical replacement for discrete precision resistors.

**SELECTED SPECIFICATIONS**

<table>
<thead>
<tr>
<th>RESISTANCE RANGE</th>
<th>1K ohms to 2 meg, standard 25 ohms to 50 meg, special (Single substrate range — 10,000 to 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCR LEVELS</td>
<td>±25 ppm/°C, ±10 ppm/°C, ±5 ppm/°C at -55°C to +125°C</td>
</tr>
<tr>
<td>TCR TRACKING</td>
<td>±5 ppm/°C standard to ±1 ppm/°C special</td>
</tr>
<tr>
<td>TOLERANCES</td>
<td>Absolute to ±0.1% @ +25°C Matching to ±0.005% @ +25°C</td>
</tr>
<tr>
<td>RESOLUTION</td>
<td>Line width and spacing to 0.001 inch</td>
</tr>
<tr>
<td>ENDURANCE</td>
<td>Exceeds MIL-R-10509F Characteristic E Procedure: MIL-STD-202D</td>
</tr>
</tbody>
</table>


**ALLEN-BRADLEY**
Mellonics offers new automated diagnostic tools for detecting functional logic faults in sequential digital circuits. These computer programs have already cured test headaches in dozens of circuits, some with more than 400 logic elements.

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Letters

‘Unsung hero’ sings praises of the ME

Sir:

Having just read your survey, “Engineers Want More Challenges,” in the May 24, 1970, issue (ED 11, p. 96), I have some comments.

Change “challenges” to “respects.” Engineers have the respect of only intelligent management, which the survey indicates is lacking.

Also, your survey indicates that the electronics industry consists solely of electronics engineers. Unfortunately, most of management thinks so. Too, but it is the mechanical engineer who is the unsung hero in the electronics field. Not only must he evolve designs into producible practicalities but he must contend with bad managers and egotistical EEs.

Remember, when it comes to the packaging of electronic devices, there is no such thing as an electrical part.

George Franklin
Scottsdale, Ariz.

In the Ideas for Design item, “Voltage Window Detector Provides Logical Output?” (ED 10, May 10, 1970, p. 114) diode D2 is shorted. The connection between the R3/D2 junction and D2 should be removed.
GENERAL ELECTRIC wants to GIVE you an SCR

BECAUSE WE KNOW YOU'LL BE BACK FOR MORE

We're so confident that our C103 will meet your low current SCR needs that we'd like to give you one so you can try it in your circuit. Just fill out the coupon below and we'll send you, free, a new 800 ma SCR. This new C103 features the same pellet structure as the performance-proven C106 (4-amp SCR). Epoxy-encapsulated in the TO-18 plastic package, GE's C103 is available in peak reverse voltage ratings from 30 to 200 volts. The C103 combines high surge capability (8 amps) with a low forward blocking current (1 mA) and offers a very sensitive gate (200 µA). The C103 low-cost low current SCR is so versatile that it can replace more than 200 existing SCR's and is easily interchangeable in both package and electrical characteristics. And because it's rugged, it's ideal for use in industrial and military as well as consumer applications such as motor controls, indicator drivers, off-the-line regulators for appliance and electronic equipment, light, heat and proximity detection, temperature and pressure control, counting or switching and as gate amplifiers for larger devices. GE's C103 is now available from distributors' stock or in volume from the factory.

To get your sample C103 SCR, fill out the coupon below and present it (or mail it) to your authorized General Electric distributor. For more information, write General Electric Company, Section 220-89, 1 River Road, Schenectady, N.Y. 12305. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: Electronic Sales, IGE Export Division, 158 Madison Avenue, New York, N.Y. 10016.

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INFORMATION RETRIEVAL NUMBER 47
Whether you need a complete dynamic test system or the ideal components to integrate with your present system, look no further. E-H Research Laboratories, Inc. and its subsidiary, Automated Measurements Corporation, offer you the perfect solution.

For example, the E-H 1139/1420 programmable timing unit and pulse driver combination is a new generation in pulse instruments that fits the needs of any systems designer. These two rack-mounted units are so completely programmable that there are no front-panel knobs to twist. They're ideal for any systems applications requiring pulses from 1kHz to 10MHz. And they offer the designer such features as complete waveform control, with programmable width and delay from 10ns to 100µs, amplitude from ±3V to ±10V with programmable attenuation from X1 to X40 and rise and fall times programmable from 5ns to 13µs.

The perfect mate to the E-H 1139/1420 is the AMC Model 1000 Waveform Analyzer. The AMC 1000 was designed specifically for programmed systems application. It combines in one compact box the functions of sampling oscilloscope, digital counter and digital voltmeter to provide time and voltage measurements of sampled waveforms. The AMC 1000 is the most advanced instrument of its kind, with features including ±1% time measurements all ranges, fastest measurement rates, 10 remote sampling channels, all solid-state construction, serial-by-character or parallel programming, built-in program memories, stored BCD outputs, built-in floating DVM, and digital readout.

This is just a sample of the broad line of E-H and AMC equipment available from your E-H representative. He can offer you a complete system or the most advanced components to give you the systematic solution to your problems today. And tomorrow.
How about a 'breadboard' to solve ecology crisis?

In the last few months we've been deluged with newspaper and magazine stories, television specials and oratory, all dealing with the "discovery" of a new crisis that mankind faces—environmental pollution. In the torrent of words, even elementary-school pupils have become aware of the word "ecology" and the fact that it is somehow threatened. But one thing has been overlooked: Before we can embark on a technological crusade to stem the threat, we need first to identify all of the problems. We need a sort of "breadboard model" from which we can pinpoint data before we can design solutions.

Dr. William B. McLean, technical director for the Naval Undersea Research and Development Center, San Diego, said recently: "We can all see many of the important survival test problems such as population density, energy requirements, pollution of the air, the sea and the earth by waste, insecticides and heat. I don't however believe that we are smart enough to see all of the important problems without some appeal to the experimental approach."

Dr. McLean proposes the establishment of closed communities "which must learn to survive within a limited environment with only basic chemical elements as raw materials."

"Such a procedure," he says, "will allow us to test solutions to waste processing, atmospheric control and energy conversion on a limited scale.

One such test setup, he suggests, is already indicated by our voyages to the moon: A minimum community could be set up on the lunar surface, using the basic raw materials there plus sunlight for the prime source of power. Another easier and less expensive site for a closed experiment, says Dr. McLean, is to carve caves out of the rock at the bottom of the ocean: The source of power in this case would probably be nuclear energy or the earth's thermal energy, with the ocean as the heat sink.

Far-fetched, maybe. But as engineers trained in using the scientific method and analytical approach to solving design problems, we can see sense in Dr. McLean's rather unique concepts. Before attacking man's ecological problems on a haphazard scale, we need much more data. Information on the problems arising in the closed-ecology concept and the solutions developed could supply this information.

RALPH DOBRINER
**Synthesize logic with exclusive-OR ICs.**

Decomposition maps provide a systematic approach to reduce the number of logic variables.

Logic circuits using exclusive-OR gates are difficult to synthesize by means of conventional Karnaugh maps. However, decomposition maps, which are similar to Karnaugh maps, can lead directly to exclusive-OR implementation, and thus help to decrease the count of integrated circuits needed for a given function.

While Karnaugh maps are examined for characteristic patterns of AND, OR and inversion, decomposition maps are investigated for simplification in terms of functions of fewer variables. The Karnaugh map is unique, but several decomposition maps can be drawn for a given function, and all are used in the synthesis. The best way to describe the procedure is to work through some examples.

Rearrange the Karnaugh map

For the logic function in Fig. 1a, the usual Karnaugh map synthesis would yield the map of Fig. 1b and the corresponding logic circuit of Fig. 2a.

By contrast, the decomposition maps take the variables and switch them around, so that all possible two-variable by two-variable maps are formed: AB vs CD, AC vs BD and AD vs BC, as seen in Figs. 1b, c and d. (One-variable by three-variable maps can also be drawn, but these are omitted here, since three variables cannot be related by an exclusive-OR.)

The map of Fig. 1d has two sets of matching columns: 01 is the same as 10, and 00 is the same as 11. The rows of this map can be divided into two groups. The first group is 00, 01 and 10—all identical—and the second group is 11.

To begin the decomposition procedure, the logic functions of the rows are written independently of the functions of the columns. The function that describes the columns of 01 and 10 of BC is \( f_1 = BC + BC = B \oplus C \), the exclusive OR. There matching columns are inverse of \( f_1 \), \( f_1 = BC + BC \), C, The function for row 11 is \( f_2 = A \bar{D} \) while \( f_2 = \bar{A} \bar{D} + \bar{A} \bar{D} + A \bar{D} \) covers the remaining rows.

After plotting \( f_1 \) vs \( f_2 \) on a one-by-one map, we find that the output is ZERO only when \( f_1 \) and \( f_2 \) are ZERO. This establishes that \( f_1 \) and \( f_2 \) are an OR combination. Therefore the results are \( f = f_1 + f_2 = B \bar{C} + B \bar{C} + AD = B + C + AD \), as shown in the logic circuit of Fig. 2b.

The synthesis procedure followed in the example can be formalized as follows: Plot all possible maps for the given function. Look for matching columns or rows and group them in sets. When there are only two sets, the function is decomposable. The best choice for decomposition is the map with the greatest number of matches. Designate one set of columns (or rows) of this map as \( f_1 \) and the remaining set of columns (or rows) as \( f_2 \). Plot all possible three-variable maps of \( f_1 \) and the two remaining variables, of which \( f_2 \) is not a function. Now reduce the three-variable maps, which has the most repetitions of columns or rows either directly or by using an auxiliary two-variable map. Sometimes steps can be omitted. The example skipped the three-variable map and went directly to the auxiliary two-variable map.

Exclusive-OR functions may be simpler

Another example of the procedure is shown for the function mapped in Fig. 3. The AB vs DC map (Fig. 3a) has two sets of matching columns: 01 is the same as 10, and 00 is the same as 11. First, designate \( f_1 \) to be columns 01 and 10: \( f_1 = \bar{C}D + \bar{C}D = C \oplus D \). The function for the remaining columns, \( \bar{C}D + \bar{C}D \), is \( f_2 \). Now plot all possible three-variable maps, using \( f_1 \), A and B as the variables (Fig. 4). The map of Fig. 4b has three matching columns and can be reduced by designating column 11 as \( f_3 = f_1 \). Plotting \( f_3 \) vs A on a two variable map (Fig. 4d) gives the transmission function \( f = f_3A + f_3A \).

Thus \( f = f_3 \oplus A \), where \( \oplus \) symbolizes the exclusive-NOR. If this expression is expanded, \( f = [(C \oplus D) \bar{B}] \oplus A \). The logic current is shown in Fig. 5a.

If the Karnaugh map of Fig. 3a had been used with only AND and OR gates, \( f = \bar{A} B + A B \bar{C} \bar{D} \)}
1. The truth table of a typical logic function "a" can be represented in the Karnaugh map forms: "b," "c," "d." The matching columns of "d" make it useful for decomposition.

2. The normal Karnaugh map synthesis of the table of Fig. 1a results in the circuit "a." The exclusive-OR implementation reduces this to the circuit in "b."

3. Three possible four-variable maps can be drawn for a given logic function. The AB-CD map of "a" is chosen for additional study because it has two sets of matching columns.

4. The map of Fig. 3a can be decomposed into three maps of three variables each: "a," "b," and "c." There are three matching columns in "b" that permit further decomposition into the two-variable map of "d."

5. The decomposition map of Fig. 4a results in the circuit "a." The same logic derived with conventional methods gives the circuit of "b."

References
TI's quiet revolution in TTL

2.986 NS
3ns at 20mW.

A new technology is born with TI's Schottky-clamped 54/74 TTL.

Until now, speeds below 5ns could only be achieved with current mode (unsaturated ECL-type) technology.

Now, TI has built integrated Schottky-barrier diode clamped transistors* into its popular Series 54/74 integrated circuits. Our new 54S/74S family combines the high speed of unsaturated logic and the low power of saturated TTL logic. The best speed/power combination yet – and priced below competitive ECL logic families.

You gain these advantages, compared to conventional TTL integrated circuit technology:
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- Active pulldown network squares transfer curves and raises logical '1' output level.

And you also gain these advantages, compared to current mode logic technology:
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Broad applications. Series 54S/74S Schottky TTL circuits are ideal for applications in all high-speed digital systems:
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Now available in plastic dual-inline packages are the SN74S00N—Quadruple 2-input positive NAND gates. The SN74S20N—Dual 4-input positive NAND gates. And the SN74S112N—Dual J-K negative edge triggered flip-flop (separate preset, clear and clock).

More are coming in 1970. TI is developing 13 circuits in the revolutionary 54S/74S series, including other standard TTL gates (NANDs, AND, HEX inverter, AND-OR-INVERT), dual J-K and D flip-flops, as well as MSI counters and shift registers. Ceramic DIPs and flat packs will be available soon.

For more information on the most significant TTL advance in four years, get our new Bulletin CB-118. Circle 275 on the Reader Service Card or write Texas Instruments Incorporated, P.O. Box 5012, MS 308, Dallas, Texas 75222. Or call your nearest authorized TI Distributor.
**Time or frequency?** Convert from one domain to the other with these graphs, and get more data from amplitude-modulated signals.

Although a frequency-domain measurement of an amplitude-modulated signal explicitly describes the signal's bandwidth, it's not of much help in determining the dynamic-range requirements of, say, an amplifier that has to handle the signal. Conversely a time-domain measurement gives the dynamic-range information easily enough, but does not explicitly describe the bandwidth.

Since it's not always possible to make both types of measurement on a particular signal, what's needed is a simple means for converting from one type of description to the other. The conversion is easily accomplished by using a pair of graphs that plot modulation index against an easily measured parameter for each type of display. The other parameters needed to describe the signal—carrier frequency and modulation fre-

---

**John M. Davis Jr.**, Research Assistant, Microwave Division, Hughes Aircraft Co., Los Angeles.

---

1. **Dynamic range information** is given explicitly in the time domain. Oscilloscope or power-meter measurements are particularly valuable at low-modulation rates when carrier and sidebands are very close together.

2. **When a power meter is used** to make time-domain measurements, this plot of peak-to-trough power ratio vs modulation index is a convenient tool. The power ratio is measured in decibels.

3. **Bandwidth data stares at you from the face of a spectrum analyzer display.** This frequency-domain measurement is probably the easiest to perform as long as the sidebands are clearly separated from the carrier.
quency—are easily read from either type of display.

**Low rates in the time domain**

For low-modulation frequencies, the AM sidebands are too close to the carrier to be measured with precision in the frequency domain. An oscilloscope display (Fig. 1) of the signal as a function of time is a better bet. Or, for extremely low rates, a power meter may be used. (It would be used, for example, to measure signal fading.)

Referring to Fig. 1, we see that the modulation index, \( m \), is given by

\[
     m = \frac{(E_a - E_i)}{(E_a + E_i)} \quad (1)
\]

If a power-meter measurement is made, the graph of peak-to-trough power ratio vs \( m \) (Fig. 2) should be used. Note that \( E_a = E_c(1+m) \) and \( E_i = E_c(1-m) \). The peak-to-trough power ratio is therefore

\[
    \left( \frac{E_a}{E_i} \right)^2 = \left[ \frac{(1+m)}{(1-m)} \right]^2; \text{ in decibels the ratio becomes } 20 \log \left[ \frac{(1+m)}{(1-m)} \right].
\]

**High rates in the frequency domain**

For high-modulation rates, frequency-domain measurements are probably the easiest to make.

A spectrum-analyzer display (Fig. 3) clearly shows the power of the carrier and the sidebands. To extract the mod index from this data, merely check the plot of carrier-to-sideband power ratio vs \( m \) (Fig. 4).

The amplitude modulated carrier is represented by

\[
    F(t) = \cos \omega_c t + \left( \frac{m}{2} \right) \cos (\omega_c - \omega_m) t + \left( \frac{m}{2} \right) \cos (\omega_c + \omega_m) t
\]

in which each sideband has voltage amplitude \( m/2 \). The power difference between the carrier and each sideband, in decibels, is \( 10 \log \left( \frac{m^2}{4} \right) \).

An example of the application of these graphs is in the specification of a limiter to reduce fading in a satellite communication system. The fading may be regarded as low-rate AM superimposed on the normal satellite FM wave. Let’s say that the maximum expected fade is 5.3 dB and that we want to limit it to 0.1 dB. From Fig. 2, we see that 5.3 dB corresponds to an AM mod index of 0.3. This, according to Fig. 4, means that the power of each of the sidebands is 16.5 dB below that of the carrier.

To reduce the fade to 0.1 dB, the mod index must be lowered to 0.006, corresponding to a sideband level 50.5 dB below the carrier. To achieve this performance, a limiter is required that can provide \((50.5 - 16.5) = 34\) dB of dynamic limiting.

4. Find \( m \) from frequency-domain data with this plot of carrier-to-sideband power ratio vs modulation index.
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You may have tried to solve one or more of these problems. We have solved them for you. Satisfy your requirements with an extremely fast, accurate but stable and dependable Analog-to-Digital Converter. You can rely on them to consistently provide the conversion necessary for accurate and reliable system performance.

The American Astrionics 10 MHz Family of Analog-to-Digital Converters—6 bit, 7 bit and 8 bit versions—has the following characteristics:

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- **Overvoltage Recovery:** 50 nsec typical without loss of output words.
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- **Video Response:** up to 12 MHz
- **Size:** Standard Units: 2½ x 14 x 11 without power supplies
- **Data Ready:** 90 nsec after leading edge of Hold pulse
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INFORMATION RETRIEVAL NUMBER 49
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Totally visual indication of operation. It's Cutler-Hammer's new illuminated Rockette Switch. Another example of how we go just a little further to meet your design and functional needs.

The little extras that are part of every Cutler-Hammer Rockette Switch, like the entirely translucent rocker, are what has made us Number 1. The switches people specify when designing commercial appliances and business machines—because quality equipment demands the best.

Our 9 rocker shapes, each in a wide variety of colors, offer the finest in design flexibility and distinctive appearance. And, the legend is hot stamped.


So, on the next piece of quality equipment you design, brighten it with a Rockette Switch from Number 1. Call your Cutler-Hammer Sales Office or Stocking Distributor. Or write for new full-line catalog LD-110-217

Enlightenment.
Seven engineers help design our laws.
How do they think on issues of importance to you? One point is clear - there is no stereotyped engineer in Congress.

Richard L. Turmail, Management Editor

Nineteen seventy is one of those off election years when the President doesn't have to run for his political life. With the Chief Executive on the sidelines, Congressional candidates will be running on the key issues. Although it's still too early for the pollsters to tell us how the challengers and the incumbents are running, it's never too early for us to find out how they're thinking on the more important issues—specifically those of special interest to the engineer.

Since it would be impractical to try to talk to every Congressman in Washington, we decided to limit our interviews to only those members who have engineering backgrounds.

The engineer as a legislator

Before deciding on that tack, we had no idea how many Congressmen we'd be seeing. As it turned out, most of those we interviewed were as surprised as we were to find that of the 535 seats in the U. S. Congress, only 1.3 per cent are filled by legislators who've had engineering training, experience, or both.

Two of 100 Senators, Mike Mansfield of Montana and Stuart Symington of Missouri, were manipulating slide rules before they were manipulating committees. Correspondingly, five members of the House of Representatives were drawing up designs long before they were drawing up bills, John M. Murphy of New York; Clarence E. Miller of Ohio; Ed Foreman of New Mexico; George E. Brown, Jr., and George P. Miller, both of California.

A breakdown of this group provides better insight into its makeup:
Affiliation: Democrats, 5; Republicans, 2.
Veteran: 6 (Army, 4; Navy, 1; Army, Navy and Marine Corps, 1). Engineer type: electrical, 2; mining, 1; civil, 4. Other occupations: business or banking; public service; teaching.

It doesn't take a statistics expert to figure out that engineers are definitely in the minority in Congress. There are only seven in all. Except for law enforcement, medicine, science and the ministry, engineering is the least represented occupation in Congress. More frequently, members have been lawyers, businessmen or bankers, educators, farmers, and journalists.

Engineering—a help or a hindrance?

The engineers generally agreed that lawyers predominate in Congress not so much because they are versed in the law, but because they run for public office from the first day they hang up their shingle. Since lawyers can't advertise, becoming a candidate is one of the few ways they can publicize their abilities.

Whether or not they felt the need of a legal background when they first came to Congress, the engineer-Congressmen generally agreed that although a lawyer knows the law, the engineer knows how to think out a problem logically, even a legal one. Typical of the comments they offered to back up their belief that their engineering background has been helpful to them in Congress, is this one by Sen. Stuart Symington:

"I believe my experience in the electronics industry has been valuable to me throughout my service in the Senate. It has helped me to understand many of the more technical matters which come before the various committees on which I serve. In addition, it has aided me in making my recommendations as to defense and other federal projects designed to save the taxpayer money."

Rep. Clarence Miller of Ohio said that, when he first came to Washington, he had to do "a little adjusting" to fully understand the legal maneuvering that goes on in Congress. But he observed that his engineering background had taught him logical sequence. "That training," he said, "always helped me determine what should be done to solve any problem that would come up."

Rep. George P. Miller of California, although he claims to have no quarrel with lawyers, said, "We engineers are at a slight disadvantage be-
New York's Rep. John M. Murphy congratulates one of his appointees to Annapolis upon the officer's graduation.

As an engineer, Rep. Clarence Miller of Ohio had two electrical devices patented. He is shown in his Washington office.

cause we think in straight lines, while lawyers tend to think in curves and circles."

No stereotyped engineers

What, if anything, do these seven members of Congress have in common, besides varying backgrounds in engineering? Have their careers operated, in their time, on a parallel course? To find out what makes the legislators tick, and how they think, we asked them:
- How did you get into Congress?
- From an engineering point of view, is the Safeguard antiballistic missile system feasible?
- Have you introduced any bills to help curb pollution?
- What would you do about the underemployment of engineers?
- Do members of the Administration have a solid feel for technology and where it's taking us?

What follows are the highlights of the answers:

Sen. Stuart Symington (D-Mo.)

Senate Committee membership: Armed Services; Foreign Relations; Aeronautical and Space Sciences; Joint Economic; Appropriations; Democratic Policy; and Democratic Steering.

Senator Symington came into public service in 1945 when he was appointed to the first of six successive high executive positions by President Harry S. Truman. He was the first Secretary of the Air Force. In 1952 he resigned the post of Administrator of the Reconstruction Finance Corporation and eventually decided to run for one of the Missouri Senate seats.

Symington said that he had studied metallurgy and electrical engineering by correspondence after he had earned an A.B. degree at Yale in 1923. He had started in business at the age of 14 as a machine-shop apprentice. From 1923, he was highly successful in radio and electronic manufacturing. He was so successful, in fact, that he was called upon to serve as president of the Emerson Electric Manufacturing Co. in St. Louis in 1937. He turned the company around from a loss to a profit. He also established one of the earliest profit-sharing plans in the country.

The Senator believes that employment in the engineering community would improve with the end of the Vietnam war. Since most of the research and development for weapons has been completed, the war is not stimulating the economy. He thinks that the challenge to engineers now is to help us resolve our critical domestic problems, such as transportation, urban development and conservation.

As far as Symington is concerned, the military hasn't proved that the Safeguard antiballistics missile system is a feasible one. He believes that the Department of Defense research program responsible for the ABM project has been conducted by theory rather than by engineering methods. There have been too many cost overruns, and delays have been created, in his estimation, by a tendency to skip from research to production with not enough emphasis in between on engineering.
Sen. Mike Mansfield (D-Mont.)
Senate Committee membership: Chairman of Democratic Conference; Foreign Relations; Appropriations; Policy; and Steering.

Senator Mansfield is the only member of Congress to have served in all three branches of the military before he was 20 years old. He served in the Navy at the age of 14, then enlisted in the Army, and later in the Marine Corps. He returned to Butte, Mont., in 1922, to work for the next eight years in the mines and as a mining engineer. At that time he also attended Montana School of Mines in Butte.

Mansfield is the only one we talked to who denied that his experience in engineering had helped him in Congress. Part of the reason for this, perhaps, is that after he received both B.A. and M.A. degrees from Montana State University, he was a professor of Latin American and Far Eastern history at his alma mater.

In 1942 he was elected to Congress to serve five terms as a representative. He was elected to the Senate in 1952. In 1961, he was elected Majority Leader of the Senate and has been re-elected to that post each succeeding session to the present time.

Of the ABM system, Mansfield said, “The radar is vulnerable, because it’s too large and too scattered.” He further warns, “If the radar is hit, the whole system is out. The radar should be built on a smaller scale, be better protected, and be completely computerized.

“The military,” he added, “is prone to move too quickly on such projects without having all the facts.”

Rep. John M. Murphy (D-N. Y.)
House Committee membership: Interstate and Foreign Commerce; Merchant Marine and Fisheries.

Murphy came to Congress by way of the United States Military Academy at West Point, N. Y., where he majored in civil engineering. Never actually employed as an engineer, Murphy served in the infantry in Korea for six years on the general staff. He was discharged as a captain in 1956 and organized a highly successful trucking firm in Staten Island, N. Y. Partly due to his success in business and partly because he was engaged in many public works, the Democratic Party in Staten Island asked him to run for Congress in 1962. He was elected and re-elected for the last three terms.

Of his engineering training, Murphy said, “It has given me a mental discipline to reason through to a conclusion—with no shortcuts—for every problem that comes up in Congress.

As to the question of whether or not the Administration has a solid feel for technology and where it’s taking us, he said, “The government always has a problem getting top men because the men have to take a pay cut and there are conflicts of business interests.”

In Congress, Murphy has been a strong advocate of environmental-quality legislation. He spearheaded the drive for the Clean Air Act of 1965. In 1967 he succeeded in invoking the provisions of the Air Quality Act to reverse the tide of pollution in New York City. Far from satisfied with progress in this area, he says he continues to battle for strong and responsive antipollution controls and enforcement.

Rep. Ed Foreman (R-N. M.)
House Committee membership: Armed Services.

“I became interested in becoming a member of Congress,” Foreman said, “when I became more and more concerned about the control and size of government, the high taxes and the red tape. I thought that it was up to me to do something about these problems.”

Foreman graduated from New Mexico State University in 1955 with a B.S. degree in civil engineering. After a two-year tour of duty in the Navy, he served as company officer in land companies, farms and related businesses. Foreman was active in numerous social, civic, county and state organizations. In 1960, for example, he was the campaign chairman of seven counties for President Nixon and for Sen. John Tower of Texas. In 1962, Foreman was the youngest member elected to the 88th Congress. Although he
Montana Sen. Mike Mansfield opens a meeting of the Democratic Caucus composed of the Democratic Senators Russell (Ga.) and Byrd (W. Va.).

was defeated later by Rep. Richard C. White of Texas, he was elected again to the 91st Congress as a Representative of New Mexico. He is the first individual in this century to be elected to the U. S. Congress from two different states.

Foreman said that the government needs more advice and help from engineers who've been taught a logical sequence of thinking.

"Government," he said, "needs less help from the consultant and more help and advice from the guys who've had to meet a payroll."

Rep. George E. Brown, Jr. (D-Calif.)
House Committee membership: Veterans Affairs; Science and Astronautics; Education and Labor; Foreign Policy; Environmental Affairs.

Brown was employed by the city of Los Angeles (except during service in World War II and while on leaves of absence) from 1940 to 1957 as a civil engineer, and in management of engineering personnel with the Department of Water and Power. While still a student at UCLA, where he earned a B.A. in physics, Brown was a powerstation operator, and became a member of the International Brotherhood of Electrical Workers. For a number of years he served as a public member of the Mayor’s labor Management Committee for Los Angeles. He was also busy in business and financial circles.

In 1954, Brown was elected a city councilman and Mayor of Monterey Park, and in 1958 was elected to the State Legislature as an Assemblyman. Four years later he was elected to represent California’s new 29th Congressional District.

Brown suggested, in a speech given in Washington last year, that it is of extreme importance that the structure of local government be made “more efficient, administratively, so that the mayor (for example) can make decisions that are important” and “that the people have a greater voice in the policies under which he acts.”

Rep. Clarence E. Miller (R-Ohio)
House Committee membership: Agriculture; Public Works.

Miller’s career began in 1957 when he was appointed to fill an unexpired term as a member of the Lancaster, Ohio, City Council, and was elected to a full term in 1961. Two years later, Miller was elected Mayor of Lancaster. Highly praised for his work in that office, he was elected to the U. S. House of Representatives in 1966.

Prior to public service Miller was an electrical engineer employed by the Ohio Fuel and Gas Co. for 30 years. He has two patents, including: “Magneto Having Auxiliary Pole Piece,” and “Remote Control and Alarm System for a Compressor Station and Compressor Engines Thereof.”

Miller said that he thinks the ABM system is feasible because he has faith in the nation’s ability to build it correctly.

He is working on a number of antipollution bills that he said would offer a tax break to those companies that would help curb water and air pollution.
Of his political philosophy, Miller said that it does not fall into any particular category. He believes in the individuality of man and that the community and state should make every effort to solve its problems before calling on the federal government for assistance.

George P. Miller (D-Calif.)
House Committee membership: Chairman of Science and Astronautics

"Civil engineering was equated with surveying when I was young," Miller said. "I surveyed railroads and property around Sacramento until I got my first engineering job as inspector of concrete construction and repair. We were building monolithic sewers at the time," he smiled.

He said that when there was no engineering work, he looked for a job in politics. "To get elected to the state legislature in those days," Miller said, "all you needed was $20 and 20 names on a petition. The salary was $100 a month. I stayed for four years and quit in 1940. I just couldn't afford it. Now the legislators make $19,000 per year and $25 per diem when they're in session."

In 1941 Miller became Executive Officer of the California Division of Fish and Game, a position he occupied until he took his seat in Congress in 1945. He holds a degree in civil engineering from Saint Mary's College in California.

Referring to student dissenters who confronted him on clearing up pollution immediately in California, Miller said, "They just don't know what they're talking about. You pollute no matter what you do. These things take years to turn around."

As an example he pointed out the problem caused by polluted streams in the San Joaquin Valley. "The Valley can't be drained," Miller said, "because the polluted water would stagnate San Francisco Bay the only real outlet for Valley streams." In his opinion, the only answer that makes any sense is reconstructed water—filter water that's used over and over again.

Of the ABM Miller said, "I think it's a feasible system because I have faith in our ability to build it. Even if the system is only 50% efficient, it's worth the building because it'll put us that much further ahead of our enemies."

Miller has been one of the primary backers of the space program. In 1967 he was the recipient of the Goddard Award, a trophy awarded annually for the greatest achievement to advance space flight programs contributing to U.S. leadership in astronautics. In 1970 he was given a similar tribute by the American Business Press.

What can you do for technology?

With a sizeable chunk of the national budget being meted out to technology each year, the engineer legislators mostly agree that it is incumbent on the engineering community to echo their opinions in the halls of Congress on matters that concern defense and space projects.

Most of the legislators say that they rarely hear from the engineers of their constituency. "They just don't seem to take time to write," said Representative Miller of Ohio.

Senator Symington hears from engineers only when the big technical projects such as the ABM are being discussed. "It's so important," Representative Foreman said, "for engineers to participate in local government, particularly those who are in business for themselves."

"Engineers should be active in the community," Representative Murphy said, "on the school board, for example. They should go to hearings and speak with authority on technical issues. I don't hear from engineers," he said, "probably for the same reason I don't hear from dissenting engineering students—apparently, they're too busy to take the time."

Senator Mansfield's best advice for engineers is, "Tell the truth! If you think a system is good or bad, say so!" As the Senator from Montana was called back to the floor for a vote, he further advised with a weary smile that, although more engineers should be heard in government, "They'll be a lot better off if they stay in engineering and not get into politics."
E/M Leads
In 5 Significant Specifications
Power Supplies

<table>
<thead>
<tr>
<th>TYPICAL EXAMPLE</th>
<th>WATTS PER CU. IN.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-KW E/M</td>
<td>2.15</td>
</tr>
<tr>
<td>CHRISTIE</td>
<td>1.07</td>
</tr>
<tr>
<td>SORENSEN</td>
<td>.96</td>
</tr>
<tr>
<td>H-P</td>
<td>.96</td>
</tr>
</tbody>
</table>

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Ideas For Design

Perform large-value factorial computations on a computer

Mathematical expressions involving the binomial coefficient \( \binom{n}{k} = \frac{n!}{k!(n-k)!} \) are frequently encountered in probability theory problems or in error-detecting and correcting codes.

To compute \( \binom{n}{k} \) directly requires computing three factorials. This can be time-consuming and cause overflow in computers for large value of \( n \). A better method that prevents overflow unless the final answer itself causes overflow is as follows:

If \( n \geq 2k \):
- Start with \( \binom{n}{1} = n \)
- Recursively compute \( \binom{n}{j} \) for \( j = 2, 3, 4, \ldots, k \). Then \( \binom{n}{j} = \binom{n}{j-1} \frac{n-j}{j} \)
If \( n < 2k \):
- Initialize \( I = 1 \)
- Start with \( \binom{k+1}{k} = \binom{k+1}{k} = k+1 \)
- Recursively compute \( \binom{k+I}{k} \) for \( I = 2, 3, 4, \ldots, n-k \)

The time-sharing program in the figure is written in extended BASIC language. Computation of \( \binom{9}{4}, \binom{11}{6} \) and \( \binom{100}{70} \) are included. \( \binom{100}{70} \) has the largest value of these binomial coefficients. To compute \( \binom{100}{70} \) conventionally would have caused an overflow on the computer available. The new method computed it easily.

**Ronald Lambert, Design Engineer, General Electric Co., Utica, N.Y.**

VOTE FOR 311

Improved IC fires SCRs used in auto ignition

An integrated circuit specifically designed for firing SCRs (Fairchild µA742) has become available. When connected as shown, it provides all of the desirable features for firing the SCR of a capacitor discharge (C/D) automobile ignition system.

The 742 IC has a built-in 21-V dc diode voltage regulator section. A current of approximately 10 mA is supplied from the C/D inverter through the dropping resistor \( R_{D} \). The 742 supply voltage will drop to zero while the SCR is on, but the 742 is designed for such operation. Sequential functioning is as follows:

1. During the dwell time when the distributor points are closed, pin 3 is more positive than pin 2. This biases a differential amplifier to trigger an internal thyristor “on” and charges the SCR firing storage capacitor, \( C_{S} \), to approximately 19 V dc with a time constant of approximately 1 ms.

2. When the points open, the voltage at terminal 10 rapidly rises toward +12 V. At about +2 V an internal thyristor-transistor combination triggers on and dumps the \( C_{S} \) stored charge through an internal 10 ohm resistor into the external SCR firing gate, via terminal 11. This provides a peak current of nearly 2 A, which is adequate to fire any SCR likely to be used, yet

A listing of the program for computing the binomial coefficient is given in (a), and some examples of the results obtained are in (b).
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### 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;0.5%</td>
</tr>
<tr>
<td>Transient Overshoot</td>
<td>&gt;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>
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</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>.01% to .5% of C.F.</td>
</tr>
<tr>
<td>Pass Bandwidth</td>
<td>Up to 100% of C.F.</td>
</tr>
<tr>
<td>Shape Factor</td>
<td>&lt;1.8:1</td>
</tr>
<tr>
<td>Notch Rejection</td>
<td>&gt;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;40 db</td>
</tr>
<tr>
<td>Shape Factor</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;3 db</td>
</tr>
<tr>
<td>Ripple</td>
<td>&lt;1 db</td>
</tr>
</tbody>
</table>
the energy available from $C_{st}$ is low enough not to damage even the most sensitive SCR. During the $C_{st}$ discharge, an internal inhibit action blocks the charging route of $C_{st}$.

3. When the voltage at terminal 10 reaches about 7 V, an internal zener diode allows an internal thyristor to fire, bringing the terminal 10 trigger voltage down to 1 V. This prevents false or repeated firing while the points are open.

4. The 12 V from the open points places the terminal 2-3 $C_{st}$ charging system in an "inhibit state," preventing recharging of $C_{st}$ while the points are open.

5. The firing of the C/D SCR dumps $C_p$ into the ignition coil, firing the plug and simultaneously shorting the inverter, stopping its regenerative oscillations. At this time the voltage supply to the 742 drops below required internal active circuit operation levels, further assuring that $C_{st}$ will not be recharged while the plug is firing. Oscillatory action of the coil and $C_p$ attempt to reverse the current though the SCR and it turns off, allowing the inverter to restart.

Mechanical points usually make multiple contact during opening and closing. This problem is worst at very low (cranking) and very high speeds. Such "bounces" are normally separated by a few microseconds. Attempts to solve this problem account for most of the variety in published C/D ignition system circuits. The 742 firing action in the 1-2-3-4-5 sequence redundantly prevents such point bounce from causing multiple firing.

Reputable life studies establish the optimum distributor point current in the 0.25-to-0.5 ampere region; higher values cause erosion and pitting, while lower values are inadequate to keep the points clean.

One source of oily point coatings is crankcase vapor entering via the distributor shaft bearing. Thus minimum point current adequate to remove such coatings determines the value of $R_1$.

Point condition is not critical; points can develop a closed series resistance of more than 1 ohm and an open leakage path of lower than 100 ohms without firing malfunction. Exact dwell time is not important, because $C_{st}$ accumulates adequate firing energy in less than 0.5 ms. However, crankshaft angle at distributor point opening remains significant for correct ignition timing. Timing checks and rubbing block lubrication are still needed.

Use of the $\mu$A742 integrated circuit provides simple, low-cost firing with a minimum of external components.

Bibliography:

W. L. Brown, Design Consultant, San Diego, Calif.

Use of the $\mu$A742 integrated circuit provides simple, low-cost firing with a minimum of external components.
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3. One selector switch minimizes chance of incorrect settings and burnouts.

Shown actual size
Divide-by-n counter uses unijunction transistor

The accompanying unijunction transistor (UJT) circuit is a simple counter that can be used as a divide-by-2, 3, 7, 13—or any number within the design limits. It simply charges a capacitor in step-like fashion until the UJT firing potential is reached, discharges the capacitor and starts the cycle again.

The input pulse length, $T_1$, and the time between pulses, $T_2$, determine the value of the circuit components. The base resistor $R_2$ is chosen first and should be less than 100 ohms for reasonable UJT temperature compensation. However, it must be large enough to give a sufficiently long output pulse when the capacitor discharges through it. The zener diode $D_z$ voltage $V_z$ should be slightly less than the lowest input pulse amplitude so that all input pulses charge the capacitor in identical increments.

The capacitor must fully discharge during $T_2$, which should be about four or five time-constants long. This condition requires that $4R_2C = T_2$ or $C = T_2/4R_2$. The charging resistor $R_1$ must then be chosen to give the desired counting capacity. If $n$ is the number of pulses to be counted in one cycle,

$$nT_1 = R_1C \ln \left(1 - \frac{V_p}{V_n}\right)$$

where $V_p$ is the firing potential of the UJT, and $V_n = V_i - V_{11}$, the pulse voltage that the capacitor sees. Values shown are for a divide-by-7 counter with an input pulse rate of 10 kHz and a 20% duty cycle.

E. Lee Bell, Design Engineer, Sangamo Electric Co., Springfield, Ill. VOTE FOR 313

IC compatible monostable has wide linear range

This voltage-controlled monostable is compatible with low-voltage ICs and has excellent linearity. The circuit is similar to collector-coupled monostable design, the difference being that $Q_3$, along with the "hard" voltage source $V_{in}$, provides a constant-current source to discharge the timing capacitor $C$. The constant current is

$$I_c = \left(\alpha_{Q_3}\right) \frac{V_{CC} - V_{be\ Q_3} - V_B}{R_3}$$

The quasi-stable state defined by the compound transists $Q_2 - Q'_2$ is easily found to be of duration

$$T = \left[\frac{R_{BB}C}{\alpha_{Q_3}}\right] \left[\frac{(V_{1n} - V_{cs\ SAT\ Q_1}) - (V_{be\ SAT} - V_{be\ CUT\ IN}) Q_2, Q'_2}{V_{CC} - V_{be\ Q_3} - V_B}\right]$$

which is of the form

$$T = K V_{1n} - T_s$$

The deviations from linearity are due to transistor voltages $V_{be}$, $V_{ce}$ etc., varying non-linearly with $V_{1n}$. Poor linearity at low $V_{1n}$ is also due to difficulty in precisely locating the leading and
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- Up to 1.25 amperes

For more information about General Electric integrated circuits, call or write your GE sales representative or authorized distributor, or write General Electric Company, Section 220-87, Room C-2, Northern Concourse Office Bldg., North Syracuse, N.Y. 13212. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: Electronic Sales, IGE Export Division, 159 Madison Avenue, New York, N.Y. 10016.
falling edges of the output pulse. The power limit of \( V_{in} \) occurs when it approaches \( V_{be\,Q_1} \) and is about 0.3 V.

The upper linearity limit is caused by the incomplete recovery of the voltage at the base of \( Q_2 \) to \( V_{be\,SAT\,Q_2} \) and the collector voltage of \( Q_1 \) to \( V_{in} \), when the next trigger pulse is applied. However, these recovery transients are short, providing good linearity up to 97% of duty cycle.

The upper limit for \( V_{in} \) is determined by \( BV_{CEO\,Q_2} \) because the initial OFF voltage appearing at the base of \( Q_2 \) (at the trigger pulse instant) is

\[
V_{be\,SAT\,Q_2} - |V_{in} - V_{ce\,SAT\,Q_1}|
\]

then

\[
V_{in\,MAX} \leq BV_{CEO\,Q_2} + V_{ce\,SAT\,Q_1} + V_{be\,SAT\,Q_2}
\]

The Darlington connection doubles the effective value of \( V_{in\,MAX} \).

During the quasi-stable state, \( V_{CC} \), \( R_4 \) and \( R_2 \) provide adequate base current for \( Q_4 \) to saturate up to \( V_{in\,MAX} \). From these conditions, \( R_1 \) can be obtained.

During that stable state it is required that

\[
V_{be\,Q_1} = V_{be\,CUT\,IN} \quad (=0.4 \, V)
\]

For a known \( V_{CC} \) and \( R_4 \), \( R_2 \) can be obtained.

With a full range of \( V_{in} \) from 0.2 through 25 V, the linear range (±1%) is the order of 100:1. For the widest range, \( V_B \) is kept to a minimum; this value can be obtained from

\[
V_B + V_{be\,Q_3} = V_{ce\,Q_3} + V_{be\,SAT\,Q_2, Q_3}
\]

The output amplitude is a constant in the order of 1.7 V for the component values shown. It is obtained by superposition of the voltages \( V_{CC} \) and \( V_{be\,Q_1} \).

Victor C. Sobolewski, Research Student, The University of Adelaide, Adelaide, Australia. VOTE FOR 314

Stable voltage supply has programmable output

A small dc-to-dc converter can be combined with two ICs to provide an inexpensive high-voltage supply that has good regulation and small temperature drift. In addition the output can be programmed with an external signal.

The supply shown in the figure uses an LM 300 voltage regulator and a Venus Scientific Model K15U 100:1 dc-to-dc converter. An IC op-amp LM 301 compensates for temperature drifts in the dc-to-dc converter and the voltage regulator; it also improves temperature stability.

By changing the output ground and the input polarity to the op amp, the designer can reverse the output polarity of the power supply. The output may be adjusted from about -400 V to about -1500 V with a 10-kΩ potentiometer. When the potentiometer is set for an output of -800 V, the output can be adjusted from -500 V to -1100 V by applying ±1.5 V through 10 kΩ to pin 5 of the voltage regulator.

For an output at -500 V, the line and load regulation are better than 0.1% for line voltages from 10 to 24 V and load currents from 100 µA to 1 mA. At this voltage, the temperature stability is 0.2%/°C from 20°C to 60°C.

L. E. Wood, Physicist, U.S. Dept. of Commerce, Boulder, Colo. VOTE FOR 315

Op amp compensates for temperature drift in the dc-to-dc converter and voltage regulator. At an output of -500 V, temperature stability is 0.02%/°C from 20°C to 60°C.
This Product Source Directory covers numeric and alphanumeric display devices.

For each table, display devices are listed in alphabetical order by manufacturers' names.

The following abbreviations apply to display devices:
- ina—information not available
- req—request
- n/a—not applicable

All notes used in this table are in letter series and defined at the end of the section. Manufacturers are identified by abbreviation. The complete name of each manufacturer can be found in the Master Cross Index below.
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<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
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<th>Viewing Distance (Foot)</th>
<th>Light Output F-L</th>
<th>Supply Voltage (V)</th>
<th>Current (mA)</th>
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### Display devices (numeric)

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<th>Current (mA)</th>
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<td>req</td>
<td></td>
</tr>
<tr>
<td>Pinlites</td>
<td>65</td>
<td>5/16</td>
<td>20</td>
<td>4500</td>
<td>5</td>
<td>15</td>
<td>req</td>
<td></td>
</tr>
<tr>
<td>Tang-Sol</td>
<td>DT1704</td>
<td>0.57 x 0.36</td>
<td>40</td>
<td>225</td>
<td>0.5/seg</td>
<td>7000</td>
<td>7000</td>
<td>3.5-5/seg</td>
</tr>
</tbody>
</table>

### Display devices ( alphanumeric, solid-state)

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>Character Size</th>
<th>Viewing Distance</th>
<th>Light Output ft-L</th>
<th>Supply Voltage (V)</th>
<th>Current (mA)</th>
<th>Notes</th>
<th>Price/Unit $</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-P</td>
<td>5082-7100</td>
<td>0.27</td>
<td>15</td>
<td>200</td>
<td>1.6</td>
<td>100</td>
<td>pr</td>
<td>30/1k</td>
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<tr>
<td>Monsanto</td>
<td>MAN2</td>
<td>0.35 x 0.25</td>
<td>ina</td>
<td>300</td>
<td>1.7</td>
<td>200</td>
<td>r</td>
<td>100</td>
</tr>
<tr>
<td>Monsanto</td>
<td>MAN1</td>
<td>0.27 x 0.187</td>
<td>ina</td>
<td>200</td>
<td>3.4</td>
<td>20/seg</td>
<td>rx</td>
<td>8.75</td>
</tr>
<tr>
<td>Monsanto</td>
<td>MAN3</td>
<td>0.115 x 0.086</td>
<td>ina</td>
<td>200</td>
<td>1.7</td>
<td>5/seg</td>
<td>q</td>
<td>12.45</td>
</tr>
</tbody>
</table>

- **Display** : y 7, x 5, y 7, z 5, N
- **Cold cathode**: 15 segment
- **Includes decimal point**: 16 digits/unit, character generator, drive electronics and bezel included
- **Side view display**: 15 segment
- **Optional**: Round nibble tube
- **Standard rectangular nibble tube**: Complete alphanumeric capability
- **Monolithic**: Solid state
- **Decomposition**: Includes decoder driver
- **Cold cathode, gas filled**: Seven segment readout
- **Fluorescent readout**: Seven segment
- **Inconceivable, segmented**: Seven segment
- **Unlimited color filter capability**: Up to 14 digits available

---

**Electronic Design** 14, July 5, 1970
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INFORMATION RETRIEVAL NUMBER 60
Electronic Design 14, July 5, 1970
New Products

Digital 24-bit filters
sample up to 500 kHz

Rockland Systems Corp., 131 Erie St. East, Blauvelt, N.Y. Phone: (914) 359-1818. P&A: $5000 to $20,000; Fall of 1970.

Using building-block modules, the 4000 series of programmable digital filter assemblies features accuracies up to 24 bits at sampling rates up to 500 kHz.

Each assembly is composed of four basic parts: adders, multipliers, shift-register delays and a memory. These basic components are combined into second-order building blocks (two poles and/or two zeros).

Assemblies can be combined or multiplexed in a number of ways to realize any number of any desired filter order functions.

For instance, each filter assembly may be multiplexed among several inputs, or on one input for higher-order filter functions. Both a single input and several multiplexed inputs can also be used together.

The use of recursive (poles and zeros) filter assembly structures permits the realization of extremely sharp frequency-domain cutoffs. Non-recursive structures can be used to give finite impulse response, precise linear phase and other special characteristics.

Sampling can be varied with either an internal clock or with an external clock via a front-panel connection.

Standard accuracies are 16 and 24 bits. Arbitrary arithmetic accuracies are also available. A/d and d/a conversion accuracies are limited to commercially available converter accuracies of 8 to 12 bits. Word lengths can be modified in four-bit bytes.

CIRCLE NO. 250

Chopper amplifier is non-inverting

Analog Devices, Inc., 221 Fifth St., Cambridge, Mass. Phone: (617) 492-6000. P&A: $49 or $64; stock.

Because it is a non-inverting chopper-stabilized operational amplifier with an input impedance of 1000 MΩ, model 260 op amp can hold peak-to-peak noise to 0.4 µV and 4 pA. Two versions are available—one (the 260J) with a voltage drift of 0.3 µV/°C, and the other (the 260K) with a drift of 0.1 µV/°C. For both versions, offset voltage is 25 µV.

CIRCLE NO. 251

High-speed amplifier gains out to 100 MHz

Optical Electronics Inc., P.O. Box 11140, Tucson, Ariz. Phone: (602) 624-8358. P&A: $57; stock.

Offering a slew rate of ±100 V/µs, the model 9694 general-purpose operational amplifier delivers a gain-bandwidth product of 100 MHz. Other features of the device include: a typical open-loop gain of 80 dB, a typical offset voltage drift of 20 µV/°C, and a typical bias current of 60 nA. Power dissipation is typically 210 mW, and output voltage is ±10 V.

CIRCLE NO. 253

Miniature regulator can handle 100 V

Space Age Microcircuits, P.O. Box 426, Chatham, N. J. Phone: (201) 635-8484. P&A: $15; stock.

Featuring remote sensing and programmability, a miniature hybrid power supply regulator can stabilize dc voltages ranging from 1 to 100 V. Model UR-1 can handle very low currents, as well as currents in excess of 100 A when used with suitable external power transistors. Regulation is better than 10 mV for zero to full-load changes and 5 mV for input changes of ±10%.

CIRCLE NO. 252

Multiplier for $35 covers 1.5-MHz band


Costing only $35 in single-unit quantities, a new analog multiplier provides an accuracy of better than ±1% in all four quadrants, a bandwidth of 1.5 MHz, and a maximum supply rejection of ±100 mV/V. Model 4094/15C has less than ±2% amplitude error due to frequency effects up to 500 kHz and an output slew rate of 40 V/µs.

CIRCLE NO. 254
Readout tube for $27 displays 14 digits


In only 7 in. of panel space, the Pandicon ZM1200 gas-filled cold-cathode readout tube displays 14 digits. The unit requires only 27 external connections instead of the 168 required for conventional readouts. Priced at $27, the tube offers floating decimal-point location.

CIRCLE NO. 255

Indicator lights snap into place

AMP Inc., Harrisburg, Pa. Phone: (717) 564-0101.

Completely pre-assembled, Ampilume nylon-encased neon and incandescent indicator lights snap into panels that are 0.032 to 0.062-in. thick. Standard lens styles include top-hat and flush versions. Available colors are natural, red, orange, yellow, blue, green, and purple. Life expectancy is 25,000 hours for the neon lights and 50,000 hours for the incandescent indicators.

CIRCLE NO. 256

Variable capacitors use chips as shunts

Johanson Manufacturing Corp., 400 Rockaway Valley Rd., Boonton, N.J.

Designed for uhf, vhf, microwave and stripline applications, series 505 variable capacitors are shunted with chip capacitors to improve Q, and current and capacitance capabilities. The variable capacitor with a chip in parallel is said to be a trimmable fixed device since it eliminates the need to trim by means of interchanging close-tolerance chips. Working voltage is 250 V dc, and insulation resistance is $10^6$ MΩ.

CIRCLE NO. 257

Silicone capacitors achieve Q of 5000

American Technical Ceramics, 1 Norden Lane, Huntington Station, N.Y. Phone: (516) 271-9600. P&A: 766; stock.

Encapsulated with a tough silicone epoxy body insulation, series ATC-AV01 capacitors provide a Q of greater than 5000 at 1 MHz. The units are 1/8-in. squares with silver ribbon leads. Capacitance values range from 0.5 to 470 pF and working voltage is 300 V dc. The units have a temperature coefficient of 95 ppm/°C.

CIRCLE NO. 258

Thick-film arrays use infrared LEDs

HEI, Inc., Jonathan Industrial Center, Chaska, Minn. Phone: (612) 448-3510.

Providing an infrared light for opto-electronic applications like paper-tape reading and shaft encoding, a new line of thick-film arrays use solid-state light-emitting diodes as the light source. Series LEA 400 arrays combine LEDs with thick-film packaging to provide small size, high reliability, long life, and low power requirements. They contain from 2 to 12 LEDs.

CIRCLE NO. 259

Silicon storage tubes hold image one month

Thomson-CSF Electron Tubes, Inc., 50 Rockefeller Plaza, New York, N.Y. Phone: (212) 245-3900.

Two new silicon-target storage tubes can store a full TV greyscale image for 15 minutes with constant refreshing, and a black-and-white image for half an hour with the power on. If the power is turned off, storage capability is at least one month. Model 1238 provides 800-line resolution, while model 1239 has 1200-line resolution. The stored image can be edited.

CIRCLE NO. 260
At every repeater station of a microwave relay system, there's a microwave distribution network—a circuit assembly that combines, divides, and directs the signals of one transmission channel. It interconnects the waveguides with coaxial cables that distribute microwave power to frequency mixers, modulators, and amplifiers.

Now, engineers at Bell Laboratories' Allentown, Pennsylvania, location have developed an integrated-circuit version. This one structure, smaller than a cigar box, has only a tenth the weight and a fifteenth the volume of the previous assembly. And, it costs less.

The network is shown above with its top half removed. The paths for the microwave signals are “stripline”—small rectangular channels with a copper-strip center conductor, electrically much like coaxial cable. The conductor strip is plated over an evaporated thin gold film on a ceramic substrate. Terminations and resistors are made by depositing tantalum nitride on the substrate. The four cross-shaped stubs (at the ends of the stripline) are stripline-to-waveguide transducers.

The seven black disks on the center conductor are ferrite microwave circulators, three-port devices which let microwave power flow from any port to the next one in the indicated direction only. This controls signal flow and isolates circuitry. The power splitter in the conductor feeds the test port.

Bell Laboratories engineers and their colleagues at Western Electric carefully selected this combination of modern materials and the techniques for working with them—including precision aluminum die casting and tantalum and gold thin-film technology. Analytical studies defined the geometry of the various circuit components to meet the rigorous standards of long-distance communications. This resulted in a superior component for our radio relay system and, at the same time substantial reductions in cost, size, and weight.

From the Research and Development Unit of the Bell System:
Bounce-free keyboard scans electronically


Continuously scanning all possible codes every 256 µs, a 52-key ASCII-coded keyboard completely eliminates contact bounce since the code does not come from the keys. When a key is depressed, the scanning process is stopped at the selected code. The keyboard encoder consists of an eight-page clocked ripple-through counter, two 16-channel multiplexers, a one-of-16 decoder, a monostable multivibrator, and gates. The counter operates continuously from a 1-MHz clock which is controlled by a four-input NAND gate. Any low input to the gate, other than the clock input, inhibits the clock and stops the counter at a particular eight-bit code.

Numeric keyboard augments Teletypes


An auxiliary numeric keyboard advances the speed and accuracy of data entered through Teletype and ASCII terminals. The compact portable unit is configured as a standard office calculator with terminal control keys. It attaches through a quick connect/disconnect provision leaving the main terminal keyboard fully operational. The unit's input is buffered for greater operator convenience.

Noise-free keyboards use diaphragm switch

Datanetics Corp., 2828 Spreckels Lane, Redondo Beach, Calif. Phone: (213) 542-4355. P&A: $1 per position; 10 days.

Two new 16-position keyboards incorporate a wafer-thin (0.15 in.) elastic diaphragm switch configuration for long life and noise-free operation. They are available in both standard-key (model DC-16K) and low-profile touch (model DC-16P) versions. An integral PCB board plug mates with commercially available 18-pin connectors.

Tape search system logs time codes too

Systron Donner Corp., 888 Galindo St., Concord, Calif. Phone: (415) 682-6161. Price: $3500.

Consisting of a time-code generator and tape search unit, the model 8154 tape search system can accept a serial time code input and search the recorded data during a preset time interval. As a time code generator, the system is a precise digital clock which also generates a serial modulated and dc level shift code for use in time indexing during data acquisition.

Read/write memories have 12-ns access time

Advanced Memory Systems, Sunnyvale, Calif. P&A: $1230 or $1380; 3 to 4 wks.

Organized as 128 words by eight bits (model 1288E) or 128 words by nine bits (model 1298E), two new high-speed fully functional read/write memory cards offer typical access times of 12 ns. Both cards have a power dissipation of only 7 mW per bit. Inputs are fully buffered and unterminated emitter-follower outputs permit wired-OR operation for word expansion.

Single-card data set transmits 1800 bits/s

Rixon Electronics, Inc., div. of United Business Communications, Inc., 2120 Industrial Parkway, Silver Spring, Md. Phone: (301) 622-2121.

The FM-188 data modem, which operates at speeds up to 1800 bits per second, can be supplied in two different versions—as a single printed circuit card for OEM applications or as a full-duplex stand-alone modem in a compact desktop cabinet. The unit can be used on either the DDD network or on private leased lines.
Dual preamplifier needs but one supply

General Electric Co., Integrated Circuits Project, Northern Concourse Office Building, North Syracuse, N.Y. P&A: $3.42; 30 days.

Designed for amplifying low-level signals in low-noise applications, the PA239 dual preamplifier operates with only a single power supply and as few as two external components. It consists of two identically matched 68-dB-gain amplifiers fed from an internal power supply filter. Power supply voltages can go to 16 V.

CIRCLE NO. 267

10-bit current source is for d/a and a/d use

Precision Monolithics, Inc., 1500 Space Park Dr., Santa Clara, Calif.

The monoDAI-01B is a monolithic 10-bit precision current source for current-summing d/a converters that can also be used as a feedback element in successive-approximation a/d converters. The unit has a settling time of 150 ns and can operate from ±6 to ±15 V. Its absolute error is 0.2% of full scale, and output current is 2020 to 2080 µA. Operating temperature is -25 to +85°C.

CIRCLE NO. 268

UJT's for only 53¢ come in TO-18 cans

Unitrode Corp., 580 Pleasant St., Watertown, Mass. Phone: (617) 926-0404. P&A: 53¢; 2 to 3 wks.

Costing only 53¢ each in quantities of 100, a planar family of programmable unijunction transistors is now available in a hermetically sealed TO-18 package. Series U13T1 units are functionally equivalent to standard unijunction devices but have the added flexibility of programmable parameters. Primary applications are pulse, timing, and SCR trigger circuits.

CIRCLE NO. 269

TTL shift registers accept 32-MHz clock

Texas Instruments Inc., Components Group, P.O. Box 5012, Dallas, Tex. Phone: (214) 238-2011. P&A: $7.28; stock.

Two new eight-bit TTL MSI shift registers are the SN74198, a parallel-access left-shift/right-shift register, and the SN74199 a parallel-access type. Both circuits have 87 equivalent gates and a maximum input clock frequency of 32 MHz. Average power dissipation is only 47 mW per bit. Their operating temperature is 0 to 70°C.

CIRCLE NO. 270

low cost systems

*Prices shown are 1000-lot.

ELFIN Neon Display!

Latest 7-segment Elfin neon display and matching hi-volt BCD to 7 segment decoder-driver.

Combination Price

CIRCLE NO. 131 MG-17

MSDD-721

Plug-in Display & Matrix

Segmented display operates on 5VDC and plugs into matrix module with decimal input, easy mounting.

Package Price

CIRCLE NO. 132

MS-4000B

CIRCLE NO. 133

DDM-702

Plug-in Display w/BCD Input

Similar to above, except module has BCD input, decoder-driver. Simply gang for multiple use.

Package Price

CIRCLE NO. 133

MTX-4000

ELFIN with Memory or Counter

Popular single plane neon display and BCD decoder-driver with memory or decade counter. Your choice.

Combination Price

CIRCLE NO. 134 MG-17

MSDD-722

MSDD-723

Miniature Display!

Small incandescent single plane display operates from 5V source. Decimal input. Compact size: 1.5" x 1".

Combination Price

CIRCLE NO. 135

MS-250A

MTX-250

Display Has Wire Leads

Bright image, single plane display with 10" leads and BCD input decoder-driver.

Combination Price

CIRCLE NO. 136

MSDD-702

Immediate Deliveries on Above Items
If speed drives you wild, we’ve got the control.

Our precision Adjustable-Speed Drives will give you precise control over the speed of your application with constant torque regardless of load change. They’re infinitely adjustable from 24 to 3600 rpm (150:1 speed range) with load regulation of better than 1/3 of 1% of rated speed. The Remote Control Head provides precise speed adjustment and continuous monitoring. Built for long service life, the modular plug-in design requires only a screwdriver for servicing. Over 250 models from 1/4 to 2 hp, with or without gear reduction or braking and reversing.

SERVO-TEK PRODUCTS COMPANY
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Write for our 500/600 Series catalog and get back in control.

ICs & SEMICONDUCTORS

DIP opto-isolator can handle 1.5 kV

Monsanto Electronic Special Products, 10131 Bubb Rd., Cupertino, Calif. Phone: (408) 257-2140. P&A: $5.85; stock.

Supplied in a six-lead plastic dual-in-line package, a new opto-isolator provides a voltage isolation that exceeds 1500 V and an isolation resistance that is typically 100 GΩ. The MCT2 photo-transistor coupled pair also has a current transfer ratio of 35% and rise and fall times of 2 µs. Its base-emitter resistance can be varied externally.

CIRCLE NO. 271

Quad diode chips isolate to 1000 V

Dionics Inc., 65 Rushmore St., Westbury, N.Y. Phone: (516) 997-7474.

A new line of multi-diode chips for use in hybrid circuits contain four non-gold-doped 1N914 diodes, dielectrically isolated from each other and from the bottom of the chip, with more than 1000 V of isolation between individual diodes. Types 914-1QM, -2QM, -3QM have a 1-mV forward matched characteristic; types 914-1Q, -2Q, and -3Q have a characteristic of 30 mV.

CIRCLE NO. 272

Transistors in TO cans sell for 75¢ to 82¢

Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. Phone: (414) 962-3563. P&A: 75¢ to 82¢; stock.

Metal-can equivalents of four popular plastic-packaged transistors, types 2N3903 through 2N3906, are now available for 75¢ to 82¢ in quantities of 1 to 99. Models FT3903 and FT3904 are npn general-purpose amplifiers and switches, while models FT9305 and FT9306 are their respective pnp complements. They come in TO-18 packages.

CIRCLE NO. 273

Stable 250-mW diodes sense —50 to +125°C


Ideal for temperature monitoring and sensing applications, a new line of temperature-sensing diodes feature a power dissipation of 250 mW and an operating temperature range of —50 to +125°C. The devices have a stable forward characteristic that assures a stable temperature coefficient, which is linear with temperature. They are packaged in a single-ended metal case.

CIRCLE NO. 274

Hermetic SCRs cost under $1

Transitron Electronic Corp., 168 Albion St., Wakefield Mass. Phone: (617) 245-4500. P&A: 32¢ to 75¢; stock to 4 wks.

Aimed at the computer market, a new line of hermetically sealed TO-18 SCRs are now available for 32¢ to 75¢ in quantities of 1000. Series RTC02 units offer voltage ratings up to 200 V, a gate sensitivity of less than 1 mA, and a holding current of under 10 mA. They will handle 0.4 A rms at 80°C and have a maximum operating temperature of 125°C.

CIRCLE NO. 281
**INSTRUMENTATION**

**Pulse generator separates outputs**


With its two independent channels that can be combined in common output, the model 8010A pulse generator can also perform as a complex waveform generator. Individual control of rise and fall transition times makes it possible to generate ramps, trapezoids, triangles, and rectangular waveforms. Also independently controlled are amplitude, offset, and delay.

CIRCLE NO. 276

**Low-cost IC generator pulses out to 50 MHz**

Data Dynamics Div., 240 Humphrey St., Englewood, N.J. Phone: (201) 567-5300. P&A: $475; stock.

Pulsing out to 50 MHz is the model 5102 pulse generator for TTL, RTL or DTL ICs. Single, gated and manually-generated pulses and square waves are available. The output level is adjustable from 0 to 6 V and the base-line offset is adjustable from 0 to 2 V. The output level and base-line offset voltages can be remotely programmed.

CIRCLE NO. 277

**MICROWAVES & LASERS**

**AM video detector takes 1-GHz carriers**

Avantek, Inc., 2981 Copper Rd., Santa Clara, Calif. Phone: (408) 739-6170. P&A: $90; stock.

The UD-901 video detector provides AM detection and amplification of 1 kHz to 50 MHz modulation components on any carrier in the 100 to 1000 MHz passband. Tangential sensitivity is —50 dB when the unit is used by itself and can be improved with preamplification. Video gain is equivalent to 23 dB to provide up to 7 V of peak detected output voltage.

CIRCLE NO. 278

**Uhf transistors give up to 2 W**

Kertron Inc., 7516 Central Industrial Dr., Riviera Beach, Fla. Phone: (305) 848-9606. P&A: $9 to $10.50; 2 to 3 wks.

Operating at 12.5 V, the model 3TX620 uhf transistor is designed to deliver 1 W at 470 MHz with a minimum of 7-dB gain. The model 3TX621 uhf transistor puts out 2 W at 470 MHz and has a 6-dB minimum gain. Both devices are available in either a molded or ceramic package (models 3TX820 and 3TX821).

CIRCLE NO. 279

**Binary varactor has two states**

Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. Phone: (408) 246-8000. P&A: $5.50; stock.

Designed for rf and microwave switching and tuning applications, the BV140 binary varactor is a variable-capacitance diode with two distinct capacitance states in the reverse direction. These two states are separated by a transition phase in which the capacitance is a rapid inverse function of the reverse bias voltage. Typically, the total voltage required to swing the device between 8.5 and 1.4 pF is only 7 V.

CIRCLE NO. 280

**THE HI-RELIABLE!**

No fragile nail heads. Silicon junction aligned between two, parallel, offset tantalum heat sinks ... great lead tension strength. All welded and brazed assembly. High pressure molded package. Gold plated nickel-clad copper leads. Write or phone for Form 68-4 for complete rating data and other tolerance prices.

Semiconductor Division

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INFORMATION RETRIEVAL NUMBER 67
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*when protector is properly selected and connected

When you can't afford a failure . . .

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Evaluation Samples

Dry transfer patterns

JotDraft patterns are tough plastic dry transfer patterns for PC, drafting methods. They are printed on see-through polyethylene strips so they can be precisely positioned before transferring. Once in position, a pattern is transferred with a ballpoint pen or burnisher in 3 to 5 seconds. Included are 1x, 2x, and 4x PC pad clusters, TO and DO case, and resistor outlines. Samples are available. Datak Corp.

PC-board interconnect

The Modu-Con terminal, a printed circuit board-to-board interconnect, is now available as a free evaluation sample. It is designed to press-fit into 0.049 to 0.052-in.-dia holes on printed circuit daughter boards, leaving an extended tapered male blade for insertion into corresponding-diameter holes on the mother board. This provides a wide variety of modular approaches in printed circuit packaging. The terminal adapts to modules with center-to-center spacings of 0.1 in., and to boards that are 1/32 to 3/32-in. thick. Malco Manufacturing Co. Inc.

Washers and spacers

About two dozen washers and spacers are included in a free evaluation sample kit. The assortment shows typical sizes and materials, both metallic and nonmetallic, for this universal type of hardware. Also available is a 48-page list of stock dies. Boker's, Inc.
Design Aids

Thermocouple tables

Recently published thermocouple temperature millivolt tables are available to aid users of temperature instrumentation and thermocouples. Fahrenheit and Celsius charts conveniently cover the temperature ranges from -300 to +3270°F and -200 to +1800°C, with their respective reference junctions at 75°F and 25°C. Eight thermocouple calibrations, J, Y, K, T, E, S, R and B, based on Instrument Society of America and National Bureau of Standards tables, are provided. Thermo Electric.

CIRCLE NO. 285

Relay chart

Several types of relays are conveniently listed with their characteristic features in a handy relay locator chart. These include subminiature, microminiature, blue-ribbon, latching and terminal-junction types. Listed are their operating characteristics, series designations, electrical and mechanical specifications and corresponding military part numbers. Units covered include 2pdt, 4pdt and 6pdt models. Deutsch Relay Div.

CIRCLE NO. 286

Audio recording guide

A handy reference guide to commonly used track configurations for audio recording is available in two formats: an 8-1/2-by-11-in. notebook-size chart or a 22-by-34-in. wall chart. The guide shows all configurations and dimensions generally used for the popular 1/4-in. tapes and 0.15-in. cassette tapes as well as 1/2, 1 and 2-in. studio tapes. Also provided in the guide are model number designations for recording heads that are applicable to each configuration. Nortronics Co., Inc.

CIRCLE NO. 287
At last. A DC to 250 MHz Reed Switching Matrix. With 60 dB min. isolation. Available from Integral Data Devices.

Model SMR-55HA is a computer compatible 5 x 5 building block device. Permits hot switching to 3W and 100% random access. Hermetically sealed reeds are used in a broadband stripline matching structure. The unit maintains effectiveness at lower frequencies, too. For instance, isolation is 80dB at 60 MHz.

OTHER FEATURES • Insertion loss: 0.5dB max. • VSWR: 1.5 max. • Operation time: 2 msec max. • Primary power: 5V, 40 ma per crosspoint • Operation life: to 100 million operations per crosspoint • Size: 3¾" x 3¾" x 3½".

Electronic or magnetic latching is optional. With magnetic latching, configuration is maintained under high power transient conditions or power failure.

APPLICATIONS • Antenna switching • Receiver Channel Selector • Broadband Data Switching • Communications Systems Multiplexing • IC Logic Circuit Tester • CATV Switching.

Call or write for details on both reed and solid state matrices and complete switching systems operating to 12 GHz.

Integral Data Devices Inc.
35 Orville Drive, Bohemia, New York 11716
(516) 567-3400

INFORMATION RETRIEVAL NUMBER 71

Data transmission

Wide-band vs narrow-band data transmission and how it affects supervisory control systems is discussed in a two-page application bulletin. It compares wide-band and multiple-channel narrow-band data transmission systems in terms of the need and time required for polling. It also discusses the interruption encountered when transmitting a station command, the adverse effect of differential delay distortion, and the consequence to system integrity with the loss of a channel. Quindar Electronics, Inc.

CIRCLE NO. 291

Thyristor rectifiers

The advantages, disadvantages and differences in performance of two basic thyristor circuits for three-phase controlled-rectification applications are listed and illustrated in a new brochure. The 12-page brochure compares the three-phase full-wave full-converter with the three-phase full-wave semi-converter circuit. Topics include rectification characteristics, delay angles vs system response, gate firing, double pulsing and inductive loads. Illustrations include circuit diagrams and curve traces of circuit responses. Westinghouse Electric Corp.

CIRCLE NO. 292

Chip capacitor book

The Ceramic Chip Capacitor Handbook is a handy 69-page handbook written to assist users of ceramic chip capacitors in their proper selection and application. Discussions include an introduction to chip capacitors, their design and manufacture, electrical properties, environmental characteristics and attachment and bonding techniques. An appendix follows with explanations of the piezoelectric effect, ion migration, and bonding effects. A glossary of capacitor terms is also included. San Fernando Electric Manufacturing Co., West-Cap Div.

CIRCLE NO. 293
New Literature

Scientific instruments
The latest edition of the 68-page Heath Scientific Instrumentation catalog is available. It is packed with instruments for industrial and academic laboratories such as the popular Malmstadt-Enke line, modular digital and spectroscopy systems, and chemical, biological and physical equipment. It also includes the regular Heath-kit line of instruments such as oscilloscopes, voltmeters, power supplies, generators, decades, transistor testers, impedance bridges and accessories.

Heath Co.

CIRCLE NO. 294

Power supplies
A complete line of stock-delivery dc power supply modules including the latest miniaturized power supplies and rack assemblies is shown in a new six-page short-form catalog. The catalog is arranged to provide designers with the necessary specifications and prices for easy and proper power supply selection.

ACDC Electronics Inc.

CIRCLE NO. 295

Connection systems
Completely revised and expanded to 16 pages, a guide describes how new contacts, staked and dip-soldered to perpendicular, parallel, or tandem PC boards, constitute a high-reliability low-cost connection system. The contacts are supplied with proper spacing for insertion in PC boards and are imbedded in disposable strips that facilitate installation.

Elco Corp.

CIRCLE NO. 296

Instrumentation
Optical test instruments and data systems are outlined in a new series of data sheets. The equipment can make digital measurements of radiation and differential temperature from the far-infrared region to the ultraviolet. These systems can operate with or without an automatic on-line data processing calculator.

Cintra Inc.

CIRCLE NO. 297

Data processing
"Stepping up Performance" is a 20-page catalog that describes 15 public electronic data processing training courses, and gives presentation schedules for major U.S. cities. Seminars and workshops described are presented at three levels: overviews of data processing for non-technical corporate executives, training in managerial and control techniques for data processing directors, and training in systems analysis and programming for technical personnel.

Brandon Systems Institute.

CIRCLE NO. 298

Power supply kits
A new building-block concept in power supply design called "Power Kits" is described in a 12-page booklet. The concept involves putting together a series of major components and complete circuit specifications, which are designed to specific performance standards, for building power supply kits.

Lambda Electronics Corp.

CIRCLE NO. 299

IC op amp applications
Two new application reports discuss the use of the SN72709 operational amplifier integrated circuit. Application report CA-149 describes in eight pages, two circuits which have logarithmic or exponential characteristics. Application report CA-151 covers in eight pages three methods of compensating amplifier frequency.

Texas Instruments, Inc.

CIRCLE NO. 340

Metal film resistors
A 16-page designer's guide shows design engineers how to get the maximum benefit out of a line of ultra-precision high-stability metal-film resistors. The guide contains a chart showing the performance of typical metal-film resistors within the limits specified by MIL-R-55182C and MIL-R-93.

Airco Speer Electronic Components.

CIRCLE NO. 341

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- NEW MODEL C-6
- More Force - @ .100" stroke force is:
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Deltrol Controls

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Phone (414) 671-6800 Telex 2-8871

INFORMATION RETRIEVAL NUMBER 72

Electronic Design 14, July 5, 1970
In 1966, the Chicago Post Office ground to a halt. For three weeks, the mail was almost at a standstill.

If you want that to happen in your town, just wait.

Today's U.S. Post Office is probably the most inefficient, most antiquated business in the United States. Unless something is done right now—by people like you—the situation is going to get worse.

Are you interested in straightening out the mess?

Right now, there's a bill before a committee of Congress called HR 11750. HR 11750 is, in brief, the recommendations of a bipartisan committee for the reorganization of the U.S. Post Office on a business-like basis (along the lines of TVA). HR 11750 is designed to take the Post Office out of politics, to apply modern business methods to its operation and, in the process, to save taxpayers the $1,200,000,000 annual deficit that today's horse-and-buggy Post Office incurs.

You can help get HR 11750 out of committee and enacted into law by letting your congressman know how you feel. Tear out this column, pin it to your letterhead and mail it to your congressman today. Let your voice be heard.

If the Post Office in your city breaks down next, you can't say you haven't been warned.

NEW LITERATURE

Semiconductors

A comprehensive 32-page guide to a line of semiconductors is available. It contains charts, diagrams and complete specifications for both standard and industrial semiconductors. Among the standard types included are germanium and silicon diodes and transistors and NTC resistors. The industrial types covered include silicon charge-storage varactors, magneto resistors, and Hall-effect devices. Siemens Corp.

CIRCLE NO. 342

Modular enclosures

A complete line of modular enclosures for electronic instrument systems is available in a 28-page catalog. Four different frame configurations are featured. These are straight-front, slope-front, wedge-front and slope-front-wedge styles. Also featured are a wide range of accessories such as doors, panels, bases and casters. Complete outline dimensions are given. Honeywell Inc.

CIRCLE NO. 343

Photo-sensitive cells

A complete listing of light-sensitive devices with typical characteristic curves is included in an illustrated catalog. The listing includes silicon cells, solar power modules, readout arrays, cell standards and selenium cells. Technical discussions cover the theories of operation, response characteristics and circuit applications. A multitude of curves and circuits is included. International Rectifier.

CIRCLE NO. 344

Product checklist

A highly simplified checklist that highlights essential information about resistors, capacitors, microcircuits and edge connectors is available. It is organized to give engineers and procurement officers instant access to basic data covering each component. Mepco, Inc.

CIRCLE NO. 345

Computer manual

A 660-page systems manual for the Raytheon 706 computer is available. It provides the basic information required for programming and using the 706 computer and features detailed information on the computer's organization, addressing, instruction repertoire and classes, software, and detailed specifications. Raytheon Computer.

CIRCLE NO. 346

Graphic art supplies

A complete catalog of graphic art supplies for the draftsman, engineer, artist, architect, student and designer is available. It contains such items as drawing instruments, triangles, drafting machines, scales, templates, and many others that are fully illustrated with descriptive literature. Plasticoid Products Inc.

CIRCLE NO. 347

Delay lines

A four-page brochure containing a series of lumped-constant delay lines is available. It includes general descriptions, applications, mechanical details, electrical specifications and outline drawings. Engineered Components Co.

CIRCLE NO. 348

Ceramic capacitors

The complete line of Mucon subminiature ceramic capacitors are described in a 12-page catalog. These units cover a full range of capacitance values as low as 0.5 pF. Republic Electronics Corp.

CIRCLE NO. 349

Television equipment

A new folder about a 1970-1971 line of closed-circuit television equipment and video tape recording equipment is now available. Panasonic VTR/CCTC.

CIRCLE NO. 350
Bulletin board

Bulletin board of product news and developments

DUAL (Dynamic Universal Assembly Language), a practical software program, is a new machine independent processor for creating user languages. Able to define languages for specific or general applications, DUAL makes it possible to communicate with a computer in the user's jargon, or in terms which are intended for a particular application. It is immediately operational on most major computers and can be adapted to run on any new computer in only one or two months. Dual was developed by Proprietary Software Systems, Inc., Los Angeles, Calif. a sub. of Image Enterprises Inc.

CIRCLE NO. 351

BASIC computer language is now available for use with Digital Equipment Corp.'s recently introduced PDP-11 small computer. The new package requires only 4096 words of core memory.

CIRCLE NO. 352

Plated-wire memory elements are now available from Nemonic Data Systems, Inc., Denver Colo. This NW-100 plated wire is expected to find application in high-speed, non-destructive readout, random-access and read/write memories. For 15-in. lengths, the cost will be 10¢ per inch for 100,000 wires.

CIRCLE NO. 353

At the flick of a switch, a new microphone from Ingenuics, Inc., Gaithersburg, Md., can either accept or reject environmental sounds. Through its switchable distance-discriminating network, the microphone can uniformly pick up all sounds, both near and far — or it can respond primarily to near sounds while greatly suppressing those that are distant. The unit, which has a “T” shape, contains two cartridges whose outputs either add or subtract, depending on the operation mode.

CIRCLE NO. 354

How small are your EMI problems?

An EMI/RFI problem used to be one of the least appealing facts of circuit life. Add the requirements for a small unit with high attenuation characteristics and you were in trouble. Not anymore. Today, you'll find lasting happiness with two proven USCC series of miniature filters. Both provide up to 70 dB of attenuation.

Series 2000 suppresses conducted noise from SCR's, switches, relays, motor commutators, etc., in low voltage dc lines from 10 kHz to 10 GHz. Available in Pi, L or T section units for 50/100/200/300 WVdc and 115/230 Vac in 10 current ratings and 2 thread lengths.

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Other reliable USCC EMI/RFI products: general purpose filters, signal line/communications filters, power line filters and cabinet assemblies, data processing filters, and special/custom filters.
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Want to contact us? If you have any comments or wish to submit a manuscript or article outline, address your correspondence to:

Editor
ELECTRONIC DESIGN,
850 Third Avenue,
New York, N.Y. 10022.

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Terminal Block Selector

A new 24-page, completely illustrated catalog contains photos, descriptions, ratings, engineering drawings, and prices of the complete line of Curtis terminal blocks. Included are printed circuit, insulated feed-thru, quick disconnect, track type, and high current terminal blocks. Handy selection chart quickly locates the perfect block for your particular requirements. Send today for your free copy.

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FUNDAMENTALS OF INTEGRATED CIRCUITS

A practical guide to integrated circuits, their theory, manufacture, and applications. This new guide by Lothar Stern offers complete, 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. 196 pages, 7 x 10, illustrated. $8.95, clothbound. Circle the reader-service number below for 15-day examination copies.

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Soshin's One Finger Speciality Mica Capacitors

The only mica capacitors to pass evaluation testing by Japanese Government equivalent to MIL-C-5D

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Teles: 246-6377

INFORMATION RETRIEVAL NUMBER 76
Electronic Design 14, July 5, 1970
OUR ANGLE: four frequency phase voltmeters

North Atlantic's 214 FOUR-FREQUENCY PHASE ANGLE VOLTMETER introduces a new flexibility in AC voltage measurements. It enables direct reading of null balance, total voltage, fundamental voltage, in-phase voltage, quadrature voltage, and phase angle.

It's also pre-wired to handle four operating frequencies from 30Hz to 20kHz, which means extended longevity and broader application. Even if you only need one frequency, there are three extra spots to add other frequencies later. Frequency changes can be made rapidly and conveniently in the field with plug-in modules. The 214 can be completely recalibrated at the installation site by a single rear-panel adjustment.

Harmonic rejection and high signal overload design of the unit screens out conventional distortion and errors in measurement and calibration. The all solid-state Model 214 offers full accuracy over ±5% bandwidth, 1° phase measurement, adjustable meter scaling for go/no-go testing, and 300 µV full-scale sensitivity. Priced from $1215.00.

Options? Other models offer 0.25° phase accuracy, lower-cost single frequency operation, broadband phase-sensitive performance from 10Hz to 100kHz.

Whether your AC measurements are large or small, contact your North Atlantic sales engineering representative today. He'll show you a new angle to your AC voltage measurements.

NORTH ATLANTIC industries, inc.

200 TERMINAL DRIVE, PLAINVIEW, NEW YORK 11803
cable: noatlantic / twx: 510-221-1879 / phone: (516) 681-8600

INFORMATION RETRIEVAL NUMBER 77
It used to be that double-balanced mixers only came in large packages. But then, it used to be you couldn’t get outstanding performance any other way.

Now, RELCOM designers have changed all that! RELCOM’s new TO-5 packaged M6S and M6T Double-Balanced Mixers will give you the same modulation, attenuation, switching, phase detection and mixing capabilities you’ve depended on in larger units. They’re small (less than 1/32 cu. in.); lightweight (1.4 gms.); and, only 0.4 in. high. What’s more, we guarantee all specifications—and that includes noise figure—over the −54°C to +100°C temperature range. We even guarantee all specifications after exposure to the shock and vibration stresses of MIL-STD-202D!

Need more information? Check the isolation and noise figure curves. Better yet, circle our number on the Reader Inquiry Card and we’ll send you additional M6S and M6T data, plus a catalog of other RELCOM products. Or, call us collect. Ask a RELCOM sales engineer for your own evaluation unit. Delivery from stock.

**Price:**
- M6S $52.00 ea. 1-4 units
- M6T $55.00 ea. 1-4 units

**LOOK AT THE MIXERS WE MADE...**

**...SMALLER!**

RELCOM
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Telephone (415) 961-6265 • TWX (910) 379-6979

INFORMATION RETRIEVAL NUMBER 78

Electronic Design 14, July 5, 1970
New High Q Toroids

Now PC-mount toroids designed to meet MIL-T-27C are part of Dale's growing standard inductor line. Two epoxy encapsulated styles: TE-2 (.437d x .270h) and TE-3 (.685d x .385h) conform to Type TF55X20ZZ. Inductance range: .05 mh to 400 mh; Frequency: Audio to 5 mHz. And there are more styles coming to meet your applications for wave filters, frequency discriminators, DC power supplies and loading coils. Give Dale a shot at your next toroid requirement. Standard or special, you'll find there's plenty of time and money to be saved in Coil Country.

CALL TODAY
605—665-9301

DALE ELECTRONICS, INC.
Box 180, Yankton, South Dakota 57078
In Canada: Dale Electronics Canada, Ltd.
A subsidiary of The Lionel Corporation
INFORMATION RETRIEVAL NUMBER 113
RCA Linear IC Arrays: performance, dependability, and versatility in application.

Here are ten important answers to some of your most pressing circuit design problems. These monolithic, active-device arrays combine the attributes of integrated circuits with the design flexibility and accessibility of discrete devices.

In this series of transistor and diode arrays, you get the economy and availability of mature devices. But you are in no way locked into a circuit configuration which may not meet the requirements of your application.

RCA IC Arrays offer four, five or six transistors in three package styles; six diodes in bridge configuration or as an array of independent diodes.

For new design freedom, for excellent device matching and temperature tracking, for significant savings—look into these RCA IC Arrays.

For further information, see your local RCA Representative or your RCA Distributor. For a copy of RCA's Integrated Circuit Product Guide (or a specific technical bulletin by File No.) write RCA, Commercial Engineering, Section 57G-1/CA37, Harrison, New Jersey 07029. International: RCA, 2-4 rue du Lièvre, 1227 Geneva, Switzerland, or P.O. Box 112, Hong Kong.

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### RCA AC Arrays

#### Device Type

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<th>Package</th>
<th>Description</th>
<th>Technical Bulletin File No.</th>
<th>Price [1000-unit level]</th>
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<td>CA3018</td>
<td>12-lead</td>
<td>Two isolated transistors and Darlington-connected transistor pair</td>
<td>338</td>
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<td>CA3018A</td>
<td>12-lead</td>
<td>Premium version of CA3018 (performance controlled)</td>
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<td>CA3019</td>
<td>10-lead</td>
<td>One diode-quad, two isolated diodes</td>
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<td>CA3026</td>
<td>12-lead</td>
<td>Dual differential amplifier</td>
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<td>Dual Darlington array</td>
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