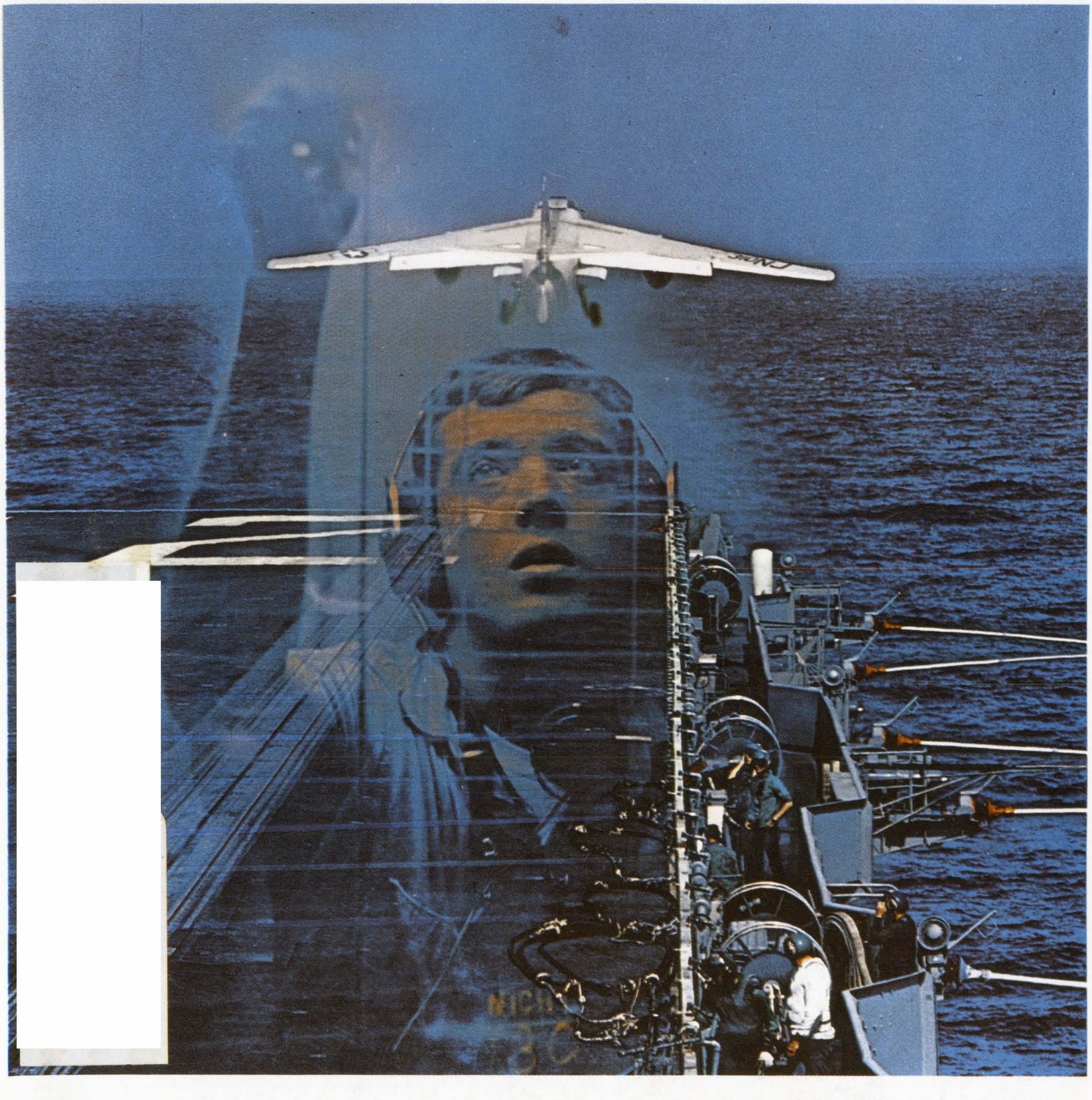
VOL. 18 NO. 2

Electronic Design

FOR ENGINEERS AND ENGINEERING MANAGERS

JAN. 18, 1970

Come aboard the USS Roosevelt —a floating airfield, fortress, city of 4500 men, and a complex of electronic systems. Most of the equipment works fine, but it's being updated to meet the needs of the high-performance nuclear-powered Nimitz carrier. There'll be more radar, data-processing, and automation. See page 58.



If price and performance are important — here's a 7 MHz value

This is a lab-quality, all-solid-state scope—at a price you'd ordinarily expect to pay for older vacuum-tube models.

Value — DC to 7 MHz bandwidth. This frequency range covers audio, video and most control circuit applications.

Value—5 mV to 20 V per division deflection factor. Here is sufficient capability to pick up most electronic or electro-mechanical system outputs without distortion or need for additional amplifiers.

Value—Rock solid triggering with capabilities ordinarily found only in more expensive lab type oscilloscopes . . . triggered or recurrent sweep, single-sweep, and automatic triggering.

Value — Low drift, long-term stability. Field effect transistors virtually eliminate drift from temperature changes, shock or vibration. Long-term stability means less frequent calibration.

Value—Easy to use. Logical arrangements of controls, beam finder, auto-triggering make operation easy. Interlocking controls on sweep time and magnifier prevent readout errors.

Value—Easy-to-see display. Internal graticule, 8 x 10 cm CRT for measurement accuracy. Bright, small spot-size trace increases visibility and resolution.

Value—Available in single channel cabinet or rack versions (1215A or 1215B), or in dual-channel cabinet or rack versions (1217A or 1217B). Electrical characteristics are identical. Rack version is only 5¼" high. Panel on the cabinet version is about the size of this page.

Value — Price, 1215A/B, $950; 1217A/B, $1175. Add up the features, then divide by price and you'll find this is the greatest performance/dollar value ever offered. 080/8

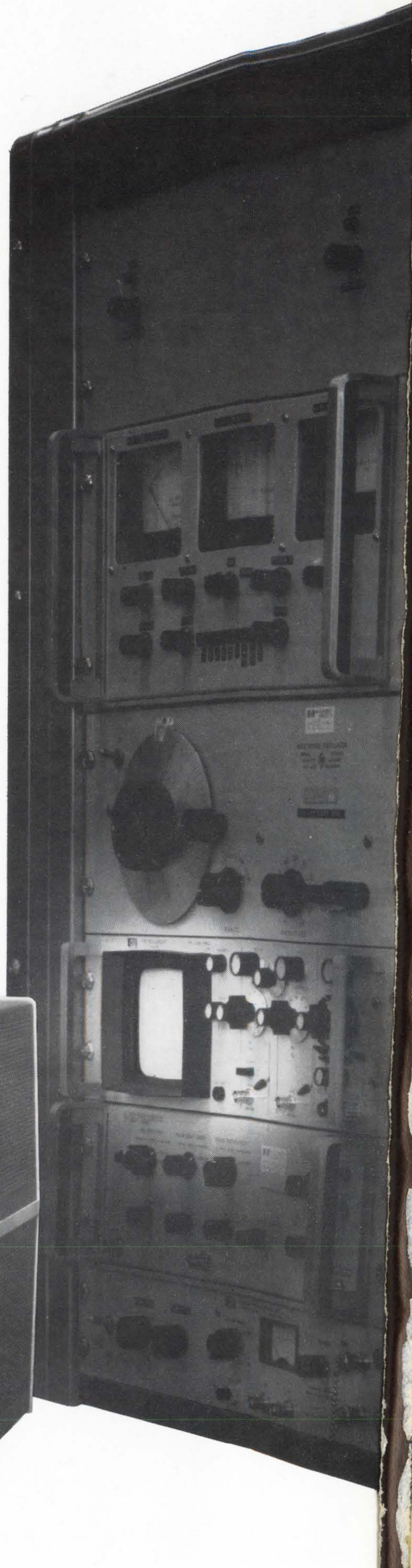
These 7 MHz oscilloscopes are new members of HP's growing family of low- and mid-frequency oscilloscopes. In addition to these new mid-range scopes you have 500 kHz scopes in 14 models with your choice of: Single or dual trace, 100 μV/cm or 5 mV/cm deflection factors, conventional display or variable persistence and storage, all in cabinet or rack versions.

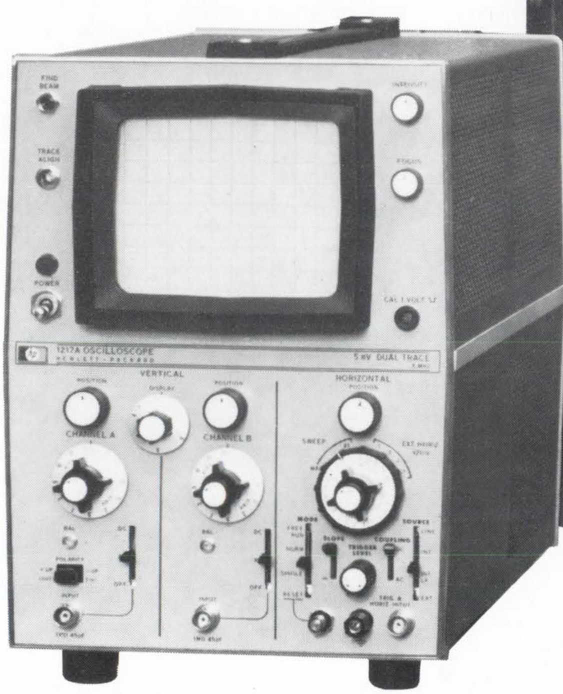
If you're looking for accurate mid-frequency measurements, ease of use, reliability—all at a low cost—here's a real 7 MHz value!

Call your local HP field engineer. Or, write to Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

OSCILLOSCOPE SYSTEMS





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

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

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

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

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

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

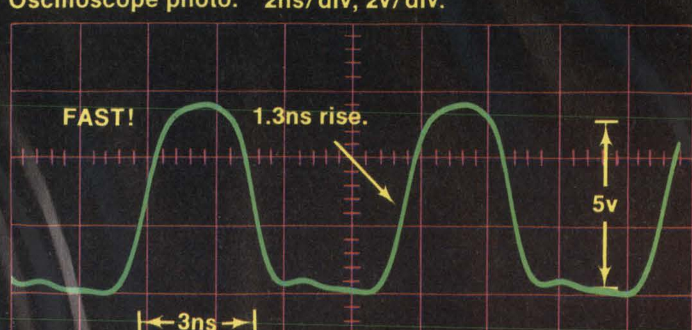
Oh, yes. Even at $1200, the 1662 Resistance Limit Bridge is available with a quantity discount for two or more. For more information, write General Radio Company, West Concord, Massachusetts 01781 or telephone (617) 369-4400. In Europe write Postfach 124, CH 8034 Zurich, Switzerland.

Prices apply in U.S.A.

GENERAL RADIO

INFORMATION RETRIEVAL NUMBER 2

Oscilloscope photo. 2ns/div, 2v/div.



Electronic Design

FOR ENGINEERS AND ENGINEERING MANAGERS

VOL. 18 NO. 2

JAN. 18, 1970

NEWS

TECHNOLOGY

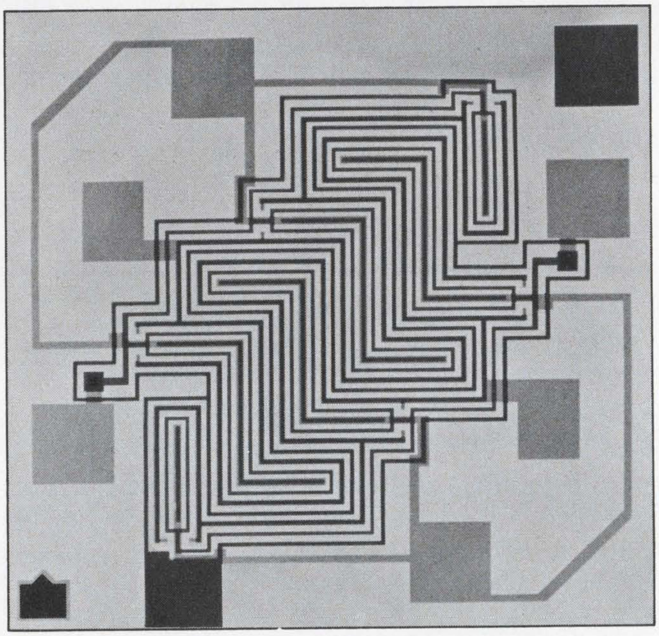
PRODUCTS

Departments

Cover: Photographic montage taken on the aircraft carrier Roosevelt by John F. Mason, Military-Aerospace Editor.

ELECTRONIC DESIGN is published biweekly by Hayden Publishing Company, Inc., 850 Third Avenue, New York, N.Y. 10022. James S. Mulholland, Jr., President. Printed at Brown Printing Co., Inc., Waseca, Minn. Controlled circulation postage paid at Waseca, Minn., and New York, N.Y. 81,402 copies this issue.

How to get the world's first monolithic dual FET.



By design.

By tomorrow.

There's never been an N-channel dual FET remotely like it. We should know. With FETs by the millions under our belts, this little 2-in-1 device is something else again.

It's monolithic. It's matchless. It's National's FM3954. Wipes out the sticky problem of matching two separate FETs for identical specs. This revolutionary new dual eliminates the entire costly, time-consuming process. By designing both FETs on a single chip, the match is built in to stay.

Our monolithic marvel's a unique performer too. Even the best discrete matched duals can't touch its track record; offset voltage (5mV max.), temperature drift (5μV/°C max.), from 50μA to 500μA.

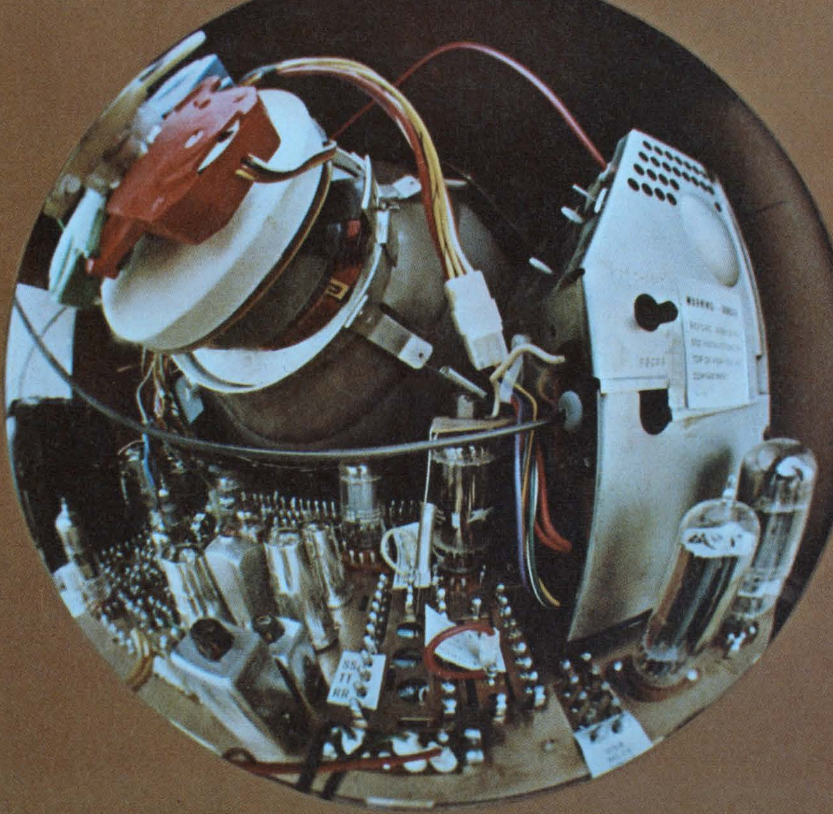
Not to mention its flexibility of use or the reliability advantage because it's monolithic. And because it's National.

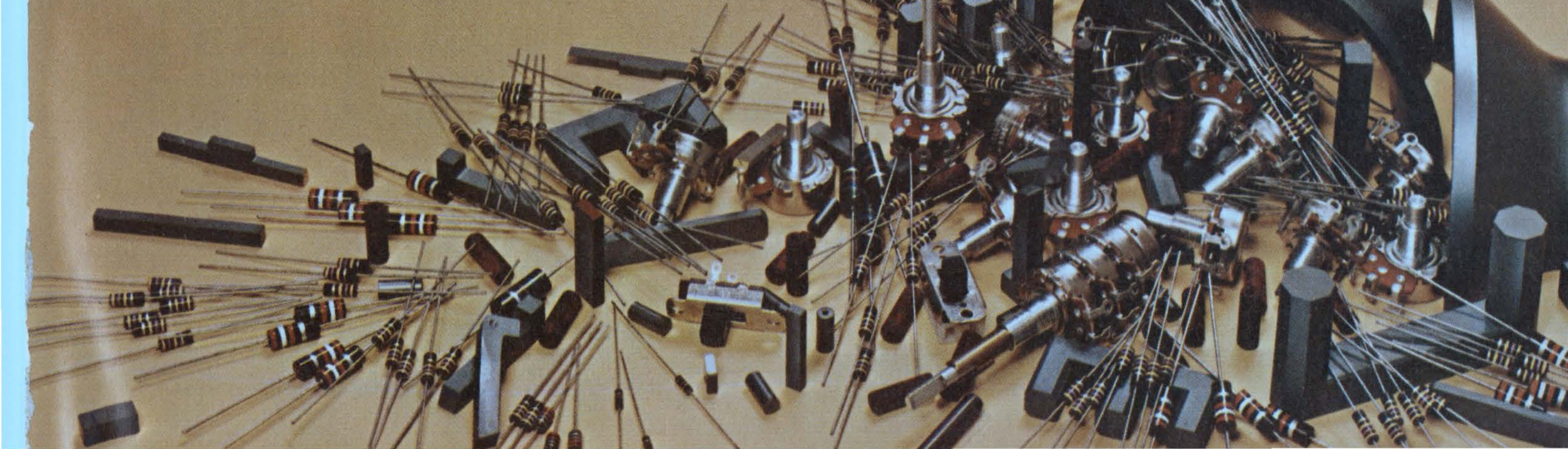
Available now. No maybe's about it. We've got monolithic dual FETs packed on the shelves, ready to ship without delay. Priced from $2.40 to $15.00 in hundred lots.

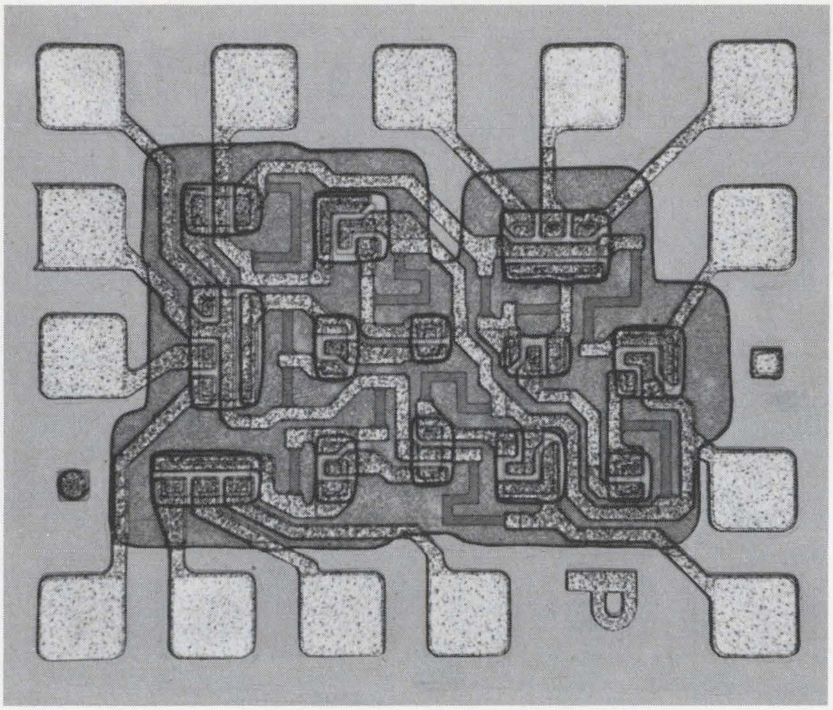
Write or call for complete spec data. We'll throw in a brief listing of our hundred or so other discrete FETs. National Semiconductor, 2900 Semiconductor Drive, Santa Clara, California 95051 (408) 732-5000 TWX: 910-339-9240
Cable: NATSEMICON

National/FET

INFORMATION RETRIEVAL NUMBER 4







Next generation radiation-hardened IC's are here today.

Here's a better idea from Philco-Ford in radiation-hardened integrated circuits. It's a proven technique for mass production manufacturing which eliminates precision lapping and etching steps.

The payoff in performance: just by changing from conventional circuits to their Philco-Ford dielectrically isolated equivalents, you can get an order of magnitude increase in radiation tolerance; the circuit performance will no longer limit the overall system capability when exposed to a weapons environment.

The payoff in price: we expect that these circuits will turn out to be your most economical solution to radiation hardening.

The following circuits are immediately available in quantities for your evaluation:

Part No.	Description	Price: 100-499
PLR93051	DTL dual 4-input gate with expander	$25.00
PLR93251	DTL dual 4-input buffer with expander	$27.50
PLR94451	DTL dual 4-input power gate with expander	$27.50
PLR94551	DTL RS/JK master-slave clocked flip-flop	$37.50
PLR96251	DTL triple 3-input gate	$25.00
PLR98051	dual level shifter	$37.50
PLR90951	709-type operational amplifier	$45.00

For a copy of recent technical literature, write Bipolar Products Marketing, **Philco-Ford Corporation, Microelectronics Division,** Blue Bell, Pa. 19422.

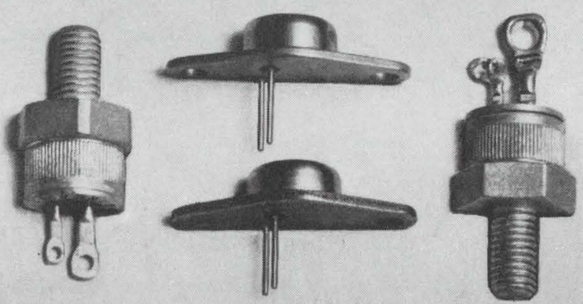
The better idea people in bipolar IC's. **PHILCO** Ford

INFORMATION RETRIEVAL NUMBER 7

Breach the current barrier

Fast-switching RCA SCR's have high di/dt capability

SCR families	Volts	Current (rms)	Typical Applications
TA7395	600 400 200	40A	modulators/inverters, small radars, sonars, high frequency inverters, pulse modulators
40555	600 400 200	5A	
40216	600	35A	
2N4101	600 400 200	5A	



Sock most SCR's with a 400 A/μs pulse and they're destroyed—they can't turn off fast enough. Slam the developmental RCA-TA7395 with the same kind of pulse, and it keeps working . . . and working . . . and working. (It literally breaches the current barrier!) That's because RCA SCR's turn off in 10 μs and spread forward current faster—so switching losses are low—and less heat is dissipated internally.

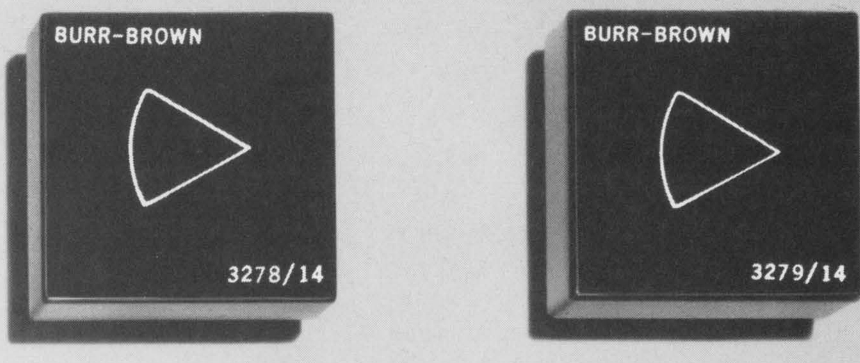
In addition to fast turn-off times, the TA7395 and other RCA SCR families have high dv/dt characteristics, and may be used at frequencies up to 25 kHz.

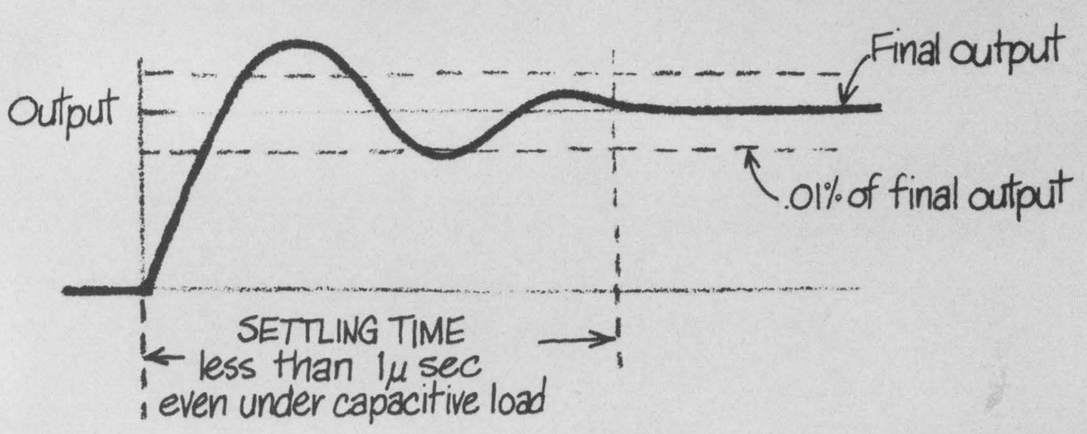
Engineers take notice: RCA SCR's are subjected to the most stringent quality assurance tests in the industry. With case temperatures held at 120°C, the SCR's are pulsed by 100 A/μs and 250 V/μs (up to rated voltage) signals to check turn-on switching losses and turn-off times.

For further details, see your local RCA Representative or your RCA Distributor. Or write RCA Electronic Components, Commercial Engineering, Section G1-1/UR5, Harrison, N.J. 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

RCA

These new FET op amps are fast!





Now you can settle for less!

Here are two wideband FET operational amplifiers that deliver fast settling times under realistic circuit conditions. Equally fast in both inverting and non-inverting modes, these new Burr-Brown units are stable with up to 1000 pf of capacitive load without external compensation.

Their fast response, low output impedance and 6 dB/octave rolloff is ideal for such applications as A/D and D/A converters, high-speed buffer amplifiers, pulse amplification, sample/hold circuits and high-speed integrators. The 1.5" x 1.5" x 0.4" Burr-Brown package is compatible with high-density card spacing.

HIGHLIGHT SPECIFICATIONS

MODEL NO.	3278/14	3279/14
Settling Time, max. to .01% of final value including slew rate	1.0 μsec	1.0 μsec
Slew Rate, min.	32 V/μsec	32 V/μsec
Bandwidth Unity Gain	10 MHz	10 MHz
Voltage Drift, max.	± 20 μV/°C	± 50 μV/°C
Open Loop Impedances CM & Diff. Input	10^{11} Ω	10^{11} Ω
Rated Output	±10V @ ±20 mA	±10V @ ±20 mA
Price, 1-9	$47.00	$37.00
100 Unit Price	$35.00	$28.00

FOR COMPLETE TECHNICAL INFORMATION on these new fast-response FET op amps, contact your Burr-Brown Engineering Representative or use this publication's reader service card.

BURR-BROWN
RESEARCH CORPORATION
International Airport Industrial Park • Tucson, Arizona 85706
TELEPHONE: 602-294-1431 • TWX: 910-952-1111 • CABLE: BBRCORP

BB

Operational Amplifiers
Instrumentation Amplifiers
Function Modules
Active Filters
Power Supplies

INFORMATION RETRIEVAL NUMBER 9

When it comes to high voltage dc power supplies, come to the

INNOVATORS

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

CAPABILITIES:

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

FACILITIES:

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

AND . . .

- ☐ *85,000 square feet of modern air-conditioned plant facilities.*

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

HIPOTRONICS INC.

High Potential Electronics

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

INFORMATION RETRIEVAL NUMBER 11

Designer's Calendar

FEBRUARY 1970						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

For further information on meetings, use Information Retrieval Card.

Feb. 10-12
Winter Convention on Aerospace and Electronics Systems (Wincon) (Los Angeles) Sponsor: IEEE. R. Banks, Los Angeles Council IEEE, 3600 Wilshire Blvd., Suite 1920, Los Angeles, Calif. 90005

CIRCLE NO. 336

Feb. 18-20
International Solid-State Circuits Conference (Philadelphia) Sponsor: IEEE, Univ. of Penna., L. Winner, 152 W. 42 St., New York, N.Y. 10036

CIRCLE NO. 337

Feb. 18-19
Instrumentation Fair (Los Angeles) Sponsor: Instrumentation Fair Inc., Calif. L. Courtney, Larry Courtney Co., 16400 Ventura Blvd., Encino, Calif. 91316

CIRCLE NO. 338

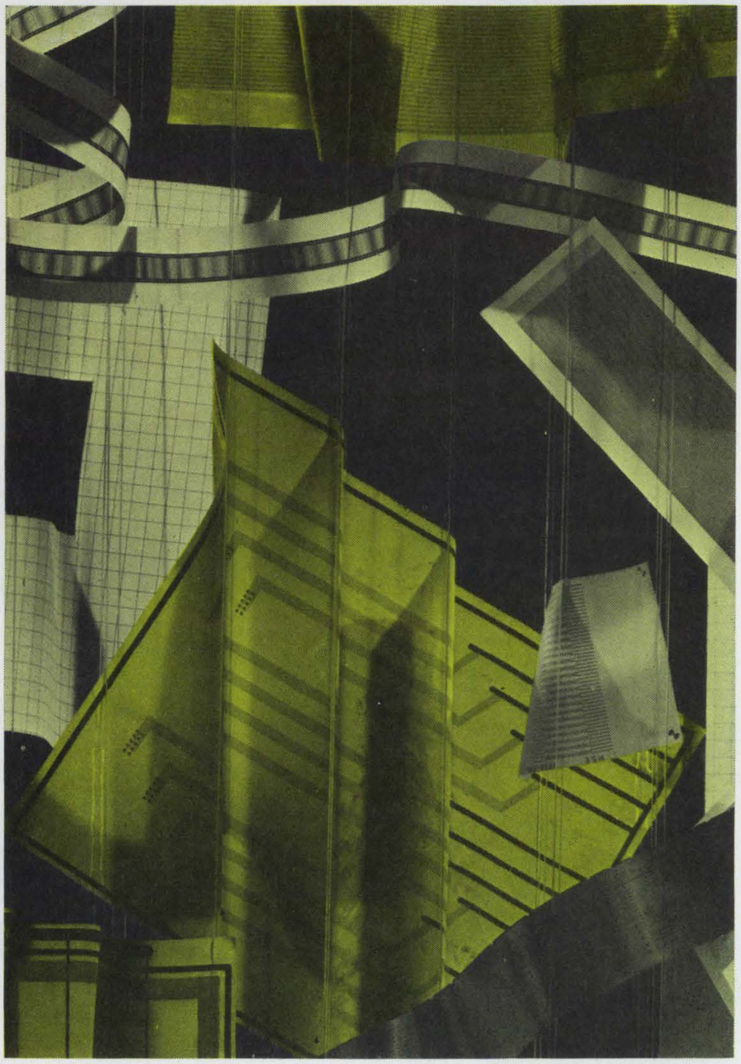
MARCH 1970						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Mar. 11-13
Scintillation & Semiconductor Counter Symposium (Washington, D.C.) Sponsor: NBS, IEEE. R. L. Chase, Brookhaven National Laboratory, Upton, N.Y. 11973

CIRCLE NO. 339

Buckbee-Mears offers the biggest variety of flexible circuits on the market today!

We also produce the best.



The most flexible, accurate way to produce flexible circuits is by precision photomechanical reproduction. As it happens, Buckbee-Mears invented the photomechanical technique. Our facilities are larger and more advanced than anyone else's.

Using the photomechanical process, we offer sharp definition and close tolerances in both Mylar* and Kapton* base circuits. We produce smaller wires to two mils apart on four mil centers. We also produce very large circuits. Once, for example, we etched two sided circuits that were five feet square. Another time we etched a single sided flexible circuit six feet long by just three inches wide. Most important, we hold tolerances to ± .0002 inches on wires and space. You can't buy a more accurate circuit.

There are other advantages to having Buckbee-Mears produce your flexible circuits by photomechanical reproduction. We etch holes through the dielectric material, saving a drilling or punching operation. After etching the holes, we can pull the wire down through the holes, or leave them hanging out for pin connectors.

The holes can be plugged with a conductive material for a good electrical path from top surface to bottom surface. We offer gold, 60% tin and 40% lead, or pure lead plating over the conductors. The plating can be done selectively or over the entire circuit. We guarantee shrinkage control on any flexible circuit pattern we produce.

More and more industries are finding applications for flexible circuits today. Major users include computer manufacturers, the auto industry and microcircuit packaging. But anyone who has a space or weight problem can use Buckbee-Mears flexible circuit technology.

If we can help you, call or write Bill Amundson, our industrial sales manager. He has a staff of experts in flexible circuitry who can solve your particular problems. Bill's phone number in St. Paul is 612-227-6371.

*DuPont trademark

PRECISION METAL AND GLASS ETCHING • ELECTRO FORMING • AUTOMATED DESIGN

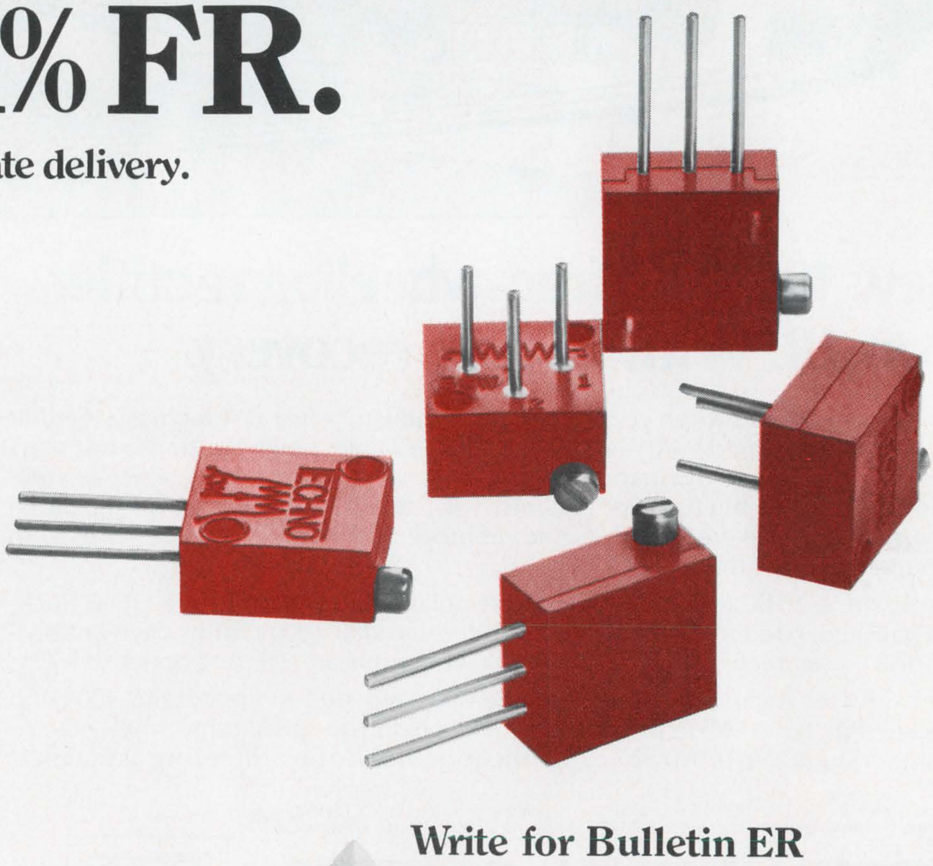
bmc BUCKBEE-MEARS COMPANY

SAINT PAUL, MINNESOTA 55101

INFORMATION RETRIEVAL NUMBER 13

Techno has 3/8″ RTR24 style (MIL-R-39015) wirewound trimmers qualified at the P confidence level for 0.1% FR.

Available for immediate delivery.



Write for Bulletin ER

TECHNO-COMPONENTS CORP.

A SUBSIDIARY OF OAK ELECTRO/NETICS CORP

7803 LEMONA AVENUE / VAN NUYS, CALIFORNIA 91405

(213) 781-1642 / TWX: 910-495-2015

INFORMATION RETRIEVAL NUMBER 15

INFORMATION RETRIEVAL NUMBER 16 ►

Op Amps go *High Voltage*

Tear-off and file for future reference . . .

MC1536 sets a new pace for Operational Amplifiers with low input currents, internal compensation, plus high-voltage capability!

Here's the one that changes the whole ball game for monolithic Op Amp applications where a large output swing is required. The MC1536 doubles the maximum supply voltage now available to Op Amp users . . . ±40 Vdc . . . while still preserving input differential voltage protection and output short-circuit protection. And, with all that, typical input bias current is just 8.0 nA and offset current is 1.0 nA. Just think how you can utilize your full supply voltage in a wide variety of control-system applications. Even in servo-amplifier work, you can have both higher voltage and lower current.

Here are some other applications made possible by the high-voltage breakthrough of the MC1536:

- High-Voltage Differential Amplifiers and High-Impedance Differential Buffers.
- ***Voltage Regulation***

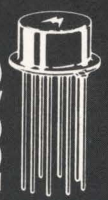
  Op Amp regulators that used to "float," can now be driven directly. This results in better regulation (both load and line) and, of course, fewer parts.
- ***Current Regulation***

  With the MC1536, it's possible to have a 5 mA current source with .01% regulation, where R_L = 0 to 10 K.
- ***Wide-Range Sample and Hold Circuits***

  A pair of MC1536's will simplify these traditional discrete device designs and will give an input voltage range of ± 30 V. A 2.0 V/μs Slew Rate allows moderate chopping speeds and the internal compensation provides for a stable unity gain buffer without external components.

For information about the specifications that make possible this wide range of new applications for monolithic operational amplifiers, simply turn the page. ▶

- Output Voltage — 60 V P-P (min)
- Max. Supply Voltage ±40 V
- Input Bias Current — 8.0 nA (typ)
- Input Offset Current — 1.0 nA (typ)
- Internally Compensated



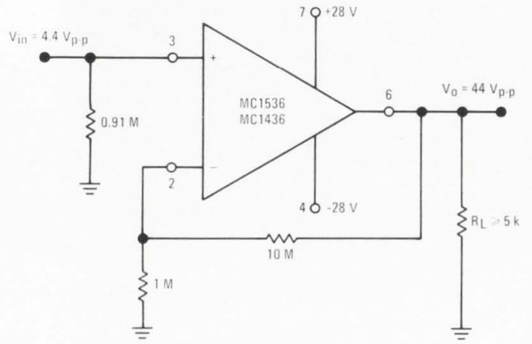
—where the priceless ingredient is care!

MOTOROLA
Integrated Circuits

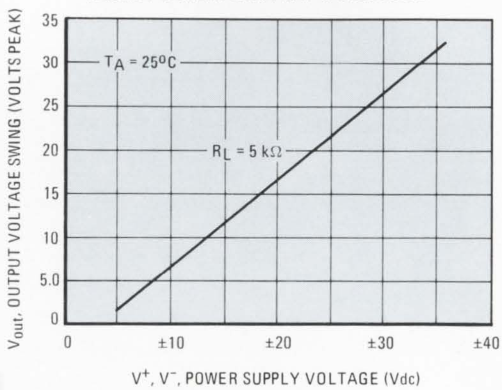
Check these pace-setting specs for the MC1536G, MC1436G, industry's first high-voltage monolithic Op Amp

- Maximum Supply Voltage – ±40 Vdc
- Output Voltage Swing – (min)
  $\pm 30\ V_{pk}$ ($V^+ = +36$ V, $V^- = -36$ V)
  $\pm 22\ V_{pk}$ ($V^+ = +28$ V, $V^- = -28$ V)
- Input Bias Current – 20 nA max
- Input Offset Current – 3.0 nA max
- Fast Slew Rate – 2.0 V/μs typ
- Internally Compensated
- Offset Voltage Null Capability
- Input Over-Voltage Protection
- A_{VOL} – 500,000 typ
- Characteristics Independent of Power Supply Voltages – (±5.0 Vdc to ±36 Vdc)

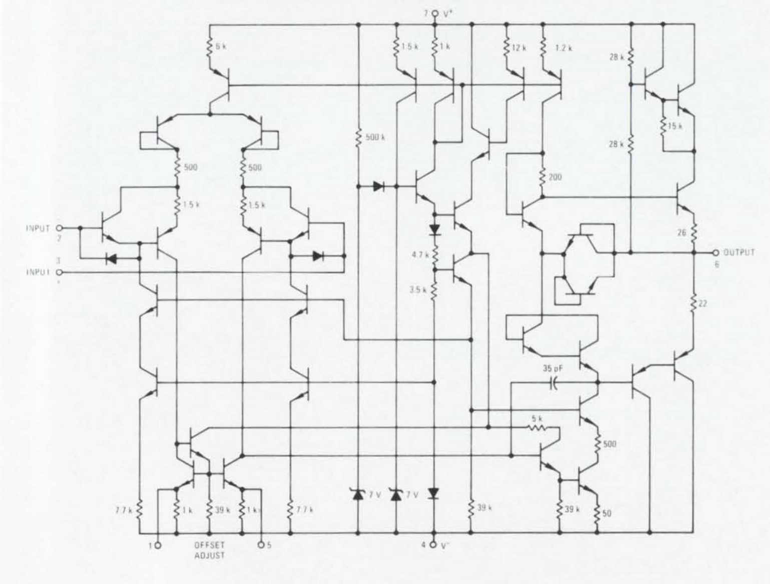
TYPICAL NON-INVERTING X10 VOLTAGE AMPLIFIER



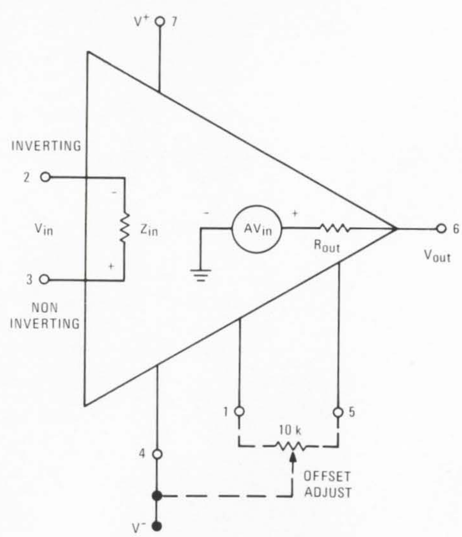
PEAK OUTPUT VOLTAGE SWING versus POWER SUPPLY VOLTAGE



CIRCUIT SCHEMATIC



EQUIVALENT CIRCUIT



Double your supply voltage ...double your Op Amp applications range with the MC1536

The MC1536G and the low temperature-range MC1436G are available in the 8-pin (TO-5) package from distributor stock. The 100-up price for the MC1536G is \$39.00, and the MC1436G is \$18.00. For complete specifications and applications information, circle the reader service number on the opposing page, or write: P. O. Box 20912, Phoenix, Arizona 85036.

– where the priceless ingredient is care!

MOTOROLA
Integrated Circuits

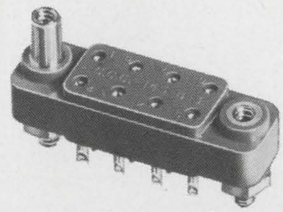
The circuitry shown external to Motorola products is for illustrative purposes only, and Motorola does not assume any responsibility for its use or warrant its performance or that it is free from patent infringement.

5653 PRINTED IN USA 12-69 IMPERIAL LITHO 814450

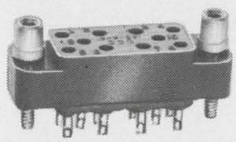
If your circuit calls for RELAY SOCKETS

check Continental's complete line...

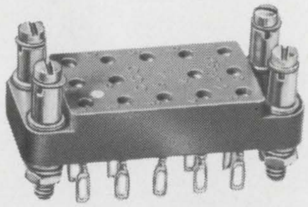
FIXED CONTACTS



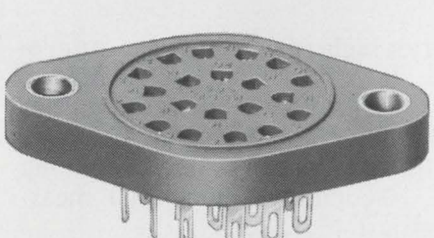
145-8-3/8 CONTACTS/FIXED



145-8-41/10 CONTACTS/FIXED



145-8-10/14 CONTACTS/FIXED



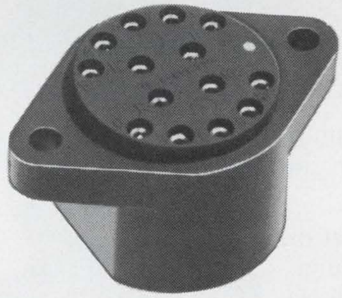
145-8-15/20 CONTACTS/FIXED

with fixed or removable contacts in 8, 10, 14 and 20 sizes.

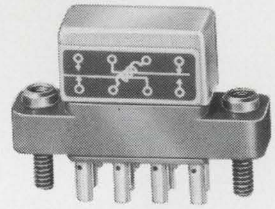
Terminations: solder cups, dip solder, turret terminals, eyelet lugs.

For a free copy of our illustrated brochure on Relay Sockets, including outline drawings and technical data, write to Advertising Department, Continental Connector Corporation, 34-63 56th Street, Woodside, N.Y. 11377. Or phone (212) 899-4422 for fast action.

REMOVABLE CONTACTS



145-8-51
14 CONTACTS/REMOVABLE



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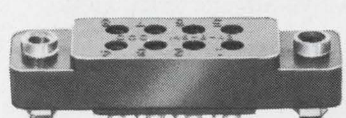

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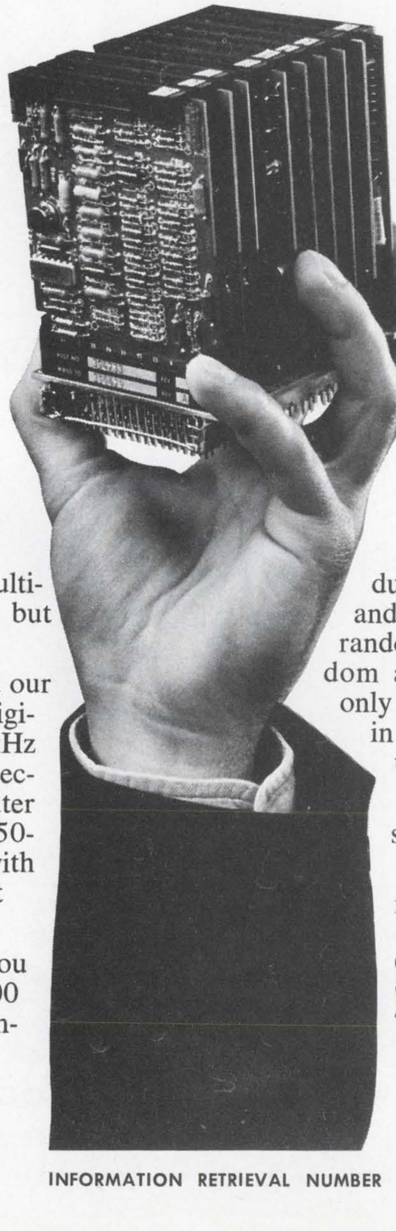

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RAYTHEON

Industry edgy as NASA and Sylvania shut centers

Electronics research in the New England area has been dealt a sharp blow—and the industry is wondering whether it isn't a harbinger of similar misfortune elsewhere in the country.

NASA's Electronics Research Center in Cambridge, Mass., will be closed by June 30, resulting in the transfer or termination of $25-million in contracts. The 831 employees are scheduled to lose their jobs.

And Sylvania's Applied Research Laboratory in Waltham, Mass., is also shutting down. According to a company spokesman, "It's the result of a Congressional rider to the defense budget that specifies that work not directly related to specific defense programs be limited." Dr. James E. Storer, director of the Sylvania Research facility, who has resigned, says about 150 employees will be shifted to other divisions in the company.

In reporting the demise of the space agency's center, Dr. Thomas O. Paine, NASA's Administrator, said: "We are simply faced with the hard fact that NASA cannot afford to continue to invest broadly in electronics research as we have in the past."

The NASA shutdown came as a distinct surprise. As late as December, there were openings for 19 more employees, which would have boosted the total personnel to 850. In addition a $1-million program providing direct support to NASA's space-station and space-shuttle program had recently been assigned to the Cambridge center.

The center has a current payroll of about $12-million. Of the 831 employees, about 100 hold PhDs. No transfers are scheduled at present to other NASA centers.

A spokesman for NASA says that there is a hiring freeze at all NASA centers and that this is part of "an all-around belt-tightening effort."

One hope for the New England area is that the Dept. of Transportation will take over the $36-million Electronics Research Center complex. According to Oscar Griffin, director of public affairs for the department, this is "under staff study"; the center is one of "as many as 10 places being considered."

The Federal Aviation Administration has indicated that it could use the center in Cambridge, but budgetary matters and policy considerations have not yet been formulated.

Experiments for Mars set for 1973 landing

The experiments and experimenters for NASA's unmanned Viking mission to Mars in 1973 have been selected. Besides trying to answer the age-old question of whether there is life on the "red" planet, instrumentation packages will make a number of other probes.

Two orbiting craft will make a visual map of Mars with some kind of optical device—television or perhaps a photographic camera. If a photographic camera is selected the film would be developed, electronically scanned and transmitted digitally to earth. This technique was used in the early lunar missions.

The orbiters will also measure the water distribution in the atmosphere and determine the variation in surface temperature and thermal balance.

Two landers that will descend from the orbiting craft will send back some form of pictures of the landing site. They will analyze the organic compounds in the soil and look for water in both the surface material and atmosphere.

Other phenomena the landers will study, include meteorology, composition and structure of the atmosphere, seismic activity, the magnetic properties of surface particles and the physical properties of the soil.

Each experiment will be sponsored by five or more universities or industrial research centers. NASA's Langley Research Center, Hampton, Va., is charged with over-all project management and for the landers. Jet Propulsion Laboratory, Pasadena, will manage the orbiters, tracking and data acquisition.

The landing sites will not be chosen until two Mariner spacecraft orbit and photograph the planet in 1971.

New magnetrons offer bargain coherent radar

For radar users—missile ranges, ships, air control centers and others—a new family of high-power, injection-locked magnetrons holds high promise: The many advantages of coherent radar techniques can be incorporated into existing monopulse tracking radars, and at costs greatly below those normally paid for coherent systems. Transponders, too, can be improved.

A development of Varian Associates' Eastern Tube Div., Beverly, Mass., the new tubes can be used as follows:

The conventional magnetron in an existing radar is replaced with Varian's injection-locked unit and a stable reference oscillator. In addition some signal-processing circuitry and an improved receiver are needed. However, as a Varian spokesman explains, the additional equipment is low in cost compared with the equipment that need not be modified or replaced—the power supplies, pulse-forming networks, microwave plumbing, antennas, etc.

Basically the new tubes differ from conventional magnetrons in that their rf output frequency can be locked to that of a low-level injected signal. And they can do this over a 10% to 15% bandwidth. Thus they can be used in place of much more expensive microwave power amplifiers in such applications as moving-target-indicator transmitters and coherent transponders. In the former applications, the injected signal would come from a stable reference oscillator; in the latter, the received signal would serve as the reference.

Coherent transponders are used on aircraft and missiles to provide range-rate information as well as the range data provided by ordinary transponders. Range-rate information is obtained from the doppler shift between the transmitted and received signals on the ground.

Since the doppler shift is very small compared with the rf itself, coherent techniques must be used lest the random fluctuations and drifts of a free-running oscillator completely obscure the doppler data. The new tubes are single-port devices and are operated with very heavily loaded resonant circuits. Thus they can provide useful gains in excess of 15 dB.

So far the tubes have been delivered to the Control Science Corp., Alexandria, Va., to be used in coherent transponders at various missile-tracking ranges. The units have peak operating powers of 150 W at C-band, and Varian expects to have Ku-band units soon that will be capable of delivering hundreds of kilowatts.

Navy needs telemetry gear in L and S bands

The Navy is having a hard time finding L and S-band telemetry transmitters that work and are not too expensive. "About three out of 10 operate satisfactorily," says Capt. J. R. Foster, commander of the Air Test and Evaluation Squadron Four at Point Mugu, Calif. "And they are expensive. The old vhf transmitters cost $128 each. These uhf transmitters cost between $4500 and $6000.

"It's a problem and a big one," he adds. "We're going to need 2500 to 3000 transmitters a year, mainly for testing air-to-air missiles, but also for subsystems in aircraft."

Squadron Four waited a year for a good transmitter from Giannini Voltex, Inc., of Whittier, Calif. Two were received, but neither passed inspection. They drifted and were off frequency, a Navy engineer says. With an allowed tolerance on the bench of 0.001%, or 15 kHz for the 1500-MHz transmitter, the device was 75 kHz low after five minutes, and 90 kHz low after 10 minutes.

Giannini Voltex was given 10 days to produce an acceptable device or forfeit the contract without pay. Instead, the company dissolved its telemetry transmitter business altogether—"at least for the time being and probably forever," the company's chief engineer, John Stelzried, told ELECTRONIC DESIGN.

"It's a pity," says Point Mugu's Capt. Foster. "The company builds some excellent equipment."

"There are two problems in designing good L-band telemetry transmitters," Giannini Voltex's Stelzried says. "We can't get transistors that will operate at the power we need, and it's hard to meet the extreme frequency stability specifications coupled with extreme modulation capability."

The power required for transistors varies widely, Capt. Foster says. "Sometimes we can get by with 1 watt but often we need more. Never more than 10 watts, however."

"We know we're pushing the state-of-the-art," says L. P. Melancon, a Squadron Four engineer. "We're trying to jam a lot of transmitter in a very small case. And," he adds, "there just aren't many people in the country who can design microwave power circuits that will do the job."

Melancon adds on a more hopeful note, "We've received three L-band transmitters from Teledyne, and two of them work. I just hope someone doesn't underbid them and give us junk."

Lee Mabee, at the Missile Test Center at Point Mugu, says, "Mainly the transmitters we get just don't work well, and we have to send them back. On the second go-round they operate pretty well. We haven't found a manufacturer who can turn out the transmitters in sufficient volume."

Mabee's group has tested "satisfactory transmitters" from Microcom Corp., Horsham, Pa., and from General Electric's Aerospace Electronics Dept., Utica, N.Y.

Coast-to-coast test for satellite TV

The Corp. for Public Broadcasting has begun a 16-week test in relaying educational TV programs via NASA satellites from the East Coast to the West. The company's president, John W. Macy, Jr., says that the experiments will yield data that can be used in commercial satellite telecasts.

The test programs are being transmitted from NASA's tracking facility at Rosman, N.C., for relay through either Applications Technology Satellite No. I or No. III, both of which are in synchronous orbit. The signals are received at the space agency's Mojave, Calif., tracking station and carried by commercial circuits to a Los Angeles TV station. At present they are being rebroadcast from Los Angeles to western portions of the National Educational Television Network. Later, programs will be sent from the west to the east.

New gear improves scuba communications

The ability to understand communications from divers wearing Scuba gear has been reported improved from 50% to 75% with new electronics gear.

Robert L. Adams, engineering manager for the Hydro Products Division of the Dillingham Corp. in San Diego, says the high degree of intelligibility has been achieved with a small 8.0875-kHz, single-sideband, amplitude-modulated transmitter attached to the diver's Scuba equipment. The transmitter puts out about 1/2 watt of acoustic energy and has a range of about a thousand yards with existing receivers.

Since a diver's ear canal fills with water, resulting in a hearing loss of from 30 to 50 dB, bone-conduction ear pieces are used.

Resonant cavity mouthpieces are used with piezoelectric transducer microphones.

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Casinos are finding the best 'system' is electronic

Elizabeth deAtley
West Coast Editor

Nevada's legal gambling establishments turn to engineering for help in catching stealthy cheats and running the games and office procedures more efficiently

Las Vegas

The atmosphere is convivial, the tension at the gaming tables taut, and the 86-proof is flowing freely because the drinks are on the house, and the careful customer—that part-time gambler from staid suburbia who comes to Vegas once in five years to pit his razor-edge intelligence against the wily pros of gambling—knows that he had better watch his step, because the dice are loaded, the cards are stacked and that sleezy-looking guy with a green eye-shade over there is pushing secret buttons to control the roulette wheel.

Right?

It's a picture that many novices have of gambling here, but the odds are enormously against its being true. The fact is that the customer need hardly ever worry about being cheated by the gambling house; strict laws of the state of Nevada protect him. Rather it's the house that has cause to worry about being cheated by the customer—and by its own employees sometimes. As a result, more and more legalized gambling houses are turning to electronics to detect fraud and to run their business more efficiently.

The owner of a gambling casino in Nevada has two big problems:

1. Closing the leaks that siphon money into the wrong pockets.
2. Predicting his customers' idiosyncrasies.

The electronics he is turning to for a "fairer" shake are not in themselves exotic, but the devices and systems employ clever designs. Already these trends are in evidence:

- Electronic slot machines, Keno machines and poker games are found in most large casinos.
- On-line systems for monitoring slot machines and gaming tables and controlling keno are being tried.
- TV monitors of gaming tables are becoming a common sight in the manager's office of the large casinos.
- Electronic scales for counting money by weight are becoming available.

Outlook favors computers

Casino owners predict that in the future the computer will be used more and more to detect possible flaws in games that cause them to lose money over long periods of time.

Gambling is an industry in Nevada, and it is under tighter government controls than anywhere else in the country. House percentages run as low as 1.4% on craps and 2.5% on blackjack. To make a profit under these conditions, casino owners must have tight accounting procedures, and they must be alert to the many ways that money can evaporate. Not only must they be on the lookout for outright theft. They must also watch the slot machines and gaming tables, to make sure there is no hidden "flaw" that may cause a slow but steady loss of money. And they must differentiate between such a flaw and a simple losing streak. For example, if a machine pays out more than it should over a period of time, is it defective or just "unlucky"? If a customer steadily wins more than the odds for that game should allow, does he have a "system" or is he lucky? Only time and data analysis will tell.

According to Robert Mulligan, agent for investigations of the Nevada Gaming Board, Carson City, some casino owners watch the so-called cycles of good and bad luck that every machine, player and dealer is said to experience and attempt to counteract the down periods—by shifting dealers from one table to another, for example.

Another big problem of the casino owner is his customers. People who gamble behave in ways that are difficult to explain or predict. William Bounds, sales manager of Bally Distributing Co., the largest distributor of slot machines in Nevada, says:

"Everything on these machines

has a psychological reason for being there—the colors, the style of the cabinet, where the coin selector is, how easy the handle pulls, every symbol on the reels. We went to card symbols on one model. I can show you 30 machines back there in the warehouse. Nobody would play them. People just don't accept playing cards on slot machines—or chickens or ducks. They do accept fruit. And not all kinds of fruit either. You'll see very few slot machines now with lemons on them. People don't trust lemons. If they see a lemon on a slot machine, they just know there's no pay."

All the decisions on the design of that machine were based on data analysis. Casino owners arrange their floor space on the same basis. They keep detailed records on such matters as the percentage realized by a particular machine or gaming table in one location compared with another, the effect of changing the color or type of machine in a particular location, the effect of decorations on the walls, attendants' uniforms, type of entertainment.

Electronic systems and devices could help in this data analysis and accounting, in the prevention of pilferage and in the running of the games themselves, but old-line casino owners formerly were reluctant to consider innovations. But now with businessmen and corporations—such as Del Webb and the Hughes enterprises—this attitude is beginning to change.

Electronic coin games of several types are beginning to edge their way into the large casinos. Managers like them because they are more reliable than mechanical or electromechanical devices. In addition some models of electronic slot machines are "faster" than their mechanical counterparts. A single such machine will play up to three separate games. Thus players who normally play several slots at once can do so on a single electronic machine. As a result, says Chester May, slot director at Harold's Club in Reno, the electronic slots are often more profitable than their mechanical counterparts, despite their hesitant acceptance by the public.

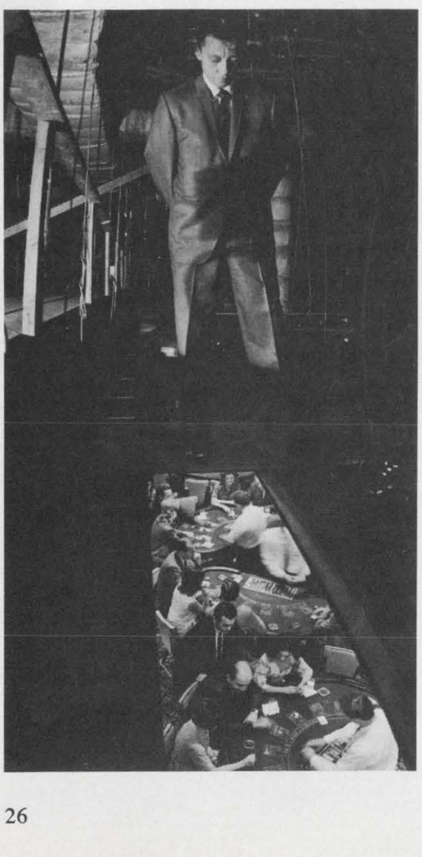
A third reason why electronic slots are beginning to find favor with casino managers is the fact that they are more difficult to cheat. Robert Horton, vice president of Raven Electronics in Reno, the principal manufacturer of electronic slots, puts it this way:

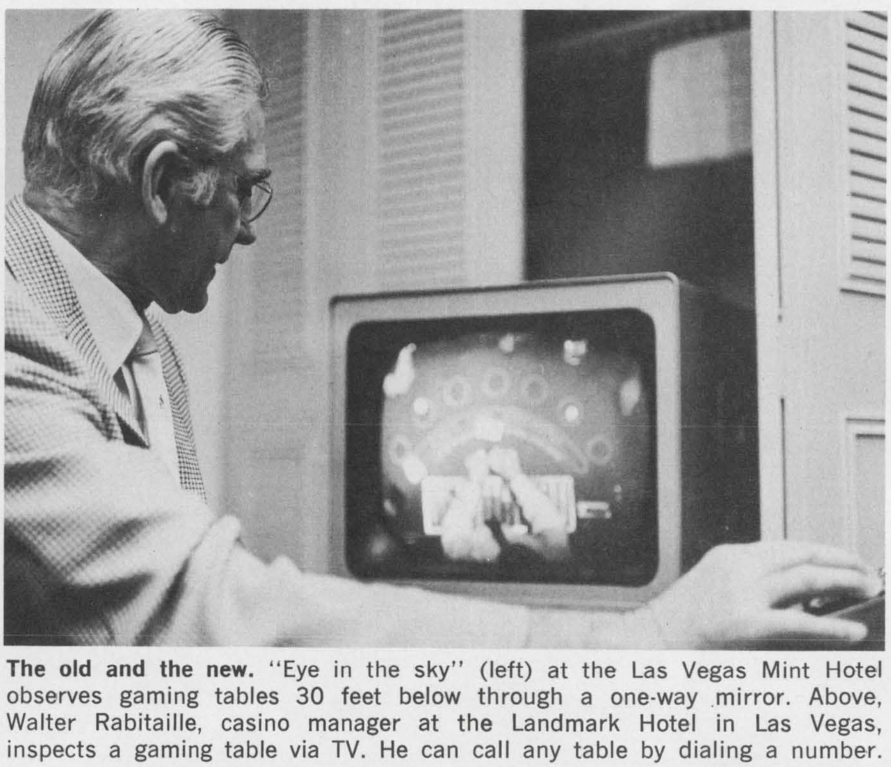
"Even with a technician's training, you couldn't find the right part of the circuit fast enough to 'fix' the machine without attracting attention.

"On a mechanical slot a good cheater with a key—and you can often purchase a key from an employee—can open the machine, set the reels on a jackpot and close the door in three seconds. There are schools in Las Vegas that teach people how to cheat the slots.

"In one club a mechanic was opening the machine as if to work on it, setting the reels almost up to the jackpot and putting a little piece of dry ice underneath the control on one reel so it wasn't quite all the way down. He would close the machine and a confederate would come up and stand there until the dry ice had evaporated and the reel dropped down to the jackpot position. One day the fellow didn't have any dry ice, so he used an ice cube instead. When the inspectors opened the machine, they found a puddle of water under the reels. Then they knew what was happening."

In essence, electronic gaming devices are small computers that keep track of the player's score and control the payoff. The most widely used is the Raven slot machine, which accepts from one to three coins, each coin playing a separate row of three symbols. The symbols are printed on transparent color film mounted in projection lamps.





The old and the new. "Eye in the sky" (left) at the Las Vegas Mint Hotel observes gaming tables 30 feet below through a one-way mirror. Above, Walter Rabitaille, casino manager at the Landmark Hotel in Las Vegas, inspects a gaming table via TV. He can call any table by dialing a number.

When the player touches the contact plate, one of the lamps turns on. Which one it will be depends on the state of the two timing circuits, which simulate the reel in a mechanical slot machine. One timing circuit is a shift register, and the other is a simple counter. The projection lamps are controlled by a bank of flip-flops, one for each lamp. When a "1" is entered into the cherry flip-flop, for example, a cherry appears on the screen. Entrance to each flip-flop is through a two-input NAND gate.

The shift register continuously addresses each NAND gate in rotary fashion. When the player touches the contact plate, he sets the counter, which counts for a fixed period of time and then outputs to all the NAND gates in parallel. A "1" then enters the memory bank through whichever NAND gate the shift register is addressing at that moment. The symbol accessed by that NAND gate will appear on the screen and remain there until the machine is reset for a subsequent play.

Unbreakable switches used

Horton points out that the play buttons on the machines are contact switches, which are activated by the change in capacitance that occurs when someone touches a plate. They contain no moving parts.

"We use this type of switch," he says, "because it is virtually unbreakable—and a gaming casino is the most abusive environment you can imagine."

In addition to the electronic slots, there are two competing poker machines on the market—one built by Bally and the other by Latron, both of Reno. The machines are similar in design, but they select the cards by different means.

In the Latron machine, the player himself chooses each card. Timing circuits within the machine address each of the 52 cards in rotary fashion. When the player touches the contact plate, the card that is then being addressed by the timing circuits appears on the screen.

In the Bally device, the player initiates only the first card. The remaining four are chosen by pulses from a random noise generator.

Both Bally and Latron are confident that their methods of choosing cards provide a truly random selection. If this were not the case, of course, they would have to face sudden heavy losses as customers began to detect the pattern (see box).

Despite the influx of electronic gaming devices, the mechanical and electromechanical slots continue to be popular with customers, and casino owners are searching for ways to counteract their deficiencies. One possible solution is to tie every slot to a central computer that would count the coins as they go in and out and flash a warning whenever a machine goes out of order or is any way tampered with. But the technical problems involved in designing such a system are formidable. Albert M.

Why the house wins without hardly trying

"People think there's something against them that causes the house to win all the time—some 'hidden percentage' in favor of the house," says Walter Rabitaille, casino manager at Howard Hughes' newest resort, the Landmark in Las Vegas.

"But actually," he goes on, "the only hidden percentage the house has is the player himself. I've seen it proved over and over again for the 40 years I've been in this business. Out of every 100 people, 99 are willing to lose 400% more than they will try to win.

"For example, suppose a man has $10,000 in his pocket and he wants to play. If he wins $2,000 to $3,500, he quits. That's a nice winning for him. It will pay for his trip and he can buy the wife a dress that will keep her appeased.

"But if he loses the same amount, he is 'hooked," and after he loses $5,000, all he wants to do is get his money back. In effect, he tells the house, 'Look, you have $5,000 of my money. If you win the other $5,000, you are a $10,000 winner, but if I win $5,000, we're even.' Under those circumstances, the house cannot lose, and in fact has got to win the whole $10,000. That's a pretty good 'hidden percentage,' but it's the only one the house has."

Crack keno writer Sammy Chung explaining why he was faster than a computerized keno system: "The man and machine had never done it before."

The random generator plays a central role in gambling

The casino is an excellent proving ground for a random generator—whether it is a roulette wheel, an electronic noise generator or the 21 dealer himself. If this "random generator" does not select numbers or cards in a truly random fashion, some alert customer will detect the fact and greatly increase the odds in his favor.

In the game of keno, for example, the random generator is a spinning wire cage from which numbered pingpong balls are removed one by one. For true random selection, the balls must be precisely sized. But, as an employee of one of the casinos pointed out to an ELECTRONIC DESIGN, this can't be guaranteed in practice. With any set of balls, no matter how carefully they are machined, a pattern begins to appear after a few hours.

To prevent the customers from detecting such a pattern, casino managers use sets of balls and change the sets frequently. But they are never sure how often they should do this, as the "pattern" time differs for different sets of balls. By using computer analysis, the casinos can "calibrate" each set of balls—that is, determine how long each can be played before an obvious pattern begins to appear.

Raven Electronics Corp. is proud of the random generator in its electronic keno machine. The payoffs in this game are very high (up to $25,000 on a single win). Thus, says Robert Horton, vice president of Raven, "if anyone ever detected a pattern, we would soon know about it."

But this has never happened, he says, despite the fact that one machine was missing for several months and finally turned up in Sweden, its interim whereabouts never accounted for.

Linnen, electronic systems engineer at Harrah's Club in Reno, observes:

"Let's say you have a thousand machines. You've got to scan all those machines and put all the data into a data bank in the time it takes for one play of the machines—and all the machines can be played simultaneously. In fact, they often are."

Encoding at the machine level is expensive, Linnen notes: "Every time you spend a dollar on each of a thousand slots, that's $1000. But if you don't encode at the machine level, then you may have 10 or more wires from each slot, which makes it a job to move the machines around. And most clubs move their machines frequently, apparently in a never-ending search for the most profitable arrangement."

Despite the technical difficulties, such a system was actually installed by the Fremont Hotel in Las Vegas in 1962. It was a financial fiasco, however. After a cash outlay of $600,000, it was finally abandoned in 1967. According to Frank Mooney, controller of the Fremont, the system was supposed to "record impulses every time a coin went into the machine or into the hold bucket and every time a coin was paid out."

"But they couldn't get the proper electronic impulses," he recalls. "More than one coin would go through at a time, and it would count two as one. Also, power failures would cause it to lose data out of memory—and we have a lot of power failures here in Las Vegas."

According to William Messer, one of the system's designers and now a staff member of Typograph Corp., San Diego, the system tied 1000 slots to a central computer by hard wire through a set of multiplexing units—one for each table of eight machines, and one at the central computer.

"Each slot had 12 to 15 wires connected to the coin collection and payout systems," says Messer, "plus 13 wires from a card-reading system used to identify any authorized employee who might be entering the machine. A local terminal at each table multiplexed the machines on that table and retransmitted the data over 80 parallel wires to a multiplex system associated with the central computer, which was a Packard Bell Model 350, now manufactured by Raytheon."

Messer agrees with Mooney that the computer memory, being volatile, lost data during the frequent Las Vegas power failures.

Another of the system's designers, Ed Bon Durant, now president of Logic Sciences, Inc., San Diego, feels that "the weakest technical point in the system was the mechanical closures used to sense the coins." The system was never off more than a few pennies a day, he says, but this was too much.

"If I were building the system today," says Bon Durant, "I would look for a better way to sense coins. One of the first sensors I would consider would be a photocell type. A coin could never get by that without being counted."

Despite this sobering experience with on-line slot monitoring systems, William Bennett, vice president and general manager of Del Webb's Mint Hotel, thinks that the advances in technology since 1962 make it reasonable to try again. As for the cost of such a system today, Bennett says, "I'll take a ranch-house guess at $100 a slot—not counting the computer." Mint Hotel officials are convinced that this cost is more than justified by the current losses due to pilferage and malfunctioning machines. Joseph O'Rayeh, director of slots at the Mint, says:

"The slot business is close to a $3-million a month business. We are sure there are at least thousands of dollars a month stolen, and we suspect the actual figures are staggering. For this reason, the cost of an on-line system could never be prohibitive."

O'Rayeh points out that such a system will "allow us to photograph slot thieves in the act of committing the theft."

Another advantage, he indicates, is that it will signal when an adverse trend occurs. "Slot machines—whether mechanical, electromechanical, or even electronic—may pay out excessively over a period of time," he observes. "The only way we can catch this is by a daily analysis of the percentage. If we see that a machine doesn't hold its percentage for the day, we aren't alarmed, but if for several days it loses continually, then we know something is wrong. The only way we can know this is by keeping track over a period of time. This all has to be done by hand now and requires a lot of people. With the on-line system, the computer will do the analysis and simply signal us when a machine reaches the point where it has had a certain number of handle pulls and still isn't realizing its expected percentage."

A new system planned

A new system for the Mint is being designed by Ricca Data Systems of Santa Ana, Calif. The details are not yet firm, but O'Rayeh points out that it will record every coin in and every coin out and give a breakdown as to whether the coins go out in jackpots or in small pays. It will also report just how much money should be in the drop bucket at the bottom of the machine.

Malcolm Niles, project engineer at Ricca, says the company is considering a system with local terminals that would receive data by hard wire from a bank of perhaps 20 slot machines—about 10 wires from each machine. The system would transmit the data in a multiplex mode to a central computer over a single, twisted-wire pair. The sensors in each machine would probably be reed relays, Niles notes.

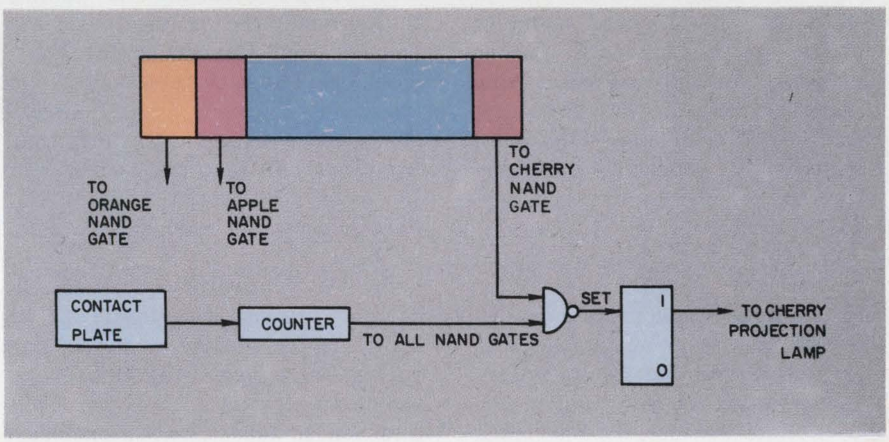
Printer displays envisioned

The displays, he says, would probably consist of "two or three printers of some type stationed at various points: one perhaps in O'Rayeh's office, so he can get interim reports instantaneously; one or two at the cashier's cage, so that if a jackpot comes up anywhere in the room, a check girl will see it, pay the customer and punch a function key on the terminal to indicate that it has been paid."

"The location of the machine might be indicated on a big light board," Niles says, "and at the same time the printer would print out the amount to be paid by the girl."

The Mint Hotel is already experimenting with an "on-line" system for playing keno. It was designed by Ricca Data Systems. Each casino employee (called a "keno writer") who receives the customer's tickets and money has a terminal, consisting of a keyboard, a card reader and a printer. If the customer presents a simple ticket, the writer merely enters it into the reader and presses a func-

This keno machine, manufactured by the Raven Electronics Corp., is an electronic version of the game that is popular in most Nevada casinos. It makes payoffs up to $25,000.



Two timing circuits—a shift register and a counter—determine which fruit symbol should appear on the screen of the Raven electronic slot machine.

What made Sammy run (faster than circuit)

The new computerized keno system being installed at the Mint Hotel ought to be a lot faster than a human. But at its first public showing last May before a group of Nevada government officials, casino executives and members of the press, a prototype of the system clocked in a minute and 15 seconds behind Sammy Chung, head keno writer at the Mint, who had nothing to assist him but a marking brush and a hand stamp.

When newsmen crowded excitedly around Sammy after the race to find out why he had won, he replied matter-of-factly: "I have done this work for five years and am very fast, but the other man and machine have never done it before."

Someone—apparently the public relations department of the Mint—later issued a statement to the press that said: "In a post mortem investigation of the equipment, it was found that hot TV lights and flashes from the photographers' strobes were confusing the sensitive circuitry."

Questioned by ELECTRONIC DESIGN, however Malcolm Niles, the systems analyst from Ricca-Data Systems who had attempted to beat Sammy, took the full blame. "We had a whole bunch of complicated ways tickets to figure," he explained, "and I had never seen one before. Sammy had almost finished before I had even entered all the combinations into the keyboard."

Apparently the machine works faster with Sammy at the terminal.

tion button. The computer then prints out a duplicate of the customer's ticket, together with the number and the price, which the customer keeps until the numbers have been drawn. But if the customer presents a complicated "ways" ticket—that is, one that contains several ways, or sets, of numbers he wants to play, each of which pays a different amount in case of a win—the writer enters each set in the keyboard, pushes the "ways" button and enters the number of sets in the keyboard. The computer determines the price automatically, displays it at the terminal and prints out the customer's receipt.

The supervisor has a special terminal that allows him to enter the winning numbers and signal the computer to print out the winning tickets and the amounts won. The computer can scan and match 500 or more tickets in a few milliseconds.

Mint officials are enthusiastic about the new system. The present way of handling the game calls for human calculation and recording of the customers' bets, duplication of their tickets by hand, and a search through the files of tickets for possible winners. As a result, says Andrew Zorne, keno manager at the Mint, the game tends to be a little slow, "particularly on weekends when the real gamblers come to town; these people love to play the ways tickets, which take the most time of all to compute."

On-line gaming is costly

A completely automated on-line monitoring system for the gaming tables would be prohibitively expensive, says Bennett of the Mint. The dealer at each table must keep track of currency, coins, credit slips and chips. A system that would sort all this and read it into the computer would cost in the neighborhood of $90,000 a table, he says.

Several years ago a very simple off-line system was tried at the Mint. In this system, the dealer was supposed to "ring up" every cashbox entry on a keyboard. This punched a tape, which somebody collected at the end of the shift and fed into a computer. As an accounting procedure, Bennett says, the system was little better than just counting the contents of the cashbox at the end of the shift—particularly since the dealers sometimes forget to enter every transaction when they get very busy.

Since that time, Centronics Data Computer Corp., Flushing, N.Y., the designers of the system, have modified it and installed an on-line version in several casinos in Puerto Rico. In the new system, says Robert Howard, president of Centronics, the cashbox is locked until the dealer causes it to open by entering a transaction into the keyboard. The cash button then lights up—along with a Nixie display of the amount—and both stay lighted until the next transaction is entered.

The system is not designed to prevent dealer cheating, Howard points out, but rather as an accounting system. However, it has tended to discourage cheating, he says.

"If the supervisor walking by sees $100 on the Nixie display and the cash button lit, yet sees a new player sitting there with a thousand dollars' worth of chips in front of him, he knows something is wrong," Howard explains.

Big Brother watches dealers

Some casinos are turning to closed-circuit TV to monitor the actions of dealers in the pit. In most casinos this job is still done by the famous "eye in the sky"—a glass plate in the ceiling above each gaming table. Viewed from the table, the glass looks like a mirror in the ceiling, but from above it is a magnifying glass. An employee of the casino sits up in the "catwalks" above the eye and watches for hanky-panky at the tables below. According to Walter Rabitaille, manager of Howard Hughes' newest casino, the Landmark in Las Vegas, this system has built-in problems.

"Sitting up there is a stool job," he points out. "It's one hired man against the other. If a fellow sits up there for a week or so and doesn't see anything going on, he starts to worry for fear we'll think he isn't doing his job. So maybe he makes up a story about somebody he doesn't like—or maybe he embellishes it a lot. Anybody who tells a story on someone else always has to dress it up a little, just to make himself look good and the other fellow bad."

The TV monitor eliminates the problem of one hired man "stooling" on another, says Rabitaille. With the monitor in his office,

In Reno, they're counting up their money by the pound

Every day in a large casino, the coins, currency and chips that have been collected at the machines and gaming tables are hauled to the vault and counted by three or four trusted employees or by the bosses themselves. At Harrah's Club in Reno, the job of counting the slot-machine coins is being taken over by an electronic "scale" that translates pounds of weight into dollar values.

According to Albert M. Linnen, electronic systems engineer at Harrah's, the system consists of a platform with a strain gauge that puts out an analog signal. The signal is proportional to the weight of the coins on the platform. A tag reader and a translator complete the setup. The system is manufactured by the Toledo Scale Co. of Toledo, Ohio. Linnen describes it this way:

"They pull a bag of money out from under a slot machine and attach an ID ticket to it. This ticket identifies which of the five Harrah's Clubs the bag came from, the denomination of the machine and its identification number. The bag is set on the scale, and the ticket is put into the reader. The translation circuitry receives the analog signal from the transducer, digitizes and stores it. Simultaneously it picks up the information from the card reader and translates the weight to the correct dollar value. The dollar values of all the bags are accumulated and displayed on another card by a keypunch machine that is hooked to the scale."

Rabitaille can personally view the entire sequence of operation at each of 32 tables, either simultaneously or one at a time. He merely "dials" the number of the table he wants to observe, and it appears on the screen, together with the sound if he wants it. A video recorder can keep a permanent record of any activity at any table, and there is a device for putting a picture into slow motion or stopping any moment of action.

Although the surveillance equipment is operated only sporadically, no employee knows when it will be directed at him, says Rabitaille.

He watches the monitor for minor infractions, such as a dealer shuffling the cards in a sloppy fashion. "When I find somebody, I immediately get on the phone and call the pit boss," he says. "He'll walk over to the fellow and say 'Deal the cards like you're supposed to.' Now the dealer knows the pit boss wasn't looking at him, so the message must have come from upstairs. He goes to the dealers' room after the shift and says, 'Well, I guess somebody is really looking at us. I wasn't doing a thing but just shuffling the cards and he came along and told me to shuffle them the other way.' That's how the news gets around."

Leaders among casino executives agree that sophisticated data processing techniques will help take the guesswork out of gambling. Determining the optimum types and arrangement of games on the casino floor is largely done by humans now, says Bennett of the Mint, but before long it will be computerized.

Rabitaille says data-processing techniques are being used at the Landmark Hotel to keep track of table percentages. A sudden drop in the percentage of a table may reveal use of a "system" that would be difficult to observe directly, he points out.

"I've got a certain percentage to keep up on all my games," he explains. "If one particular game keeps running below all the time and I've checked out all the possible leaks without being able to find the reason, then I've got to start looking at people. Some customer may have figured out a way to count—to keep track of the cards that have gone by."

Human memory still useful

This requires a good memory, Rabitaille points out, since the cards are dealt from a "shoe" containing four decks, or 208 cards. But there are a number of people in Las Vegas who are able to do this.

"I know a man," says Rabitaille, "who will put up $50,000 on what you call a freeze-out. He won't win any more than $50,000, and he won't lose any more than that. All he wants is for you to promise not to break up the deck (keep shuffling the cards so he can't memorize them). He'll guarantee to engage in conversation with anybody you want to put beside him and to drink so much whiskey per hour if you'll just let him play. And if you take that proposition, he'll beat you out of your money."

Asked what he did about a customer he suspected of counting, Rabitaille replied, "you just let him work and work, and when you see he has the deck where he wants it and he makes a bet, you break the deck down."

From physicist to gambler

One of Las Vegas' most famous counters is Jess Markham, once a physicist with the Rand Corp. He did so well as a weekend gambler that he transferred over to the gambling world full-time and now manages the Bonanza Hotel in Las Vegas. Markham's approach to the problem of customers who count is quite different from Rabitaille's. He doesn't catch counters by watching table percentages. He catches counters by watching counters.

"I don't care whether a man is winning or losing," he says. "If I see he knows what he's doing, I just tell him to take his business somewhere else."

Markham insists that counting is a relatively simple "trick" that almost anyone can learn; it doesn't require a phenomenal memory at all. "What it takes is moxie," he insists, "the heart or courage to keep playing and betting even during the long unlucky streaks. And hardly anyone has this."

But even moxie may not be enough as electronics takes over more and more of the duties in legalized gambling. ■■

Fluidics: Why not try it, specialists suggest

Speakers and equipment at Cleveland exposition point to a growing potential for air-powered logic

Don Mennie
Circuits Editor

Should you use a fluidic control system on your next project? The fluidics industry is convinced air-powered logic has come of age, and it was out to demonstrate capabilities and applications at the recent Fluidic Exposition in Cleveland.

Industry spokesmen agreed that the most promising use of fluidics at present lies in control of large industrial machinery. But they are also convinced fluidics can be useful in other areas.

Leonard Gau of the Chrysler Corp. Research Div., for example, suggested that automobile exhaust control systems be adapted to fluidic technology. Gau's emission-control design makes use of the high hydrocarbon concentration occurring at the beginning and end of the internal combustion engine exhaust pulse. These hydrocarbons are separated from the exhaust stream and fed to an afterburner. By so reducing the volume of exhaust processed, afterburning techniques would be simplified, according to Gau.

Another conference speaker, Dr. William Westerman, senior group engineer with McDonnell Douglas Astronautics Co., Titusville, Fla., indicated that experimental fluidic controls were being developed for aerospace vehicles. He pointed out that missile logic built in this fashion was not subject to radiation or electromagnetic jamming.

Dr. Westerman said about 35 Government agencies had let contracts for fluidic developments so far. He identified the Air Force as the big spender, with missile and jet-engine control contracts accounting for 40% of the $20-million Government outlay for fluidics research.

Typical application cited

Describing the problems of adapting automobile turn signal test fixtures to fluidic control, Bruce Hoppe of General Motors Corp., Oldsmobile Div., said the final results were so encouraging that Oldsmobile was looking for further fluidic applications. Hoppe said problems with limit switches and jammed relays, even though infrequent, had caused a serious loss in test time with the original electrical setup.

Conversion to fluidics was not an effortless task but once the new setup was understood and debugged, superiority over the electrical test fixture was clearly evident. Speaking with firsthand knowledge, Hoppe remarked that most user problems are due to errors in application, not fluidic device shortcomings.

Interface design important

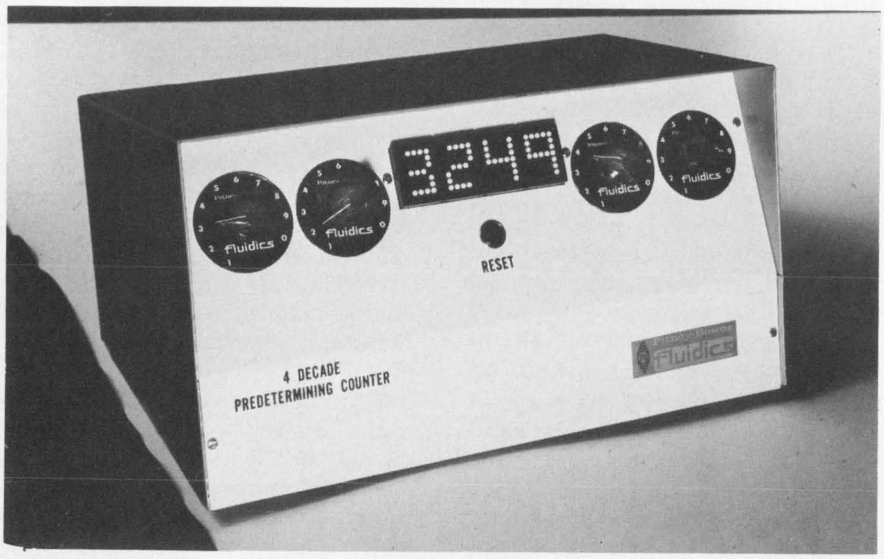
Workshop sessions at the conference emphasized input and output fluidic system interface designs. One such session featured a four-decade counter from Pitney-Bowes, Glenbrook, Conn. The readout was not electronic; it operated directly from fluidic logic air-pressure signals. Spring-mounted cylindrical pistons, arranged in a 5-by-7 matrix, formed the numerals.

A fluidic input interface design—selector valves—was shown by Norgren Fluidics, Littleton, Colo. John Johnson, applications engineer at Norgren, described these valves as usable in fluidic and pneumatic control systems wherever multiposition function selection is required. He also demonstrated a fluidic visual indicator, an equivalent to a pilot light. This device consisted of an encapsulated rotating colored sphere that provided a visual go-no-go readout.

Ample choice available

Engineers using fluidics have a variety of design approaches to consider. Once a decision to buy has been made, however, fluidics users are wise to obtain all their hardware from one manufacturer, according to James Morgan of the National Fluid Power Association. Compatibility between competing fluidic products was said to be low.

Bowles Engineering Corp., Silver Spring, Md., and Corning



Fluidic 4-decade readout operates from air pressure. Logic pressure signals provide direct counter input without electrical or mechanical interfacing.

(**fluidics,** *continued*)

Glass Works, Corning, N. Y., both supply systems and components that depend on wall-attachment phenomena. The principle of operation is illustrated in Fig. 1a. Roland Jones, engineering manager for industrial applications at Bowles Engineering, explained the operation as follows:

A low-pressure area (curved arrows) attaches the input supply pressure jet to an adjacent wall. The result is a positive pressure signal at output Q_2. Careful design insures that this same attachment will always occur when no control pressure is present at C_1 or C_2. Switching the airflow to output Q_1 is accomplished by a control pressure inserted at C_2. Once switched, the airflow to Q_1 will be maintained even when control pressure C_2 is removed. The flow to Q_1 will continue until a second control pressure is inserted at C_1. This bistable element is the basis of wall attachment logic.

Corning Glass and Bowles Engineering representatives reported that fluidic systems built on the wall-attachment principle had long life and little need for maintenance. This was attributed to the logic operation, which is accomplished by airflow phenomena without the use of moving parts. Air-supply contamination was said to be detrimental to wall-attachment fluidics, but this was not considered a serious problem, since proper air filtering and periodic system flushing would remove any contamination buildup.

Moving impact plane

The Johnson Service Co. of Milwaukee uses two opposing streams of air to power its NOR logic element, an impact modulator (Fig. 1b). As explained by John Enright, manager of fluidic sales at Johnson, the opposing air jets form an impact plane. If one of the jets is weakened relative to the other, the impact plane moves toward the weaker jet.

In Johnson's monostable device, one supply jet is weakened by sideways attack from one of several transverse jets, so that the impact plane will move from chamber A (in Fig. 1b) to chamber B. Positive pressure at the output port results with the impact plane in chamber A. When the impact plane moves to chamber B, slightly negative pressure (below atmospheric) occurs at the output port.

Johnson claims fanout for the impact modulator (pressure and flow available to drive succeeding stages) was three to four times that of other fluidic devices. They also reported their device could adapt to a wide range of input supply pressures without precision regulation.

An illustration of the fluidic circuit construction using the Johnson Service Co.'s impact modulator is shown in the top photo on page 36. Individual impact modulators are plugged into the circuit board at the top of the picture.

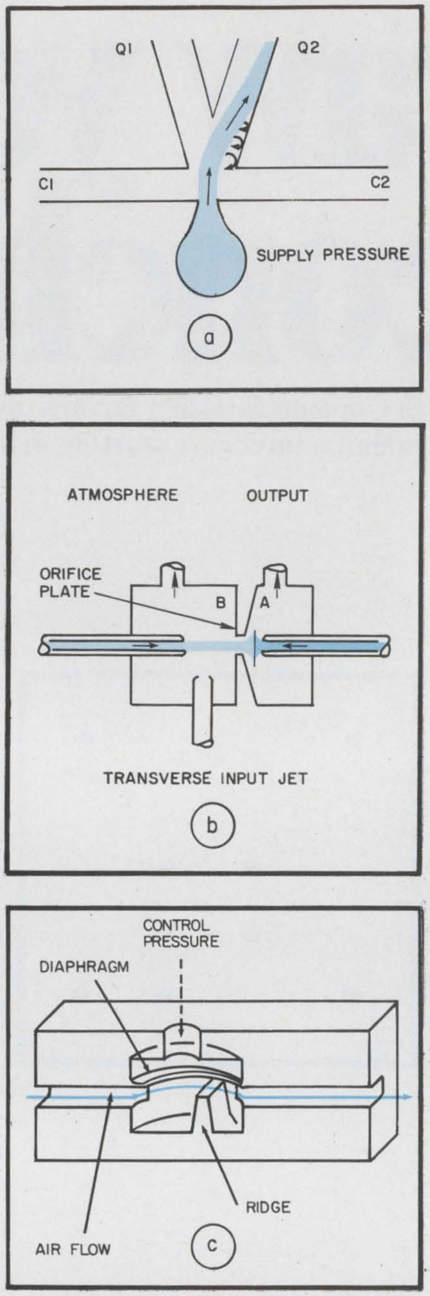
Diaphragm logic explained

Yet another approach to fluidic control design is the flexible diaphragm-valve unit developed by Double A Products Co., Manchester, Mich. Operation of this device is illustrated in Fig. 1c, which details a single control ridge and diaphragm. John Eppich, fluidics department manager at Double A, outlined the operating principle.

With no pressure applied to the top of the chamber, air flows unimpeded over the ridge (as shown in Fig. 1c). When sufficient pressure is applied to the upper side (dotted arrow), the diaphragm snaps down against the ridge, blocking airflow through the chamber. The chamber design is such that the diaphragm will not open again until the applied pressure falls well below the level needed to force the diaphragm down (closed).

Eppich further explained that Double A combined these control-ridge elements to form a single logic component containing eight identical NOR gates. Fluidic circuits are then built with several interconnected components.

The advantages claimed for Double A's fluidic logic include low cost, reliability, easy maintenance and insensitivity to contaminated air supplies. A clear plastic case allows each control ridge and diaphragm to be visible for quick trouble-shooting.



1. **Three approaches to fluidic logic** are shown above. The wall-attachment principle (a), the impact modulator (b) and the diaphragm-valve design (c).

Manual control of fluidic systems is provided by these selector valves.

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TEXAS INSTRUMENTS
INCORPORATED

(**fluidics,** *continued*)

Aro Corp., Bryan, Ohio, has developed a system of pneumatic logic controls. These devices, unlike other types of fluidic logic contain a small moving piston. Three types of logic elements are available from Aro: AND, OR and NOT. Compatible control valves, delay timers, read-out devices, enclosures and circuit boards allow users to design whatever system they require.

A significant advantage over other fluidic devices is claimed for the ability of pneumatic logic to work from a high-pressure air supply. This feature allows the logic control output to drive machinery directly without the need for pressure transducers. Aro engineers explain that the moving piston arrangement is no drawback to pneumatic logic reliability.

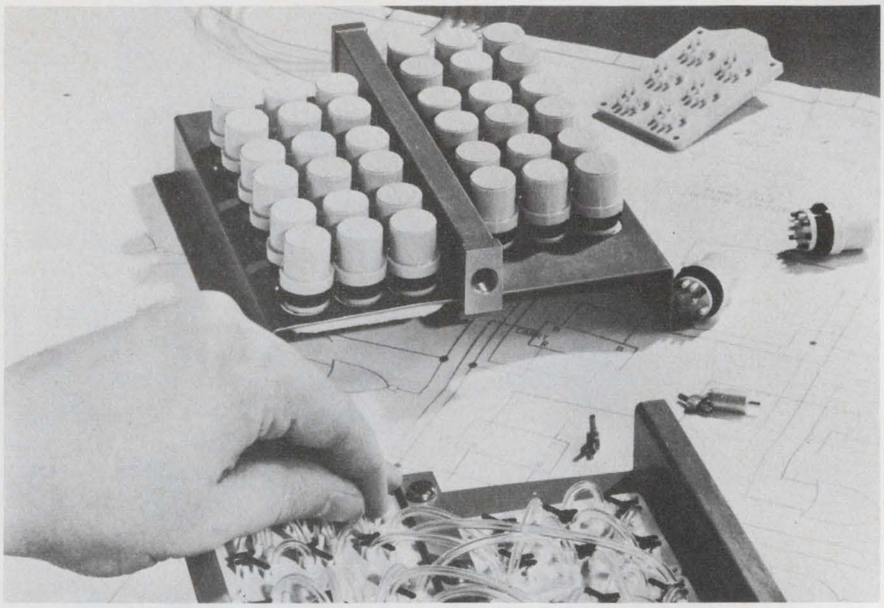
Fluidics at 50 kHz

A fluidic ear, the equivalent of an electric eye, was shown by Pitney-Bowes. Ernest DiPasquantonio, manager of engineering, explained its operation and applications (Fig. 2).

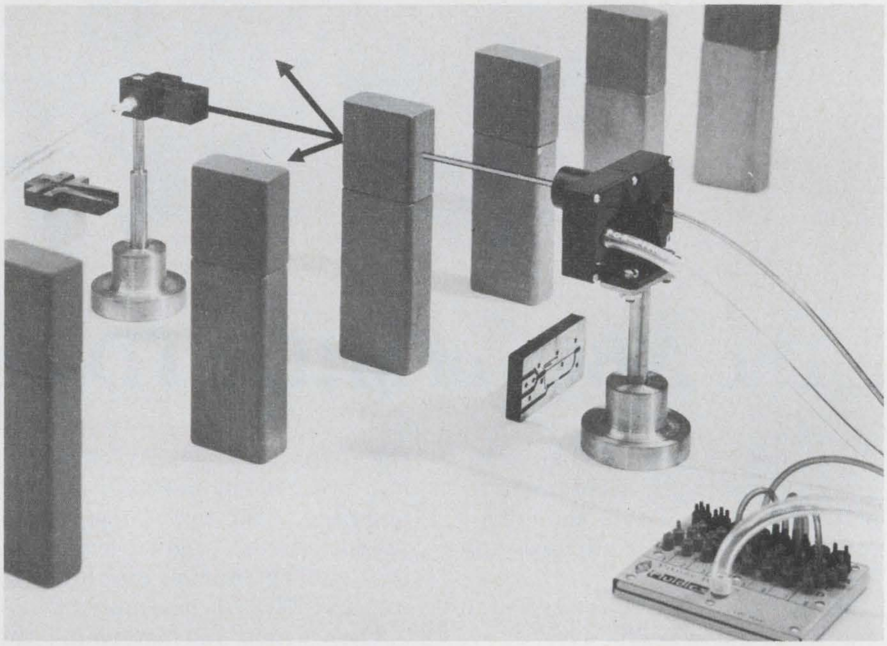
The transmitting element in the upper left of the figure is a 50-kHz, air-powered whistle. This device provides a continuous sound source.

Opposite the transmitting element is the receiver. Under steady state conditions, a continuous laminar airstream flows through the transmitter. This results in an even, positive pressure at the receiver output. The laminar flow, however, is tuned so that it becomes turbulent when disturbed with 50-kHz sound waves. Turbulent flow within the receiving element causes the internal air pressure to be vented before reaching the output port. A low, near-atmospheric output pressure is the result.

Figure 2 shows the fluidic ear counting a passing line of wooden blocks, analogous to many production-line situations. Pitney-Bowes says its design is usable without modification at spacings up to 5 feet. With focusing attachments, the range can be increased to 30 feet. The transmitting and receiving elements are reported to be insensitive to air currents and wind blasts.



NOR impact modulator elements assembled to form a fluidic control circuit. Plastic tubing connects the logic elements.



2. **The fluidic ear,** with a cutaway view of the transmitting and receiving elements. The receiver is reported to operate anywhere within five feet of the 50-kHz source.

Successes reported

Western Electric's Ben Meyers, an engineer with the company's Oklahoma City Works, told ELECTRONIC DESIGN that he had had success with several fluidic applications. One such control system operates a machine that winds cores for telephone relays. Another mixes hydrogen with mercury to create a sealed mercury switch. Still another automatically controls a riveting gun as it positions rivets on a circuit board. Meyers says the Oklahoma City plant has been working with fluidic devices since 1965, and many activities in this area are still experimental.

Industry spokesmen believe fluidic development is now at about the same stage that transistors were during the mid-1950s. Applications seem unlimited in the area of machinery control systems. Fluidics can also take on more unusual tasks, such as on-board missile logic, specialists say. ■■

A 50% rise asked in satellite circuits

A 50 per cent increase in the number of satellite communication circuits will be needed in 1970, says the American Telephone and Telegraph Co.

There are now 775 satellite circuits linking 42 countries and areas around the world. AT&T has asked the Federal Communications Commission to authorize 1148 circuits this year to meet growing demands for worldwide telephone service. This includes those countries initiating satellite communications service this year.

A breakdown of the present circuit use and projected needs for 1970, as given by AT&T, follows:

- Hawaii has 108 circuits; projected need is 225.
- Pacific area countries have 99 circuits; projected need is 194.
- Central and South America and West Caribbean have 122; projected need is 196.
- Europe, the Mideast and Africa have 446 circuits; projected need is 533.

Ocean cable expanded

AT&T is already adding a 720-circuit trans-Atlantic cable to its overseas network. The new circuits, part of the $99-million cable and radio relay system linking the United States with Spain, Portugal and Italy, are scheduled for service in March.

Thirty-two earth stations for the satellite network, including four in the continental U.S., are now in operation in 25 nations. Fifty stations are needed by the end of 1970, AT&T says.

Last year about 20 million phone calls were completed between the U.S. and overseas points. This is a 25 per cent increase over 1968.

In addition to the present 775 satellite circuits, AT&T is now using 1054 cable, 179 high frequency radio and 151 over-the-horizon radio circuits for overseas telephone service.

AT&T, which pioneered in space communications with Telstar in the early 1960s, has been a strong advocate of developing both satellite and ocean cable technology to insure diversification of communications. ■■

Washington Report

CHARLES D. LA FOND, WASHINGTON BUREAU

F-15 fighter competition questioned

Air Force officials may be called before the House Armed Services Committee to explain their direction of the hotly contested F-15 advanced fighter program, Congressional informants say. They also predict very close scrutiny of Air Force supervision over the newly selected prime contractor, McDonnell Douglas. Concern is over cost control in the $7-to-$8-billion program. The initial cost-plus contract is for $80-million; $1.15-billion is projected for 20 flight test aircraft.

Two members of the House committee, Chairman L. Mendel Rivers (D-S.C.) and Rep. Otis Pike (D-N.Y.) question Air Force handling of the competition. According to Rep. Pike, the law governing such procurements dictates that competitors be told "precisely what weightings should be given to each element in the competition" and that "these weightings shall not be changed during the competition." But, says Pike, the Air Force has taken the position that this law, passed in 1926, is obsolete and thus it need not obey it. "Ignoring this law—and it is being ignored," the Congressman asserts, "allows the Air Force to come up with any winner in any competition that political expediency demands." Rep. Rivers has asked General Accounting Office to review contract procedures.

A new Executive office to coordinate communications?

Watch for establishment by the Nixon Administration of a new Office of Telecommunications Policy. The details for such an office are contained in a White House memorandum that was circulated to the Executive staff by Peter Flanigan, a Special Assistant to the President. The memorandum was obtained by Rep. Joseph E. Karth (D-Minn.) and made public by him recently.

The President reportedly is annoyed at the premature release of the memorandum, but ultimate approval of the new office is expected on Capitol Hill. Industry informants here aren't sure at this time just how such an office would affect the powers of the Federal Communications Commission. But one thing appears certain: If such a move is carried out, it will short-circuit a recommendation of Commerce Secretary Maurice Stans to centralize all communications policy control within his department. Establishment of the Executive office was recommended, however, in the IEEE/EIA Joint Technical Advisory Committee report "Spectrum Engineering—the Key to Progress," released in July, 1968.

RCA wins the biggest award in a decade

The selection of RCA by the Navy to direct the Advanced Surface Missile System, now called Aegis, provides the largest contract the company has won in the last 10 years—and it appears that the bulk of the R&D effort will stay within the firm, an RCA spokesman says. At its Moorestown, N.J., facility, RCA will be responsible not only for program management and integration of all shipboard systems of the new surface-to-air missile effort, but it will also develop the key hemispheric-coverage, phased-array radar. The R&D project will be performed under a $252.9-million contract; the follow-on production could total out to $1-billion.

RCA will be responsible for all shipboard elements of the system except the missile and launcher. General Dynamics-Pomona will produce the Standard Navy Missile for the system and a dual-purpose launcher capable of firing the missile and antisubmarine rockets, all under separate contract. RCA has three principal subcontractors with which it is still negotiating: Raytheon will build the target radar illuminator, the weapons control system and probably the high-power radar transmitter; Computer Sciences Corp. will develop the necessary fire control and guidance computer software; and Gibbs & Cox, Inc., marine architects, will provide system configuration and structural design services.

As presently conceived, the RCA electronic scanning radar will be used for target detection, acquisition and tracking and feed directional data through the fire control system to the Raytheon target illuminator. The missile itself, employing a passive radar homing device, will zero in on the echoes reflected from the target. The system is intended to counter the threat of low-level supersonic attack aircraft and missiles of the Soviet Styx-type. It will be employed operationally during the mid-70s aboard the new DXG/DXGN conventional and nuclear-guided missile frigates.

The CAT mystery a long way from solution

A top official in the new Federal clear air turbulence (CAT) research program is pessimistic of early success for reliable detection and prediction of the phenomenon. CAT buffets airliners and other aircraft without warning, sometimes severely enough to damage the craft. A long recognized but not understood hazard, it is now the subject of a five-year study called the "Federal Plan for Clear Air Turbulence." The broad attack to extend fundamental knowledge of CAT is being waged by NASA and the Departments of Defense and Transportation. Over-all coordination is being conducted by the Environmental Science Services Administration (ESSA).

Total fiscal 1970 funding for the study is only about $4-million, according to Clayton Jensen, chief of ESSA's Federal Plans and Coordination Div. "The trouble with the whole research funding is that scientists view the chance of achieving success—to detect and predict CAT—as being very low," he says, "and no one likes to fund a program whose chance of success is so low."

Lean industry seeks space-shuttle program

Both a manned space-station program and a recoverable space-shuttle program are necessary to bolster a steadily weakening U. S. aerospace industry, say a majority of manufacturing representatives in Washington. And they expect President Nixon to announce approval soon to proceed with both efforts as goals during the 1970s. This would assure sufficient total expenditures (at least $10-billion) to hold the industry together, say the reps. While most of those polled by ELECTRONIC DESIGN had been confident for some time of a continuation, in some form, of manned orbital stations, they were less optimistic over Administration approval of the shuttle vehicle.

The President's anticipated disclosure of a plan to continue with a balanced manned and unmanned space program will come on the heels of a pessimistic annual market summary prepared by the Aerospace Industry Association. In its report, AIA showed a sales decline in 1969 of 4.1%, for a total of $28.3-billion. Further, AIA predict a sales drop in 1970 of over 2%. The association attributes losses to reductions in military, NASA and commercial aircraft procurements.

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

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

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

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

"Our experience with core dump has been quite impressive. Here is an area where the printer's diagnostic ability really comes to play. Our computer stores some four million binary bits of information, and core dumping used to take around twenty minutes. With the Clevite Printer, we're now completing a core dump in just two minutes," Mr. Curry concludes.

MORE FACTS ON THE CLEVITE 4800

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

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

No other printer gets as much out of your computer as fast as Clevite 4800. And no other printer is so economical. The Clevite 4800 reduces capital investment, because conventional equipment costs more per unit. Also, there are few moving parts, reducing the need for constant maintenance and servicing.

Clevite 4800. It's faster, more versatile, quieter, and more dependable than anything else you can buy.

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

GOULD CLEVITE

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

Our gal Nell goes to Las Vegas

Our West Coast Editor Elizabeth deAtley learned, while gathering material for a story on electronics in gambling (p. 24), that a game in one Las Vegas casino draws no house percentage. Proceeds, if any, go to charity.

Called Stakes and Odds, the game is part of a research project conducted by University of Michigan Prof. Ward Edwards. It uses a roulette wheel, a computer, and a CRT display. When the gambler presses a button, his choice is recorded on tape and sent to the university for analysis. The aim is to study the decisions people make under conditions of risk.

So far the game is in the red—not lively enough, says Johnny Ponticello who runs it. It is financed by a private foundation. The casino contributes its space and employees' time.

All in a day's work for West Coast Editor Elizabeth deAtley.

Growing role of floating airfields

With overseas land bases shrinking, the Navy is modernizing its aircraft carrier force. Military-Aerospace Editor John F. Mason was flown to the carrier Roosevelt in the Atlantic. Here Capt. H. S. Sellers (right) briefs him on facts that will appear in the report on p. 58.


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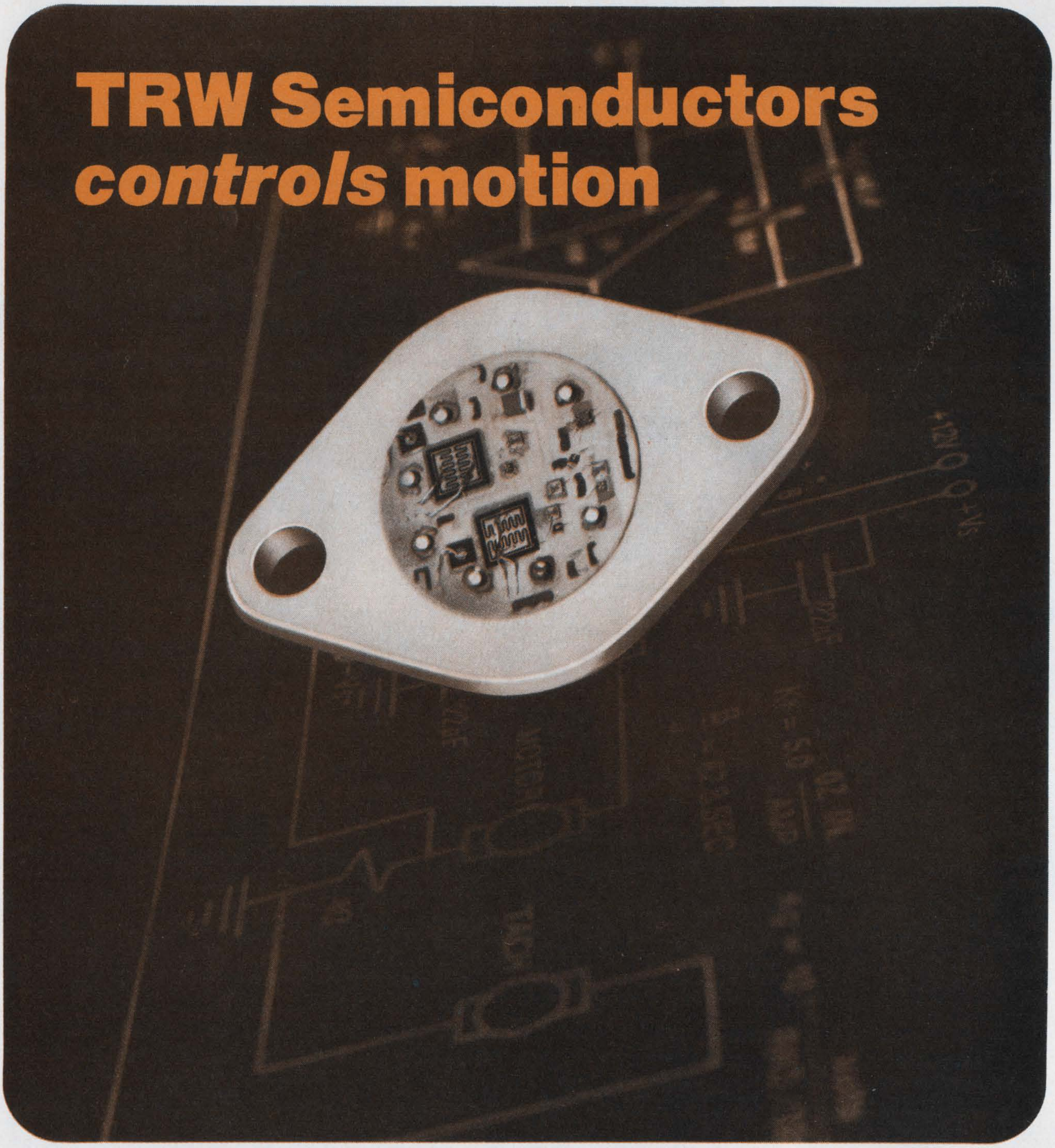


200 Watts Output...90% Efficiency...0.1% Linearity

TRW announces a hybrid switching mode amplifier that delivers 200 watts output power from an 8-pin TO-3 package. It represents an 8:1 size reduction over equivalent discrete component class B amplifiers.

Intended primarily for use in motor drive applications, these amplifiers provide a highly linear current drive control system even when operated from an unregulated power supply. They utilize high speed switching techniques (10 amps output current in 500 ns) to implement the pulse width modulation operation.

For further information, including theory of operation and applications assistance, contact TRW Semiconductors Division, 14520 Aviation Blvd., Lawndale, Calif. 90260. Phone: (213) 679-4561. TWX: 910-325-6206.

TRW®

INFORMATION RETRIEVAL NUMBER 32

EDITORIAL

Be your own boss this year—you and your job will benefit

We keep hearing in various ways that the working engineer is an economic slave. Bosses should "motivate" their workers, some say—that is, induce them to work longer hours for less pay and like it. Engineers should organize, say others, and force their bosses to pay more money for shorter hours. Always the spotlight is on the boss. He holds the strings, and the worker puppets either dance or try to make him dance.

But is the boss really that important? Who signed your time card last year? He or someone else in the same chair? In this kaleidoscopic world of electronics, everything is transient—particularly bosses. The only thing you have to count on is yourself.

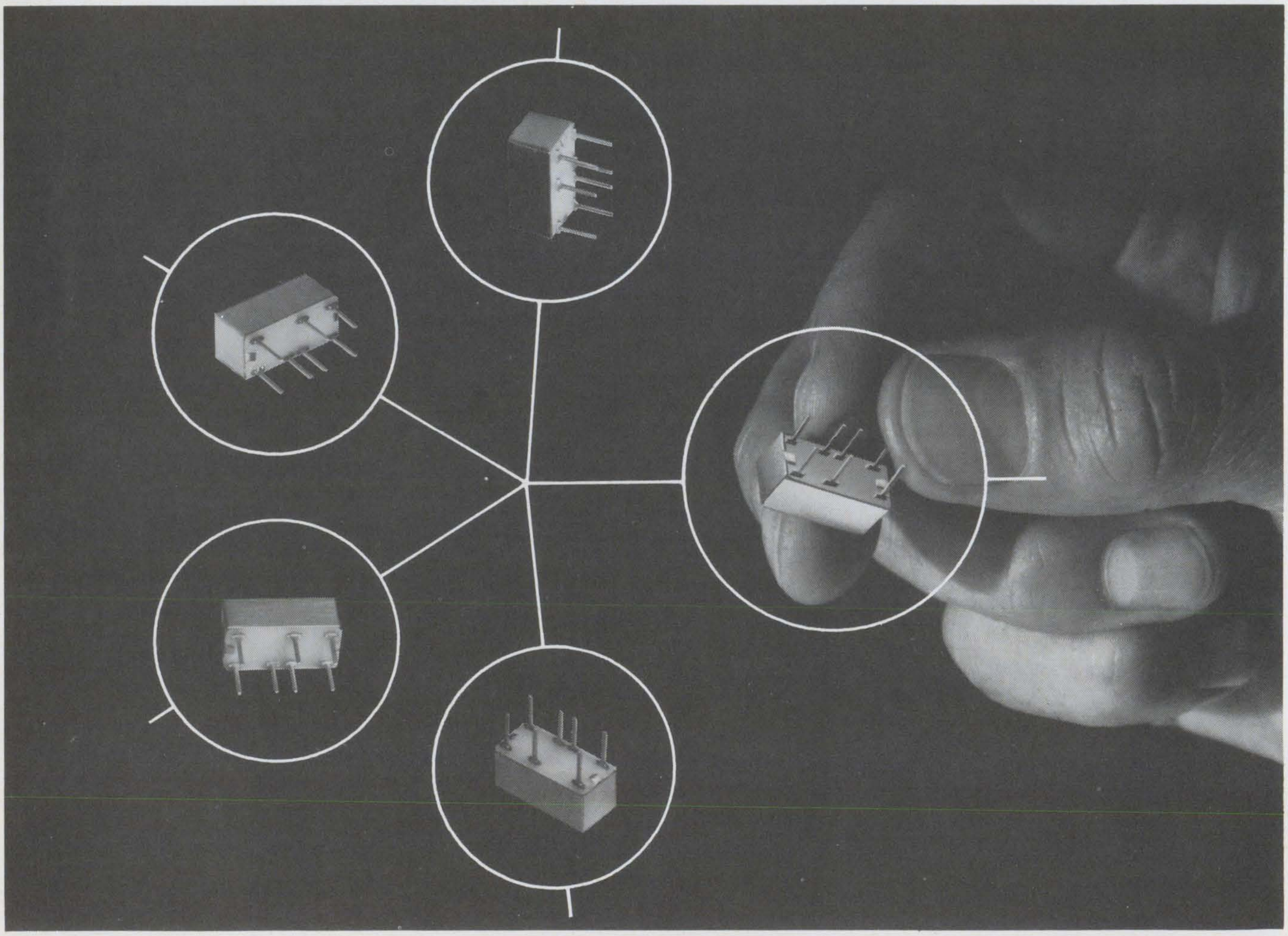
What do you want out of your job? A safe haven that pays enough to keep your family in relative comfort without straining you too much? If so, your work will seem hard and your hours long. You will always be trying to make yourself take dull courses to fight the feeling that you are a back number. And you will be afraid. You will fear the layoffs, the younger fellows and, of course, the boss.

But suppose you choose to live dangerously, to go after the high stakes—the opportunity to create something, to lead others, to make money? Then you will be less aware of your fear and more aware of life around you. From your vantage point in the driver's seat, you can look at the world, see what it needs and decide how you can fill that need.

Put yourself in the limelight. Don't wait for your boss to discover your talents and tell you how to use them. Act as if you had all the talents you need. Give a paper before a company seminar or write an article. Work out a new application for one of your company's products. Discuss it with your boss or work it out on your own time, if necessary. And when the criticism comes—as it surely will—evaluate it and learn from it, for negative feedback is as vital to people as to machines. But don't stop trying!

And if, in the end, the job is too small, change it. You're the boss.

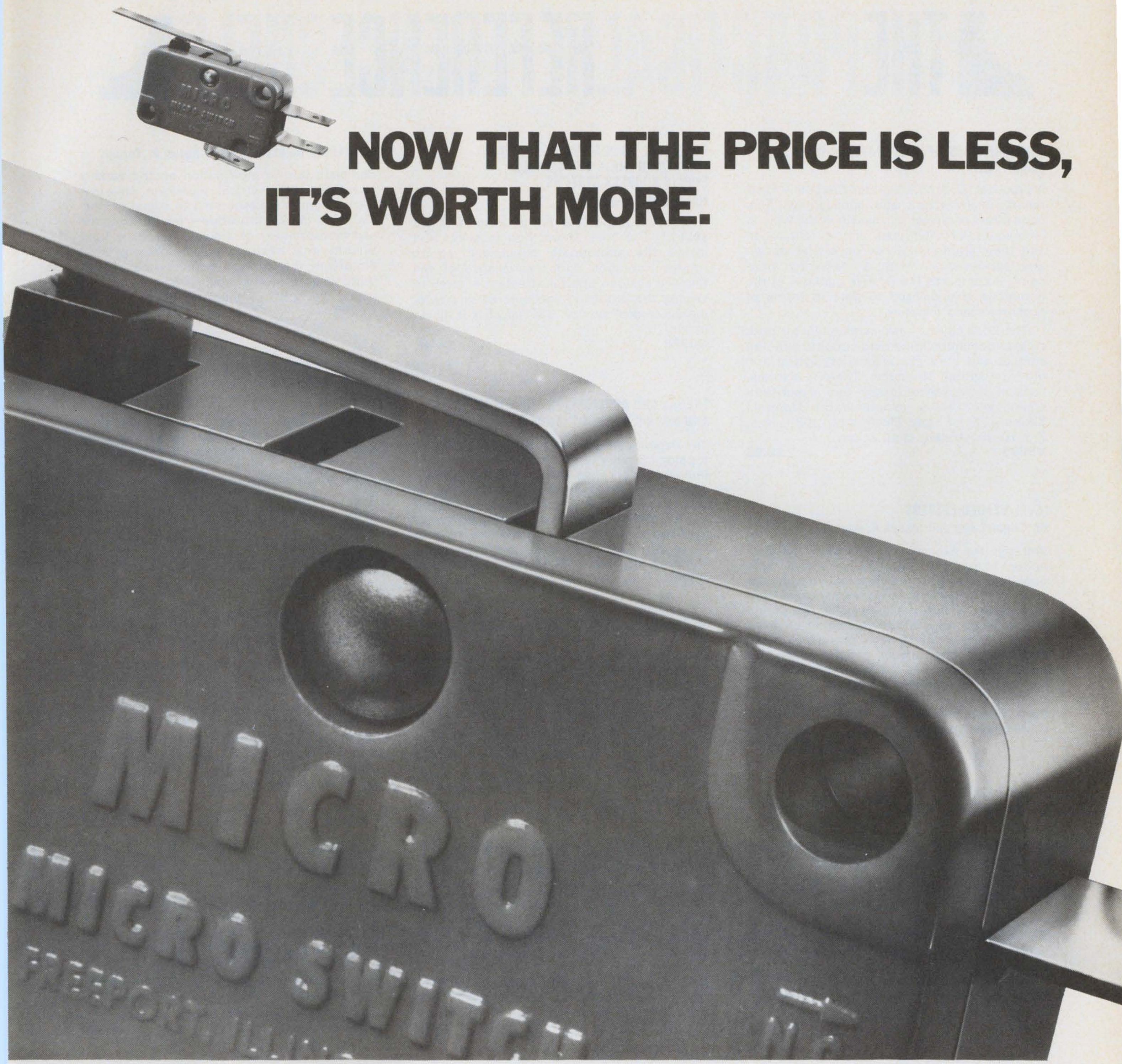
ELIZABETH DEATLEY



INFORMATION RETRIEVAL NUMBER 33

INFORMATION RETRIEVAL NUMBER 34 ►

NOW THAT THE PRICE IS LESS, IT'S WORTH MORE.



Our V3 Miniature Switches have always provided superior quality—at a little higher cost to you. So even though they won out on performance, they sometimes lost out on price.

Now we've come up with new ways to lower our prices. Without lowering quality. The result: a more favorable quality-to-price ratio. A better value all around.

Our new lower list prices and revised discounts will mean new cost savings in present and future applications. And perhaps new opportunities for us to serve you.

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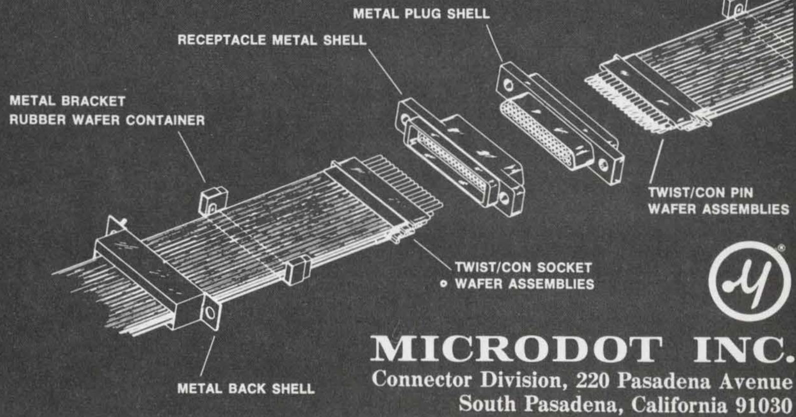
We're the only ones with .050 centers in our flat conductor cable connectors. We're the only ones with a metal shell to protect that fragile connector. And the only one whose connector will mate with any existing version. (No matter what type of wire is used.) Interchangeable. Intermountable. You can use them with any of your retrofit projects. And should repair be necessary, modular construction makes them easily repairable in the field. They can even be potted for environmental sealing. It's the newest idea yet in flat cable connectors. One more thing. We're trying to come up with a name for this connector. Something better than Flat Conductor Cable Connector. If you can think of a name we can use, it's worth a case of booze. And even if you don't win the booze, we'll be happy to send a genuine certificate recognizing your idea.



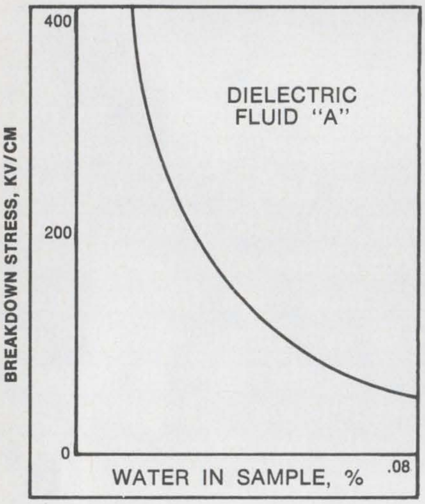
MICRODOT INC.
Connector Division, 220 Pasadena Avenue
South Pasadena, California 91030

Dielectric Fluid Problems

Seaton-Wilson solves fluid contamination problems you haven't been able to detect yet

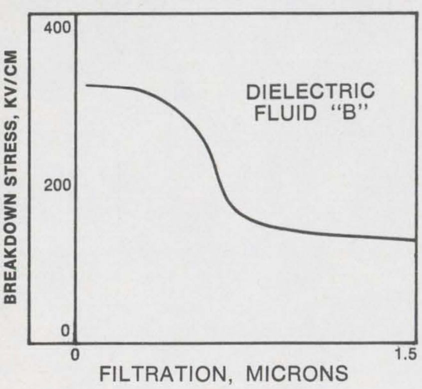
If you are involved with high voltages in tight packages, the dielectric fluid you use probably isn't performing the job you thought it was.

The above statement is not an attempt to degrade the excellent quality of the most widely used dielectric fluids, which are listed here. The graphs on this page are to illustrate the alarming rate of voltage breakdown when dielectric fluids become contaminated



with water, dirt and — last but not least — dissolved air, the unseen contaminant which is the most difficult to detect.

The sharp downward curve in the first graph charts the loss of dielectric strength when Fluid "A" is contaminated with water. The independent test results on Fluid "B" similarly illustrate the debilitating effects of dirt as a contaminant.

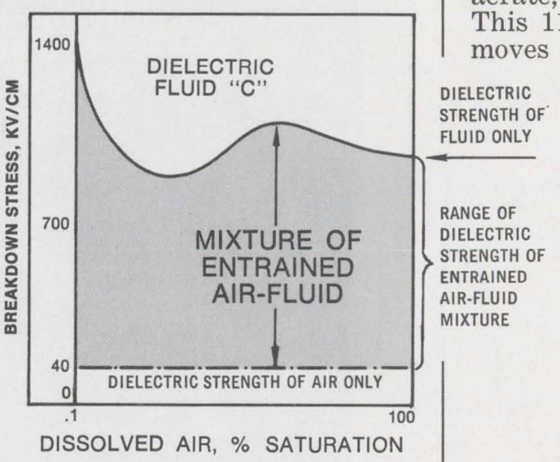


But it is in the little explored area of dissolved air that the trickiest problems arise. This contaminant is invisible and weightless. The below listing on this page spells out the dissolved air content of popular dielectric fluids as they are delivered to you.

SATURATED AIR VALUES

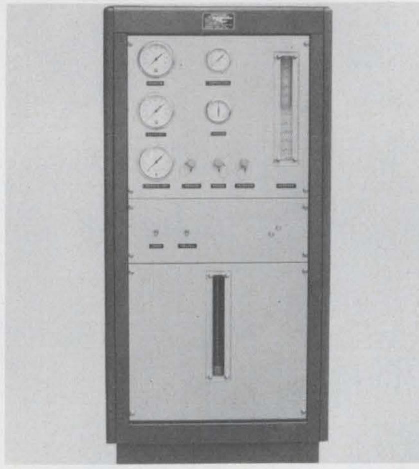
UNIVOLT 33	10%
UNIVOLT N34	10%
DIALA OIL-AX	10%
WEMCO C	10%
WEMCO CI	10%
STANDARD IOCA	10%
G.E.-10C	10%
THERMINOL FR-1	5%
THERMINOL FR-2	5%
CASTOR OIL	4%
COOLANOL 25	14%
COOLANOL 35	14%
FREON TF	40%
SILICONE DC200	20%

The graph on Fluid "C" translates these percentages into a curve which may be compared for effectiveness with the lower curve in the same graph showing the dielectric strength of air only. It is the large murky area in between where the potential danger lies, through fluctuating percentages of entrained and dissolved



air content. Present quality control methods make it virtually impossible to determine if the fluid has really been bled of air.

Obviously, the threshold at which water, dirt and dissolved air will contaminate dielectric fluids to the point of permitting arcing depends on how tight a package you work with, your filling methods and present decontamination system, if any. It is readily apparent that total conditioning of dielectric fluids is necessary if optimum performance is to be obtained.



The demand for a single conditioning console which will solve all these problems has been mounting steadily. The answer has been provided by Seaton-Wilson's exclusive SAC-1002 Fluid Conditioner Console, designed to filter, dehumidify, deaerate, store and transfer fluid. This 11-gallon capacity unit removes solid contaminants and water using a 5 micron, depth filter incorporating a molecular sieve. It deaerates most fluids to 2% dissolved air content by volume. Finally, the SAC-1002 provides a controlled vacuum for filling a closed system with *totally conditioned fluid*. Write for full capabilities data and complete specifications today.

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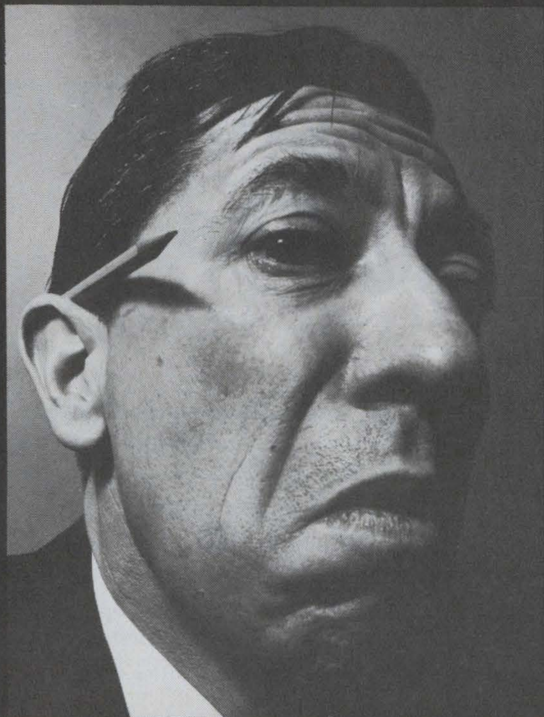
INFORMATION RETRIEVAL NUMBER 47

Here's a new way to make your own active filters.



You do it with a pencil.

My Active Filter application requires:

- ☐ Band pass filter with ________ center frequency and ________ band width.
- ☐ Low or high pass filter with ________ cut-off frequency and a Q of ________.
- ☐ More details. Please send me your new brochure.

Name ________

Title ________ Company ________

Street ________

City ________ State ________ Zip ________

Just fill this out. And mail it in.

We'll produce any number of quality active filters precisely to your parameters. And, we'll get them to you within 72 hours.

Our new Active Filter Group specializes in nothing but active filters. So, they'll be smaller, and probably better than the ones you've been making. No offense.

And, they'll be completely complete. No resistors or capacitors to add. No trimming required.

The clincher is, they're likely to cost you less money than your home-made jobs.

So, go ahead. Try this new way of making your own active filters. With a pencil. When they arrive, you'll have just one thing left to do. Plug them in.

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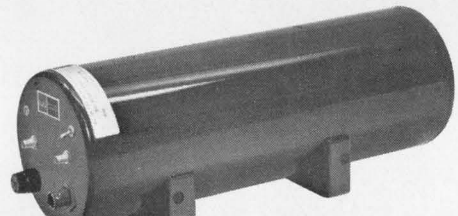
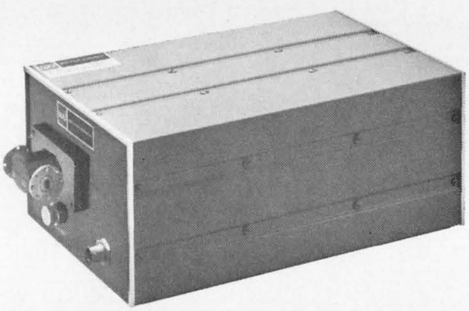
INFORMATION RETRIEVAL NUMBER 48

Makes the DIFFERENCE in MILLIMETER LNTWAs





The difference is guaranteed performance. W-J's millimeter low-noise traveling-wave amplifiers provide the kind of performance usually found only in P-through X-band units. That means you have the advantages of low noise figure, high gain and high power output, plus the built-in reliability of integral power supply operation, at frequencies from 12 to 60 GHz.

Examples of these amplifiers are shown below. Variations in frequency, noise, gain and power are available for special applications.

Type	Frequency Range	Maximum Guaranteed Noise Figure	Minimum Guaranteed Small Signal Gain	Minimum Guaranteed Power Output	Size	Weight
WJ-371	12 - 18 GHz	9 dB	25 dB	+12 dBm	a	a
WJ-425	12 - 18 GHz	10 dB	25 dB	+10 dBm	b	b
WJ-3006	12 - 18 GHz	13 dB	30 dB	+20 dBm	a	a
WJ-393–6	18 - 26.5 GHz	11 dB	25 dB	0 dBm	a	a
WJ-393–8	18.5 - 20 GHz	9 dB	25 dB	0 dBm	a	a
*WJ-3000	18 - 40 GHz	14 dB	25 dB	+ 5 dBm	c	c
WJ-338	26.5 - 40 GHz	14 dB	25 dB	+ 3 dBm	c	c
WJ-338–5	34 - 36 GHz	13 dB	25 dB	+ 3 dBm	c	c
*WJ-449–1	40 - 50 GHz	17 dB	20 dB	+ 5 dBm	c	c
*WJ-449–2	40 - 60 GHz	19 dB	20 dB	+ 3 dBm	c	c

* Presently under development

a. 4.75 x 4.75 x 12 Inches 18 Pounds
b. 3 x 3 x 10.5 Inches 7 Pounds
c. 5.1 x 7.5 x 12.2 Inches 27 Pounds

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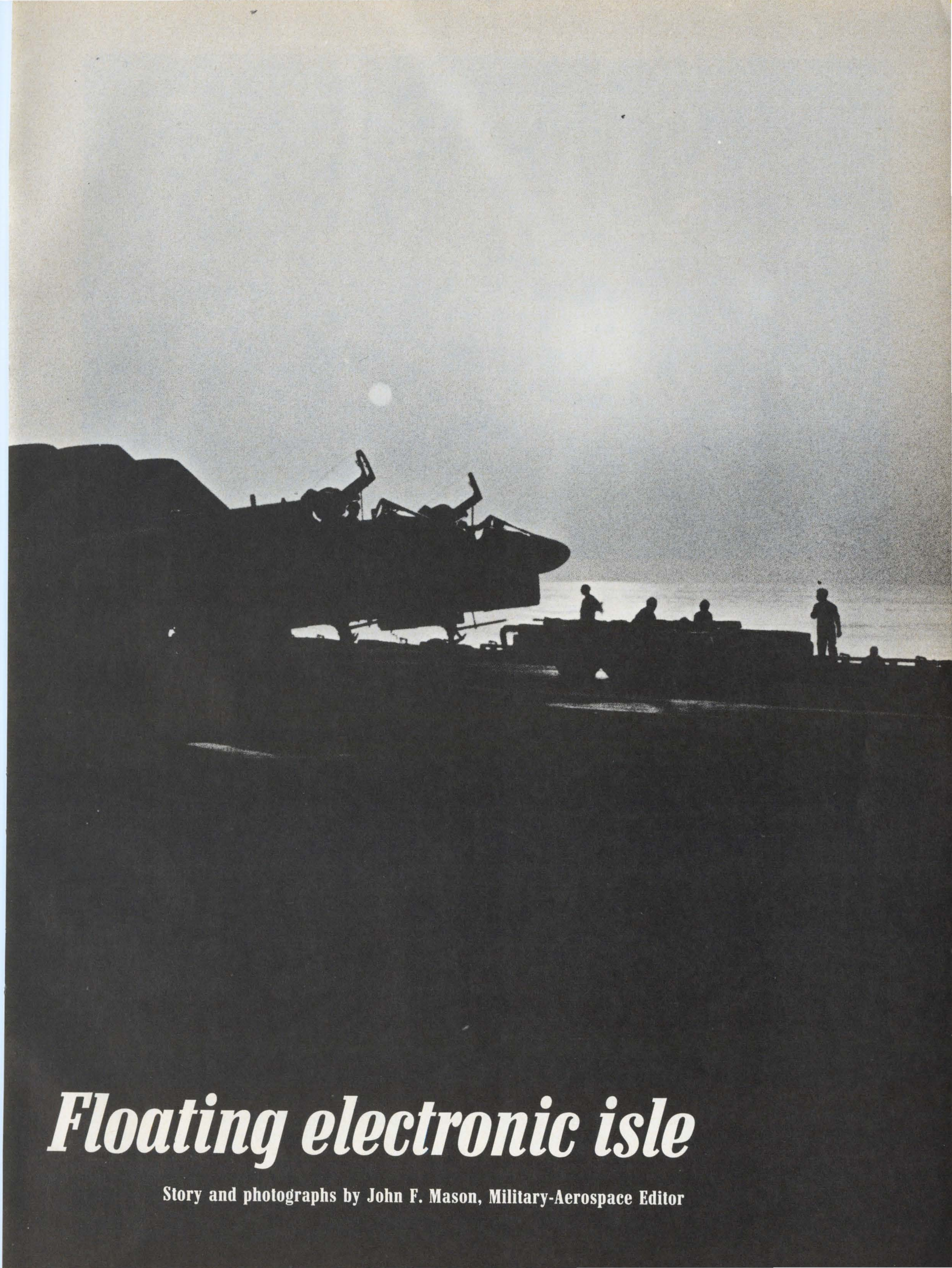
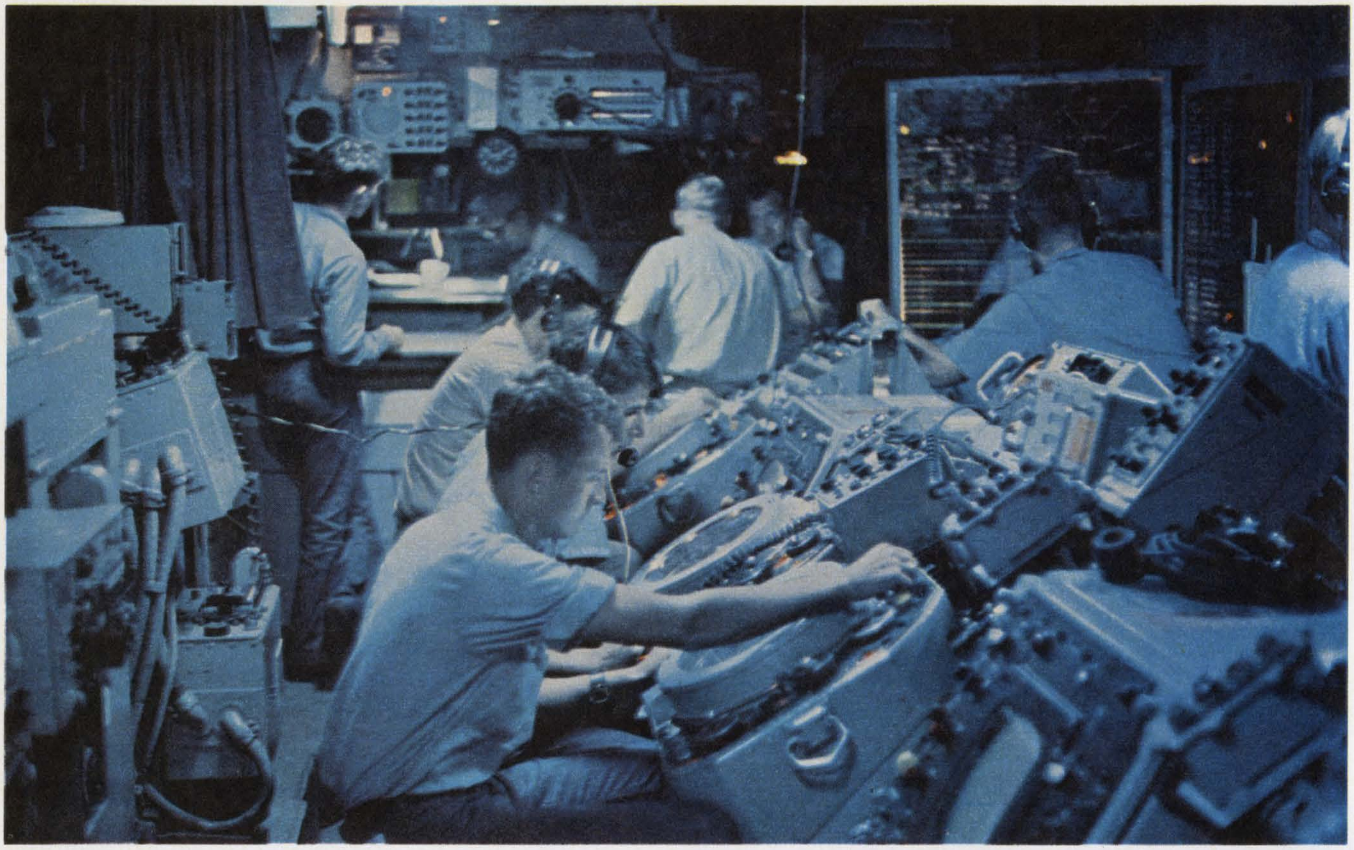
INFORMATION RETRIEVAL NUMBER 49

Airfield in the ocean...



Floating electronic isle

Story and photographs by John F. Mason, Military-Aerospace Editor



Combat Information Center on the Roosevelt keeps track of all enemy craft—sea and air—within radar range and all friendly craft beyond 50 miles. Remote scopes enable operators to switch to almost any radar on board.

Aboard the aircraft carrier
Franklin D. Roosevelt at sea

A tall, sandy-haired petty officer, who would look more at home on a basketball court than in front of a teletype machine, leans forward to watch the message clatter in. It's high priority, according to the initial code, from Atlantic Fleet Headquarters in Norfolk. The machine stops.

He tears off the original copy and writes "Captain" across the top and hands it to a communications messenger. "Rush," he says.

Other copies are also dispatched: one to the operations officer and one to the air intelligence officer. Two communications technicians stop putting addressee designations on routine messages coming in by high-frequency radios from shore stations and other ships. They step over to read the message:

Initiate a routine launch to investigate one or more unidentified surface ships. According to CL [cruiser] radar at 1000 hours, the target was 50 miles north northeast of Cape Canaveral, headed south. Photograph and fly film to Mayport Naval Station. Pilot will advise you by radio of target's description and identity. Please radio info to us."

Action is fast a hundred miles in the Atlantic off Jacksonville, Fla. In moments, loudspeakers are blaring: "Flight quarters—all hands man your flight quarters stations!" Some 400 to 500 crewmen go to their stations. And a maze of electronics around the men lends support. A barrage of radios warms to the job. Radars eye the sky and surrounding sea. Computers search their memories. And displays light up softly in a dozen stations throughout the ship.

This is routine action on one of the most battle-proven aircraft carriers in the U.S. fleet, the 4500-man Franklin D. Roosevelt. During the prop-plane era an aircraft carrier was a floating airfield with a scattering of electronics; today, with high-speed jets, a carrier is a floating electronic system.

How does this myriad of electronics work, side by side, at the mercy of the wet, salty elements, hundreds of miles from the nearest maintenance depot? A visit to the Roosevelt turns up cheerful news for designers and electronics manufacturers: The equipment works surprisingly well most of the time. There are some bugs—tuners that tend to arc, radar components that desperately need labels for easy repair, software in a landing-radar system that could be better, and other largely minor shortcomings—but on the whole the electronics are doing just what they were designed to do. And, with planned improvements, they will do even better.

The new, high-performance aircraft require more efficient support. More automation is needed. Multifunctional gear is being sought. The gigantic carrier of today is becoming so crammed with electronic equipment that "we now have to think about size for the first time," a Navy engineer says.

The mission begins

The operations officer notifies the air officer to get the flight deck ready and to pick an RF-8G photo-reconnaissance plane and a pilot for the job. The air intelligence officer looks through his files. If possible, he will show the pilot photographs of ships he might find. He will describe shipboard missile locations and how they look when they're camouflaged.

For the briefing, the initial message from Norfolk is typed on transparent tape and projected on displays in the ready room. Also displayed are flight and weather information.

The pilot calculates the probable position of the unidentified target—where it will be at five-minute intervals for the next hour—while the deck crew prepares the plane for flight.

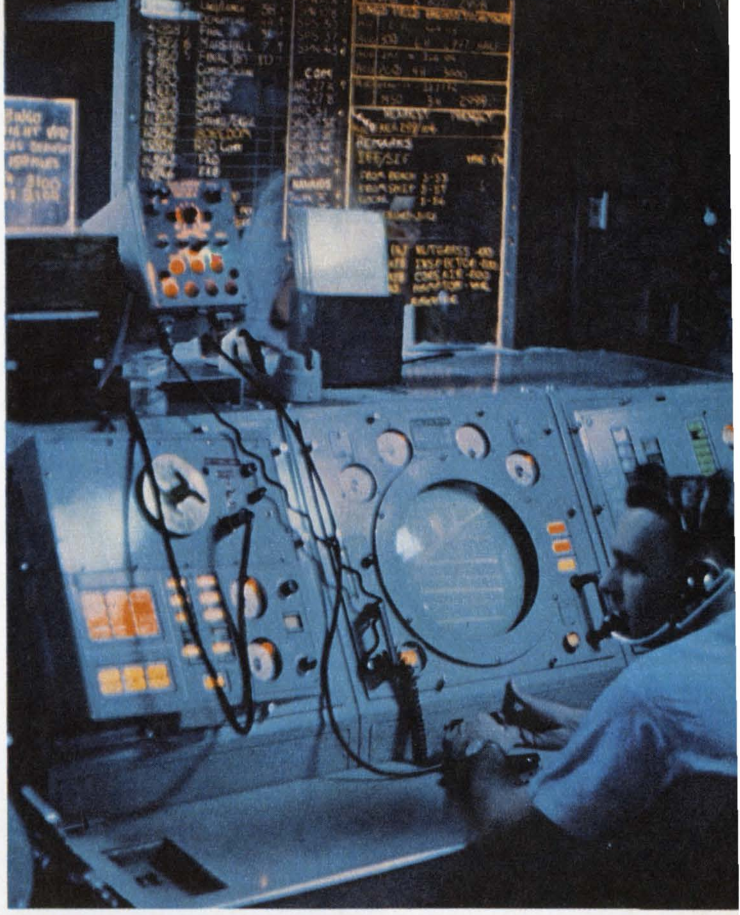
Better and better equipment

On newer, updated carriers, like the John F. Kennedy, the more sophisticated RA-5C reconnaissance aircraft would be used. Besides photographic cameras, this Mach 2 twin-jet plane is equipped with infrared sensors, a sidelooking radar and a receiver-recorder that captures on tape electromagnetic signals from a target's radio, radar and electronic countermeasures equipment.

All aircraft with inertial navigation systems—including the more advanced fighter planes on the Roosevelt—must have their inertial systems aligned before take-off. Precise positioning is necessary. The attack planes need the precision to find their assigned targets and their way back to the carrier. And reconnaissance planes need to pinpoint the location of targets they find. So important is this precision that all carriers have been equipped for the job with the extremely accurate Ships Inertial Navigation System (SINS), developed originally for Polaris missile submarines.

But the alignment operation is unwieldy. Data from SINS, which is several decks below the flight deck, must be piped up to outlets on the hangar deck and the flight deck. From there, heavy umbilical cables must be attached to each aircraft, cluttering up an already congested deck and requiring 30 minutes or more to align each plane.

Although the SINS operator on the Roosevelt says he does not consider the cables an inconvenience, the Navy is working on a system whereby data will be transmitted by rf data link to receivers in the planes. Cables will be eliminated, and there will be no limit to the number of aircraft inertial systems that can be aligned simultaneously. The job should take five minutes instead of 30.



Shipboard SPN-10 radar operator watches and gives corrections for pilot's glide-slope and azimuth errors.

A flying camera takes off

Now the RF-8G is ready on the Roosevelt's flight deck. Like a slingshot, the catapult thrusts the jet into flight. Three radars on the carrier sweep the sky as the craft heads to its target. One is the surface search radar—the AN/SPS-10C. The two others are air search radars: the SPS-37, very-long-range and two-dimensional, and the SPS-30, long-range and three-dimensional.

The recon plane finds the target—there are two ships, not one. Flying directly over them at 10,000 feet, the pilot takes his photographs. Fifty per cent of the mission is complete. Now the films must be delivered to the Mayport Naval Station near Jacksonville, Fla.

Some time later the recon plane returns to the Roosevelt. An air-traffic-control radar, the SPN-43, picks it up about 20 miles out. This radar helps guide the plane in until it is about four miles away. There, the SPN-10 landing radar takes over.

The shipboard controller in the carrier's Air Traffic Control Center watches the plane's glide-slope progress and its off-course error on the landing radar, correcting the pilot orally for as little as a 10-foot error, until the plane is a half mile away. At this point the landing signal officer, standing at the end of the deck with radio equipment, takes over visually and talks the pilot down to the deck.

While the Roosevelt landing system must talk its planes down and then hand them off to the landing officer for visual guidance, the JFK has a fully automatic system. A radar linked to an autopilot flies the plane down to the deck without the pilot's help.

An intermediate, semi-automatic mode is also used on some carriers. Instead of controllers in the Air Traffic Control Center telling the pilot what to do, the shipboard radar information is sent to the aircraft by data link; it appears on a cross-hair display that guides the pilot down. The Roosevelt could go to this mode if it had a data link.

As the RF-8G comes screaming in, a hook trailing from the fuselage catches one of four cables lying across the Roosevelt's deck. The huge jet comes to a quick, minus-5g halt. Mission completed.

Throughout the recon plane's entire flight the Roosevelt's Combat Information Center was maintaining a close watch. This center is responsible for keeping track of all contacts—air, surface and subsurface—in the vicinity of the ship. Illuminating the relative darkness in the crowded room are remote radar displays that permit an operator to switch to almost every radar on the ship. Other illumination in the rooms comes from large, Plexiglas boards, on which crewmen, writing backwards with grease pencils, note the status of all craft that are spotted—their course, speed, probable destination, identity.

Superstructure of the Roosevelt is an electromagnetic clutter, providing space for more than 100 antennas.

Friendly aircraft are plotted when they are more than 50 miles from the carrier; air-traffic control radar has them under surveillance when they are closer than that. Enemy aircraft are plotted at any range.

Had the message ordering reconnaissance photos of a target at sea been received by a more modern carrier than the Roosevelt—the JFK, say—the procedure would have differed slightly. Besides being delivered to the captain, the message would also have been taken to an Integrated Operation Intelligence Center, a large facility where data brought back by RA-5C reconnaissance aircraft is interpreted. The center has two computers for storing information, which can be recalled at the touch of a button to compare new data with old:

Was that sonobuoy there yesterday? Is that shore-based radar new? Has that ship that the RA-5C infrared sensor picked up been detected before?

The computer might answer: The sonobuoy was first seen a month ago. The radar appeared seven days ago. And a ship was detected by submarine sonar 20 minutes ago, five miles south of this position.

The Combat Information Center on the JFK and other advanced carriers is also more sophisticated; it employs the Naval Tactical Data System. Broadband rf data links between compatible computers on every ship in the task force permit quick exchange of all kinds of tactical data.

The main communications room on the Roosevelt, as well as on newer carriers, is still a manual facility. It may handle as many as 4000 messages a day, mostly routine, logistical exchanges and an occasional emergency message for a carrier crewman. Conventional high-frequency radios are used, both Westinghouse's WRT2 and Hoffman's URC32. The big problem, says an electronics maintenance chief on the Roosevelt, is with the tuners.

"They tend to arc," he says. "Plastic insulations have been known to melt during arcing."

The only complaint about the WRT2 is that "it's hard to get to the various parts in the power amplifier stage when repair work is necessary."

Besides hf radio, there is a low frequency transmitter for aircraft homing, a vhf for aircraft distress calls and uhf for talking with aircraft.

The Roosevelt's Pathfinder 1500 B short-range navigation radar (a half mile up to 32 miles), built by Raytheon, is "a good radar with good resolution, but it doesn't stand up under continuous use," says Chief Petty Officer Richard R. Eaton, technician in the electronic environment section aboard the carrier.

"It just wasn't built to operate for a month at a time," he explains. "It is a commercial set designed for helping a ship's pilot make his final approach into port. But here, they use it for close maneuvering with ships and keeping an eye on the destroyers.

"We need a more rugged set, with better schematics, a better form of layout diagrams, and better instruction for alignment. It's a nightmare to repair, because only four or five components are labeled. If you want to look at something, you have to physically trace out all your components. It takes longer to find the component than to replace it.

"A military version was built and used in Vietnam, but its range was too short."

In describing a search radar, Eaton says: "The AN/SPS-10C, with a range between 1500 yards and 90 miles, is one of the most dependable radars we've got. It's so reliable that the only complaints we get are about the operator."

A modification under way on the SPS-10F version that is on the JFK is of particular interest to Lt. Cmdr. Cliff Laning, antiship missile defense coordinator for the Naval Ship Systems Command in Washington. The need is for a clearer radar picture at low elevation. Surface-to-surface cruise missiles, such as the Russian Styx, are low flyers and could be obscured by video clutter. The cure, Commander Laning says, is "a video clutter-suppression device that looks at the electronic environment around the radar and examines the clutter, whether it be from moisture in the air, the sea or land.

"It measures the returns from the clutter by determining the voltage level being displayed on the PPI scope," he notes. "After this, the radar will not display anything at that voltage level or below. It will display only higher voltages, which results in a clean scope except for the target."

A follow-on to the SPS-10F is being developed by Raytheon. It will move up in frequency to avoid interference with missile-control radar. Designated SPS-55, the new radar is being built with more solid-state components and will have a selectable circular polarization feature. This, it is hoped, will provide better visibility at greater ranges.

"We tried a number of things on the SPS-55 but most of them didn't turn out too well," says H. M. Nordenberg, section head for air-traffic-control, navigation and IFF (Identification, Friend or Foe) equipment in the Naval Ship System Command. "We tried dithering the frequency around a nominal frequency in the band, perhaps 30 MHz or 40 MHz, to try to cut down on sea return, but it didn't work because the

F-4 fighter rides up to the flight deck on giant elevator. The plane's inertial navigation system must be aligned by unwieldy cables attached to the Ship's Inertial Navigation System. Later ships will have an rf data link.

The Navy's response to shelling by critics

The roughest battle for American carriers in recent years took place not on the high seas but in Congress last fall. Along with other weapon systems, the carrier was under attack from many quarters. There were Congressmen who felt another approach, or another kind of weapon, would be more efficient. Others said, "We have enough weapons." And still others had declared general war on what they called the "military-industrial complex."

The battle has subsided, but it may be far from over. So far, the pro-carrier forces are ahead.

The first nuclear-powered Nimitz carrier is fully funded—it will cost $536-million. For a second such carrier, $133-million has been funded for long lead-time items. Money for a third will be requested next year.

Aircraft for a carrier, according to Congressional testimony supplied by Admiral T. H. Moorer, amounts to $409.5 million; if F-14s are bought instead of F-4s, the bill is $200 million more. Four destroyers cost $855 million bringing the cost for a group to about $1,800 million.

In answer to critics who say that carriers are vulnerable to missile attack, Rear Admiral J. L. Holloway, head of the strike warfare division of the Office of the Chief of Naval Operations in Washington, and the program coordinator for development of the next generation of carriers, asserts: "Carriers have mobility plus protection by their own task force." Admiral Holloway also points out that carriers in the Gulf of Tonkin successfully operated beyond the range of the Soviet Styx, the surface-to-surface guided missile emplaced in sites in North Vietnam.

"No potential North Vietnamese missile landing platform, aircraft or PT boat has penetrated the U.S. carrier task force defense to within attack range of the carriers, the admiral notes.

Rear Admiral William D. Houser, Director of Aviation Plans and Requirements, says: "The carrier is gaining in importance, due to the somewhat less favorable position of the U.S. in terms of its overseas bases. As a floating airfield, the carrier is responsive to the orders of the President of the United States without negotiation with foreign countries."

Backing up this argument is the fact that in 1957 this country had 105 operational Air Force bases overseas. Now there are 35, with a big base in Libya soon to go.

"A major element of our foreign policy depends on having allies, who, in turn, depend on us for support," Admiral Holloway says. "To do this, we must have freedom of the seas. This calls for attack carriers. Also, our allies' forces are usually conventional, and they need air support. Our carriers can provide this."

waves don't really change that much from pulse to pulse."

One thing that was done, notes Capt. C. E. Martin, radar branch head of the Naval Ship Engineering Center in Washington, "was to put into the requirement a two-second tuning specification—the whole frequency range had to be searched in two seconds."

"We did this," he explains, "because we thought we'd have to shut down the radar while tuning it, and we couldn't afford to have it out very long. But we found that we could make the receiver follow the transmitter tuning, and the radar didn't go off at all. So, to reduce this added complexity, we decided to settle for a 30-second tuning capability.

"It really works well. To tune, you press a button, which causes it to tune automatically back and forth over the whole band. When you get the best picture, you take your finger off."

Of the Roosevelt's very-long-range search radar, the SPS-37, Chief Eaton says:

"It works well without problems, except that it's located near the stacks and the dipoles get dirty, causing them to arc or to short. This requires extra work keeping them clean.

"One bad thing about this radar is that a repeater in the circuitry causes the target to be chopped up on the scope. Every tenth sweep is used to form the cursor, thus leaving a blank strip in the target. Maybe someday someone will figure out a way to provide a cursor without sacrificing the video."

Instead of the SPS-37, most aircraft carriers use the SPS-43A, "a standard radar with no problems," Nordenberg says. "And it has a follow-on, the SPS-49, developed by Raytheon, but we haven't bought any yet."

The follow-on is L band, while the current one is uhf. "The disadvantage of uhf is that you can't operate near TV stations in certain channels," Nordenberg says. "We like a variety of frequencies, however, to make jamming more difficult for the enemy."

The uhf radar, which is for long range, is also being modified, Commander Laning says, to operate at short range, too—from 0 to 40 miles.

The Roosevelt's 3-D radar, the SPS-30, was replaced on the JFK, and will be on the Nimitz, by the SPS-48.

"The only maintenance problem with the old 3-D radar," Eaton says, "is that the dehydrator required to dry out moisture in the waveguide used the ship's regular low-pressure supply of air, and it was dirty. It contained both oil and water, requiring almost continuous maintenance. I think the radar should have its own pressurizing unit. All you need, after all, is a compressor and a desiccant or electric dryer."

Commander Laning says: "What we'd like for the new SPS-48 is a moving target indicator, auto detection and auto tracking. This would enable us to eliminate the operator."

The AN/SPN-43 air-traffic-control radar that picks up incoming aircraft as far as 40 miles, evolved from one called the SPN-6. "We needed better performance to keep up with the high-performance jets," Nordenberg says. "We added a new transmitter, receiver and antenna reflector assembly. The new reflector—a cosecanted squared antenna—enables us to cover from the horizon to 30,000 feet, as well as a 360° azimuth. The radar is all-solid-state, with a low-noise front end that operates at room temperature. It's not as quiet as a cooled device—sometimes the Varactor diodes in the preamplifier get noisy—but it's good enough for our needs, and we don't have

"An aircraft in that area wouldn't show up at all," Eaton says. "And this is the quadrant we use for final approach. We couldn't control the aircraft coming in."

Gilfillan engineers finally discovered two problems: The sensitivity time control [STC] circuit used to minimize sea return had a recovery time that was too long, and there was also quadrant blockage due to physical interference from another radar antenna. The STC had been set to reduce the gain for nearby targets, while increasing gain gradually with a parametric amplifier to cut in for targets at 12 miles on out to 25.

It was corrected by moving the blocking antenna and then modifying the trigger generator card, which controls the gain vs range on the STC. The STC curve on this radar, Nordenberg

to bother with liquid nitrogen cooling agents."

Chief Eaton on the Roosevelt says that every time the SPN-43 got a new modification, it became more like the SPN-6—"same resolution, same range, capability and picture size."

"We had a lot of problems with the SPN-43 in the beginning," he notes. "When we left port, it had a blind spot, poor resolution and a very short range—a maximum of 60 miles with an optimum range of 40 to 45 miles. A represenative from the manufacturer, Gilfillan, came out and spent a month and a half going over the system, trying to isolate the problems. He went back, worked on it and sent another engineer out. The solutions were good."

The blind spot was in the southwest quadrant, from 8 miles to 17 miles.

explains, is a composite curve, consisting of two STC curves, one on the receiver i-f amplifier and one on the parametric amplifier. This was the first operational shipboard radar on which this technique was employed. The curve of the parametric amplifier is phased in with the other curve, with its additional gain at approximately 12 miles and with full gain at 25 miles.

The original design had the latter curve as a fixed value, with the dynamic range provided by verification of the first curve. However, the variations with installations, such as lengths of waveguide runs, proved to be too great. Therefore, as a "quick fix," the Roosevelt changed one resistor and one capacitor to change the time constant and eliminate the "hole" in the pattern.

"However, we are modifying the paramp STC

to provide adjustment for both starting point and rate-of-gain change with range as a permanent fix," Nordenberg notes.

The SPN-42, which takes over the job of landing the plane when it reaches a distance of four miles, takes a new approach to compensating for deck motion. Instead of using the computer's prediction for the position of the deck at time of touchdown, and bringing the plane down accordingly, the glide slope moves up and down with the pitch of the ramp. The reason for this is that the prediction method made the pilot nervous.

"It takes a lot of faith in the computer to look down at a rising deck and believe it will sink in time for you to make the proper touchdown," Nordenberg observes.

"Our main modification goal for the landing radar is to improve the software. We've got 120 aircraft and one landing system. It's easier to change the software for different landing requirements than the hardware.

"To make the aircraft show up better on the SPN-42 scope, we may put beacon transponders in the aircraft instead of relying on the passive corner reflectors we use now. This would improve the system's all-weather capability."

The auxiliary landing radar, the SPN-41, is a microwave scanning system that provides the pilot with a heads up, cross-pointer display in the cockpit. The Navy has ordered 23 systems from the producer, the AIL division of Cutler-Hammer—13 for carriers and 10 for shore-based landing strips.

The other radar that will go on the Nimitz is the SPN-44, a new solid-state, hand-steered doppler used for determining the airspeed of an approaching plane. The landing signal officer uses this information to decide whether or not the plane's flight characteristics are right for a successful landing. If they aren't, he turns a red light on, and the pilot goes around again.

"We'd like to have one radar to do everything, but instead, the Nimitz has four," says Jerry Hamilton, a Ship Systems Command engineer who is helping to plan the Nimitz class of carriers. Capt. James D. Small is project manager for developing these new ships.

Why isn't the Nimitz going to get a wrap-around, phased-array radar, like the one on the Enterprise? "It costs too much," Hamilton says. "Phased array is excellent for a carrier. All four sides of the island are covered, there's no mast to get in the way and cause a blind spot, and there are no moving dishes and mechanical failures. But phased arrays are custom-made and expensive. We had to use what was available off the shelf."

Nordenberg notes: "There has been talk of improving radar displays—bright displays that can be used in daylight on the bridge without the need for a hood. But there have been problems of getting adequate persistency without smearing. Also, there have been proposals for large-screen displays, but they would be in the Naval Tactical Display System room."

One innovation for the Nimitz will be an automatic test system that tells how the radars are working: whether they're being degraded and how they can be repaired. Called CATS (Computer Automated Test System), the system is being developed by the Naval Electronics Laboratory Center in San Diego.

Small-sized electronics needed

"The trend in all carrier electronics," Hamilton says, "is toward solid state in smaller packages, with small heat dissipation. Formerly we didn't worry about reduction in size because a carrier is a pretty big ship, but we're getting more and more equipment and have begun to think of size.

"Increased automation is calling for more computers and more memory capacity. We'd like to have integrated computers, or a system to which we could add more memory when the load became greater.

"The Nimitz is getting more computers to handle the increased automation. It will have 15 computers: two for the Integrated Operational Intelligence Center, six for the Naval Tactical Display System, three for the Message Processing and Distribution System, two for the SPN-42 radar, one for the Ships Inertial Navigation System and one for logistics.

"In building carriers beyond the Nimitz, the designers will probably look at all the automated operations on the ship, decide how much memory capacity is needed and buy a computer or a family of computers that can communicate with each."

The superstructure of a carrier, which may have to hold 100 antennas, can create a nightmare of electromagnetic interference.

"We've had problems with our radar antennas," a member of the engineering planning staff for Nimitz carriers concedes. "To minimize RFI we have reduced the side lobe and the back lobe of the antenna reflector. Or we put blinders on the feedhorn. This has been successful. It has also improved the performance of the radar itself, since it puts more energy back into the main lobe where you want it.

"The trend, of course, is to design antennas as part of the ship rather than putting them up after the ship is built.

No room at the top

"As for communications antennas, the maximum you can separate them is the length of the ship, about 1000 feet, but actually you're restricted to about 100 feet in the superstructure. This means a receiving antenna system will pick-up a lot of rf energy. Isolation between transmitting and receiving antenna systems is on the order of 15 to 20 dB attenuation. Sometimes it's down to 10 dB. Also, you get into the dynamic range problems of the receiver because of the large amount of rf energy present that can overload the front end. This creates spurious responses within the receiver. To preclude overloading problems, we go into a complicated frequency spacing and filtering system. If, for example, we have a receiver on 4 MHz and a transmitter on 4.5 MHz, we use a filter in front of the receiver that will reject the 4.5-MHz signals. This filter is part of the multicoupling system, which allows us to connect many receivers to one antenna. It allows fewer communications antennas to be used. Rather than one antenna per receiver, we could have as many as 8 to 15 receivers on one antenna. This is the manner in which larger ship communication designs are handled.

Instant tactical data

The Naval Tactical Data System on the JFK and the Nimitz does the work of the Combat Information Center on the Roosevelt. The difference is that the data system is automated and ties together an entire task force. One ship might detect a target and pass the information on to the display and computer of a ship with more appropriate weapons, or one in a more advantageous position to make the kill. The system is not new—the first was delivered to the Navy in 1959—but it's expensive and has been installed on only a few ships. When those vessels slated to get the system are finally equipped, the total will reach approximately 40.

But its success story has been phenomenal, according to Donald L. Ream, head of the Navy's Combat Systems Management Office in Washington. "It just won't wear out," he says. "In the old days we thought if you got 40,000 hours of life from equipment, it was great. We've got computers that have been running for 80,000 hours and are still good. We run them day and night. The equipment is two orders of magnitude better than projected.

"The biggest problem we have is finding components when we do need them, because the manufacturers stop producing them after the equipment is 10 years old. We have to pay a premium price for certain transistors today."

Two big innovations are being readied for carrier communications: Space is being reserved on the Nimitz for satellite communications equipment and for a new, computerized message processing and distribution system. Fully automatic, the latter system will speed the operation of the communications room and reduce its 100-man staff by 30. Instead of manual screening of messages for priorities, decoding and addresses, a computer will do the job. It will also log, file and send messages along to one or more of 10 remote terminals, which will display them on cathode-ray tubes or print them out on high-speed printers.

The message system, which is being developed by the Naval Electronics Laboratory Center in San Diego, is being installed piecemeal on the old attack aircraft carrier, the Bunker Hill, tied up in San Diego harbor. It is to undergo complete system testing late next summer. And by November, 1970, it will be ripped out, system by system, and sent to the Newport News Shipbuilding & Drydock Co. in Virginia for installation on the Nimitz.

The system uses a central general-purpose computer that accepts messages in teletypewriter code as digital data and then processes them. ■■

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INFORMATION RETRIEVAL NUMBER 51

Go push-pull for magnetic deflection.

Despite yoke resistance changes caused by temperature, you'll get stable sweep amplitude and linearity.

Electromagnetic deflection of electron beams offers many advantages to the electronic designer. It costs less than electrostatic deflection, offers better bandwidth, requires much lower voltages, and provides high brightness where required.[1] However, the yoke resistance — and therefore the deflection linearity of electromagnetic displays — varies with temperature when low-inductance yokes are used, and precautions must be taken to compensate for this temperature sensitivity. One way is to use a differential push-pull deflection system.

First, get a linear current

For an ideal inductance

$$E = L\frac{di}{dt} \text{ or } i \approx \frac{E}{L}t.$$

Unfortunately, the ideal inductance does not exist. In order to obtain a linear current, i, through a physical inductor, L, we must know or define the terminal voltage that must be applied.

To briefly review the design of a linear current sweep circuit, a deflection yoke may be represented by the equivalent circuit shown in Fig. 1. The voltage equation for the circuit is:

$$e_{ab} = i_y R_y + L_y\frac{di_y}{dt} = (1/c_y)\int_{t_1}^{t_2} i_{cy}dt \qquad (1)$$

Initially, capacitor c_y is unchanged ($t = 0$). When e_{ab} is applied, c_y must charge in zero-time, and an impulse occurs. We can denote this as a unit impulse at $t = 0_+$.

After the impulse, a current must be applied to the capacitor, allowing its voltage to rise at the same rate as the terminal voltage e_{ab}. If the capacitance across the yoke terminals can be kept small, the current will be equal to a constant (thus $E_{cy} = \frac{It}{c}$ during the time e_{ab} is applied. We may rewrite Eq. 1, dropping the y subscripts:

$$e_{ab} = iR + L\,di/dt - i_0\delta\,(t) \qquad (2)$$

where $i_0\delta(t) \cong E_{cy}$, assuming the yoke and stray capacitance is a constant.

We then equate terminal voltage to a straight-line function, for ease of generation:

$$e_{ab} = e(t) = e_0(1 + \gamma t) \qquad (3)$$

where e_0 = initial voltage across terminals at $t = 0^+$

γ = slope

t = time.

From Eq. 2 and 3,

$$iR + L\,di/dt - i_0\delta\,(t) = e_0\,(1 + \gamma t).$$

Taking the LaPlace transform of both sides and solving for the current:

$$RI\,(s) + LsI\,(s) - i_0 = \left(\frac{1}{s} + \frac{\gamma}{s^2}\right)$$

now,

$$I\,(s) = e_0\left(\frac{s + \gamma}{s^2}\right) + i_0/R + Ls$$

$$= \frac{e_0}{L}\left[\frac{S + \gamma}{s^2\,(s + R/L)}\right] + \frac{i_0}{L\,(s + R/L)}.$$

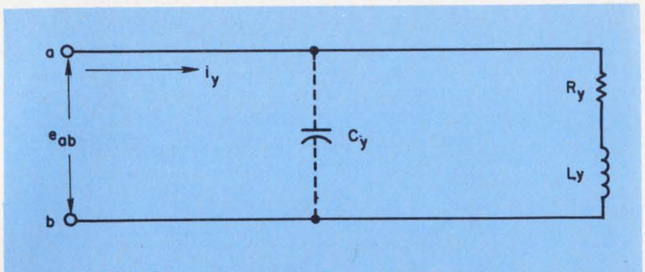
The inverse LaPlace transform then yields[2]

$$i\,(t) = \overbrace{\frac{e_0}{R}\left[\gamma t - \left(\frac{\gamma L}{R} - 1\right)\right]}^{\text{Steady state term}} + \underbrace{\left[\frac{e_0}{R}\left(\frac{\gamma L}{R} - 1\right) + i_0\right]e^{-Rt/L}}_{\text{Transient term}}$$

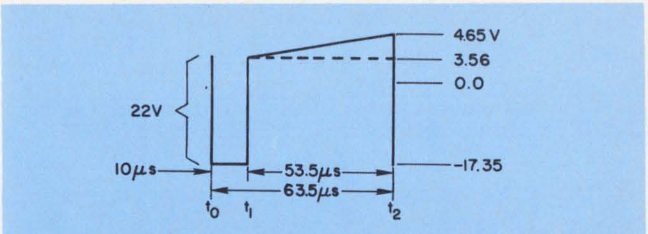
Consider the steady-state term

The yoke and capacitor current is now expressed as a function of time and shows a steady-state term and a transient term. Since we are interested in obtaining a linear sweep current during the active scan period (neglect retrace), only the steady-state term is considered. Considering the step function (to produce a linear rise in current due

A. M. Hildebrant, Design Engineer, Aerospace Electronics Dept., General Electric Co., Utica, N.Y.



1. **Deflection yoke can be represented** by simple equivalent circuit, R_y = yoke resistance, L_y = yoke inductance and C_y = yoke capacitance.



2. **Voltage waveform for linear sweep** consists of impulse, step and ramp. Note that t_1 = start of active scan period, t_2 = end of active scan period, and (t_1 − t_0 = retrace time.

to inductance)

$$i\ (t) = -\frac{e_0}{R}\left(\frac{\gamma L}{R} - 1\right) \qquad (4)$$

and considering the resistance of the yoke:

$$i\ (t) = \frac{e_0}{R}\ \gamma t. \qquad (5)$$

Equations 3 and 4 relate to moving the electron beam from deflection center to the edge of the CRT. Therefore, taking into account full deflection, Eq. 5 becomes

$$2\ i\ (t) = \frac{e_o}{R}\ \gamma t.$$

Since $i(t)$ is the steady-state current, we can let $i(t) = i_0$, so that

$$i_0 = -\frac{e_0}{R}\left(\frac{\gamma L}{R} - 1\right) \qquad (6)$$

and

$$2i_0 = \frac{e_0}{R}\ \gamma t. \qquad (7)$$

Then, from Eq. 6 and 7,

$$\gamma = \frac{2i_0R}{e_0t}$$

$$e_0 = i_0\left(\frac{2L}{t} - R\right) \qquad (8)$$

so that

$$\gamma = \frac{2R}{2L - Rt} \qquad (9)$$

As an example of the foregoing procedure we can find the voltage driving function, which will result in a linear deflection current, for a TV deflection yoke having the following parameters:

$L = 20$ microhenries
$2i_0 = 11$ amperes (peak-to-peak)
$t_l = 10$ microseconds (retrace time)
$t = t_2 - t_1 = 53.5$ microseconds (active sweep)
$R = 0.1$ ohm (yoke resistance)

The time periods correspond to a standard 525-line TV system, where the horizontal line frequency is 15.75 kHz. When using a class-A deflection amplifier, a preliminary step is to check the yoke flyback (retrace) voltage to determine if it is within the limits of the power supply.

Step 1, fly-back voltage:

$$E_f = L\frac{di}{dt}$$

or

$$E_f = \frac{20\times10^{-6}\times11}{10\times10^{-6}} = \frac{220}{10} = 22 \text{ volts}$$

Step 2, from Eq. 8:

$$e_0 = i_0\left(\frac{2L}{t} - R\right)$$

$$= 5.5\left(\frac{40\times10^{-6}}{53.5\times10^{-6}} - 0.1\right) = 5.5\times0.648$$

$$= 3.56 \text{ volts}$$

Step 3, from Eq. 9:

$$\gamma = \frac{2R}{2L-Rt}$$

$$= \frac{0.2}{(40-5.35)10^{-6}} = \frac{0.2}{34.65\times10^{-6}} = 5760$$

Step 4, using straight-line equation for end point:

$$e(t_2) = e_0(1+\gamma t)$$

$$e(t_2) = 3.56(1+5760\times53.5\times10^{-6})$$

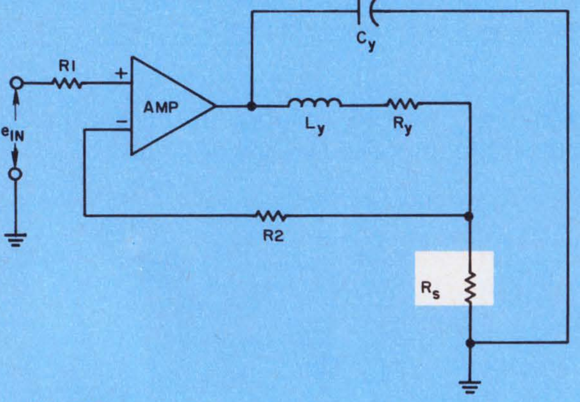
$$= 3.56(1.308)$$

$$= 4.65 \text{ volts}$$

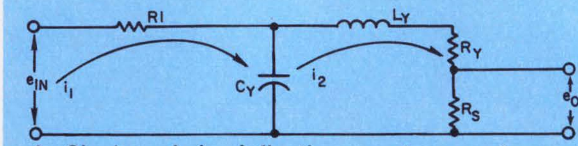
The voltage waveform for this example is shown in Fig. 2. Note that the total voltage excursion is equal to 22.00 volts. This is due to the transient term in the previously derived equation for $i(t)$. A class-A amplifier will saturate during flyback to the supply voltage limit because it cannot follow this transient.

Use feedback for stability

As mentioned previously, the resistance of the deflection yoke varies with temperature. This affects both the sweep amplitude and linearity.



3. **Stability of differential-input, single-ended deflection system** is influenced by amplifier and bandwidth. R_s, the current sampling resistor, is $\leqq 1$ ohm.



4. **Single-ended deflection system** reduces to double loop equivalent circuit (resulting in a second-order system). R_1 includes the amplifier output impedance, plus the cable resistance, and C_Y includes the cable capacitance, plus the distributed capacitance across the yoke.

One means of compensation is to monitor the deflection yoke current with a sampling resistor. A voltage based upon the difference between the current in the sampling resistor and a reference signal can then be used to maintain constant amplitude and linearity.

To start with, the circuit shown in Fig. 3 could be used. This type of system may be called single-ended output, because only one end of the load is driven. Note that the system does have a differential input provided via the amplifier.

The equivalent circuit shown in Fig. 4 may be used to represent the load on the amplifier in Fig. 3. The loop equations for this circuit are:

$$e_{in} = \left(R_1 + \frac{1}{sC}\right) i_1 - \frac{1}{sC} i_2,$$

$$0 = -\frac{1}{sC} i_1 + \left(sL + R_y + R_s + \frac{1}{sC}\right) i_2.$$

Solving for $e_o = i_2 R_s$, we get

$$e_o = e_{in} R_s / \overline{s^2 R_1 LC + s(R_1 R_y C + R_1 R_s C + L) + (R_1 + R_y + R_s)}.$$

The transfer function is:

$$\frac{e_o}{e_{in}} = \left\{ \frac{R_1 LC}{R_s} \left[s^2 + s\left(\frac{R_1 R_y C + R_1 R_s C + L}{R_1 LC} \right) + \frac{R_1 + R_y + R_s}{R_1 LC} \right] \right\}^{-1}$$

$$\approx \frac{1}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

where

$$\zeta = \text{damping factor} = \frac{R_1 R_y C + R_1 R_s C + L}{2\sqrt{(R_1 LC)(R_1 + R_y + R_s)}}$$

and

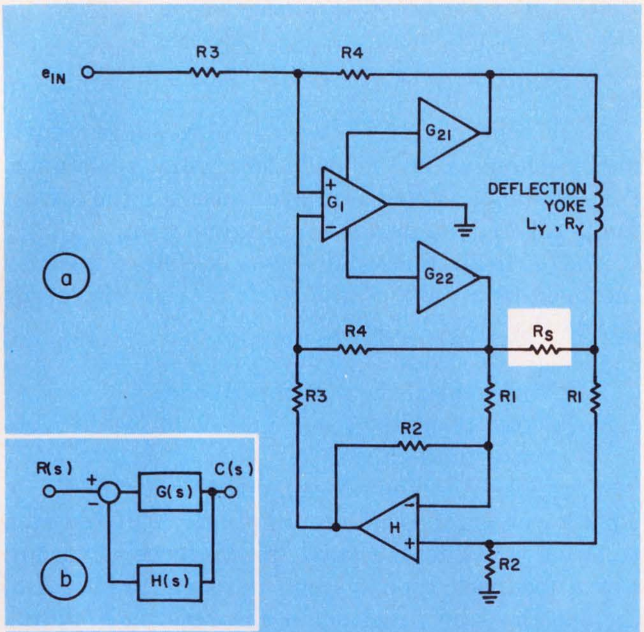
$$\omega_n = \text{natural frequency} = \left(\frac{R_1 + R_y + R_s}{R_1 LC} \right)^{1/2}.$$

Now ω_n and ζ, and therefore the system stability, are influenced by the amplifier gain and bandwidth. The system may become unstable if the gain is too high. This characteristic of a second-order system places limitations upon the system design.[3]

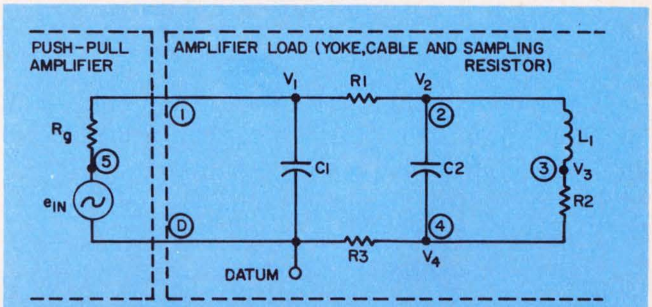
In addition, although this type of system has zero steady-state error, it has: (1) a static error constant that is proportional to the ratio of the velocity to the velocity constant, (2) a velocity error that is present during the ramp function input to the system, and (3) an acceleration error during flyback.

Furthermore, the capacitance, C, is dependent upon the cable length and the grounding of the Faraday shields within the deflection yoke. The value of C will thus affect ζ and ω_n. In order to keep the damping ratio large, the natural frequency ω_n must be decreased.

The open-loop amplifier bandwidth should be



5. **Differential-input, push-pull system** (a) provides increased bandwidth, R_1 and R_2 are part of the bridge arrangement across the output yoke. This presents a differential input to amplifier H. Amplifier G_1 has a differential input and output, G_{21} and G_{22} are current boosters, and H is the amplifier in the feedback loop. A servo model of the system is shown in (b).



6. **In equivalent circuit** of double-ended push-pull deflection system, L_1 is the yoke inductance, R_g the amplifier output resistance, R_1 the cable resistance, R_2 the yoke resistance, R_3 the current sampling resistor, C_1 the amplifier output and intercable capacitance, and C_2 the yoke (distributed) capacitance.

made greater than the load bandwidth. The closed-loop response will then be determined by the load characteristics — that is, by the deflection yoke and cable capacitance. The system ω_n will be the natural frequency of the yoke itself, and the system gain will determine the damping ratio and static errors.

Such characteristics can be obtained using a differential push-pull system, as shown in Fig. 5. This type of system provides a floating load, which is an advantage in increasing the system bandwidth. In a single-ended system the cable capacitance and the capacitances associated with the Faraday shields must be taken to signal ground. In a double-ended (push-pull) system the capacitances are floating; therefore, the magnitude of the capacitance is smaller and not a significant factor in the transient period (retrace) ; likewise, the capacitance impulse and charging currents are small. Wider system bandwidth can thus be maintained with greater stability.

The double-ended, push-pull system may be related to the equivalent circuit of Fig. 6.

The nodal equations for the system are as follows:

$$\frac{V_1 - e_{in}}{R_g} + V_1 C_1 s + \frac{V_1 - V_2}{R_1} = 0,$$

$$\frac{V_2 - V_1}{R_1} + \frac{V_2 - V_3}{sL} + (V_2 - V_4) C_2 s = 0,$$

$$\frac{V_3 - V_2}{sL} + \frac{V_3 - V_4}{R_2} = 0,$$

$$\frac{V_4 - V_3}{R_2} + (V_4 - V_2) C_2 s + \frac{V_4}{R_3} = 0.$$

Computer speeds analysis

The stability analysis of the double-ended system of Fig. 6, based upon its transfer function, can be quite laborious. The work can be greatly simplified by using a suitable computer analysis program. For example, the GE linear network analysis computer program, known as BELAC[4] (written in FORTRAN IV), can be used. It will solve the nodal equations, find the transfer function for the network, and provide frequency plots (Bode diagrams) of the system response.

To illustrate the analysis of an actual system, consider one having the following parameters:

Active sweep time: 53.5 μs (15.75 kHz line frequency)

Deflection yoke inductance: L = 28.5 mh

Deflection yoke resistance, Ry:

26.4 ohms at –55°C
37.3 ohms at 20°C
46.7 ohms at 85°C

Cable resistance, R_c:

1.17 ohms at –55°C
1.65 ohms at 20°C
2.07 ohms at 85°C

Current sampling resistor, R_s:

2.5 ohms (temperature compensation)

The load impedance seen at the output of the G2 (push-pull) amplifier (Fig. 5) will be:

$$Z_{load} = R_y + 2R_c + R_s + {}_jX_L \text{ ohms}$$
$$= 26.4 + 2(1.17) + 2.5 + j10.75$$
$$(\text{where } X_L = 10.75 \text{ ohms})$$
$$= 31.24 + j10.75 \text{ (at } -55°\text{C) ohms,}$$
$$= 43.1 + j10.75 \text{ (at } 20°\text{C) ohms,}$$
$$= 53.34 + j10.75 \text{ (at } 85°\text{C) ohms.}$$

If the G_2 amplifier has a forward current gain of 1600 (minimum at –55°C), then the reflected impedance, Z', to amplifier G_1 will be:

$$Z' = 33(1600) \ \underline{/19°} \text{ at } -55°\text{C}$$
$$= 52{,}800 \ \underline{/19°} \text{ ohms.}$$

Due to the push-pull differential output, the impedance at the input to each G_2 is

$$Z' = \frac{52{,}800 \ \underline{/19°}}{2} = 26{,}400 \ \underline{/19°} \text{ ohms.}$$

If the required terminal voltage is approximately 15.0 volts for this load impedance and an input reference ramp voltage of 5.0 volts is desired, the closed-loop gain should be 15/5 or 3.

For a closed-loop system[3]

$$\frac{\epsilon}{e_{in}} = \frac{1}{1+GH}$$

where

$\epsilon = e_o$ (desired) $- e_o$ (actual) = error

$G(s)$ = transfer function (forward components)

$H(s)$ = transfer function (feedback components)

If $G_1 = 30$, $G_2 = 1$, and $H = 10$, then

$$\frac{\epsilon}{e_{in}} = \frac{1}{1+(30)(10)} = \frac{1}{301} = 0.33\% \text{ or } \epsilon = 0.33\% \ e_{in}.$$

Since the gain of G_1 varies with temperature, due to changes in the deflection yoke resistance, the resistance values used are those for the lowest temperature, the case of minimum gain.

The over-all linearity error is determined by the open-loop gain of the system, plus the error due to the "KLC" factor[2]:

$K = R/(R + R_y)$

R = differential output impedance

Ry = yoke resistance,

L = yoke inductance,

C = yoke distributed capacitance.

This latter error is due to elimination of the step function prior to the start of the sweep current. For a feedback type system, it is not practical to include the step function in the reference signal, since inclusion of the step function would result in an acceleration, giving rise to two values for the damping ratio. Since the yoke resistance changes with temperature, addition of a step function would make an additional error because the step function amplitude on the positive slope would have to change with temperature (yoke resistance change). If a closed-loop system has sufficient open-loop gain and bandwidth, the output will follow the input signal with only the constant position error due to acceleration and the KLC product. ■ ■

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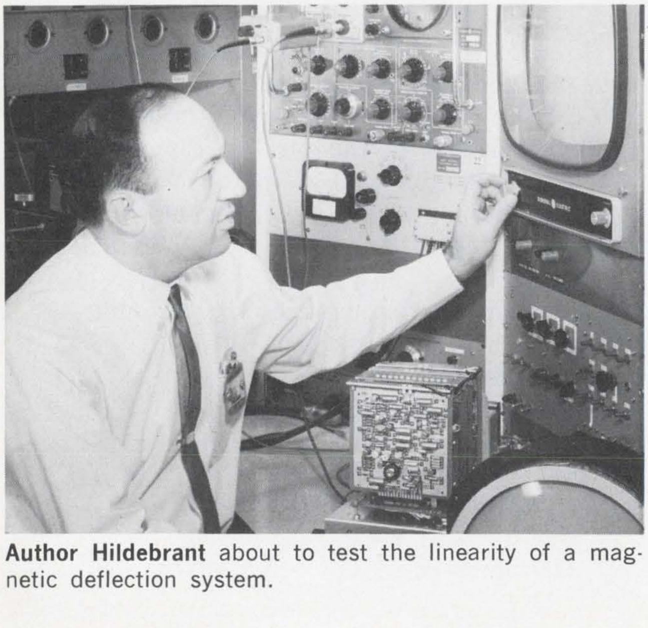

Author Hildebrant about to test the linearity of a magnetic deflection system.

Test your retention

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

1. What are the three input voltage constituents of a magnetic deflection system with a linear current output?

2. Why must a magnetic deflection system be stabilized?

3. What are the advantages of a push-pull magnetic deflection system?

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ELECTRONIC COUNTERS

02915

Improve receiver frequency stability

with digital automatic frequency control. The technique uses a counter for tuning flexibility at reasonable cost.

All wide tuning-range receivers suffer to some extent from the problems of tuning-dial inaccuracy and local oscillator (LO) drift. The problems are particularly severe if the i-f bandwidth is narrow and the local oscillator frequency is high compared with the i-f. In such a receiver, a very small fractional error in the LO frequency can put the i-f signal completely out of the i-f passband.

A new stabilizing technique called digital automatic frequency control (dafc) can be used to combat this error—often with better results and at lower cost than are obtained with methods now used.

What's wrong with existing methods?

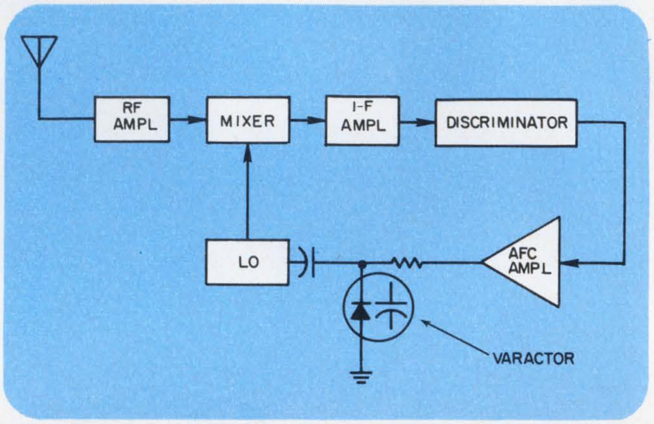
Presently used methods include the employment of:

- Automatic frequency control (afc).
- Crystal-controlled oscillators.
- Frequency synthesizers.
- Frequency counters.

When afc is used (Fig. 1) the stability of the receiver becomes a function of the stabilities of the incoming signal frequency and discriminator center frequency and of the loop gain. The receiver is never really locked to the incoming signal; a small offset error always remains.

The afc approach has two major disadvantages: It doesn't even attempt to solve the dial-accuracy problem, and it is difficult to apply to pulse, single-sideband, frequency-shift-keyed or continuous-wave signals. In its favor are its low cost and relative ease of application.

Both limitations of the afc approach are overcome by the use of a crystal-controlled local oscillator. This method has good accuracy and stability and is not affected by the nature of the received signal. In fact, it operates perfectly well with no incoming signal at all. Thus it can be set to a specific frequency when the transmitter is off the air and can be relied upon to be on frequency whenever a transmission occurs.



1. **Conventional afc is simple and easy to apply.** Unfortunately, it doesn't help the dial-accuracy problem, and it works only when an input signal is present.

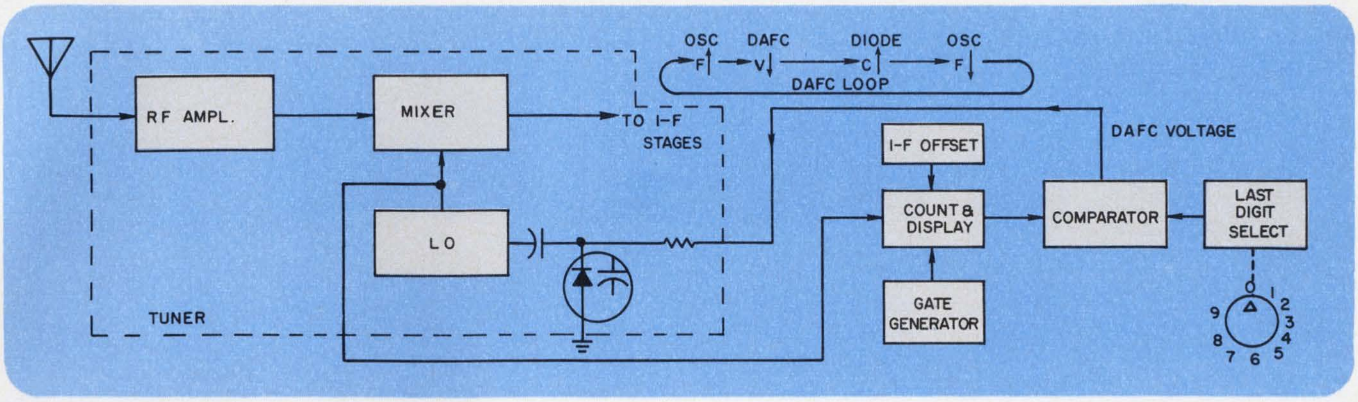
Unfortunately, a separate crystal is needed for each receiver channel. As soon as the required number of channels grows beyond a small number, the size and cost of the receiver can make this approach uneconomical.

Crystal oscillators are also limited in frequency. Above about 150 MHz, overtone crystals can no longer be used and frequency multipliers must be added to the circuitry.

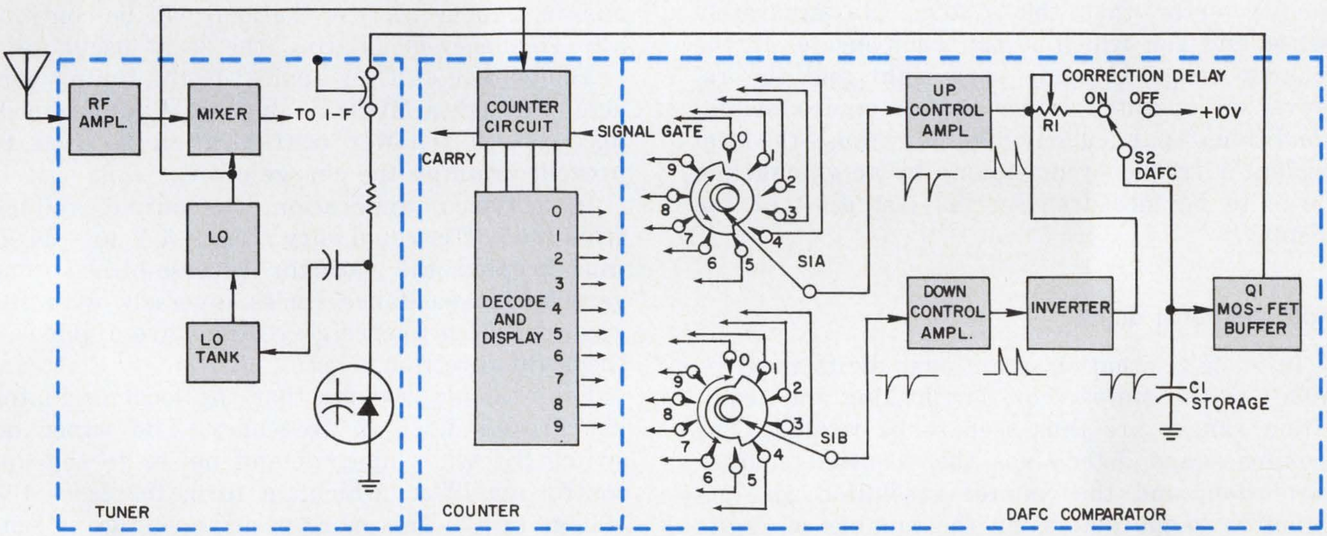
Frequency synthesizers remove many of the disadvantages of crystal oscillators when they are used as local oscillators. They can be precisely tuned over a wide range of frequencies. The trouble with them is their size and cost. Units with an upper frequency limit of 500 MHz cost more than $10,000, and microwave units are even more expensive. Synthesizers, obviously, cannot be economically justified except in the most sophisticated receivers.

An electronic counter can be used to measure the local oscillator frequency and subtract the i-f from it. The counter thus provides a very accurate digital readout of the received signal frequency. Although the receiver-counter combination allows precise logging of the frequency of an unknown signal, it does nothing whatever to reduce local oscillator drift. And a counter is a

Charles E. Dexter, Electronic Engineer, CEI Div., Watkins-Johnson Co., Rockville, Md.



2. **Digital afc slaves the local oscillator to a digital counter.** The comparator unit compares the last digit (or digits) of the display with the selected number (or numbers) and adjusts the LO as needed.



3. **A single switch performs two functions** in this implementation of the dafc technique. S_1 selects the last digit and compares it with the actual readout. Each displayed digit is connected to the like-numbered terminals on both decks of S_1. The actual connecting lines have been omitted for simplicity.

rather expensive replacement for a tuning dial—it can cost more than the rest of the receiver.

Lock the receiver to the counter

The new digital afc system provides many of the best features of a synthesizer at little more than the cost of a counter. Its use is particularly desirable when many channels are to be monitored simultaneously, because the counter used in the scheme can be time-shared among several receivers.

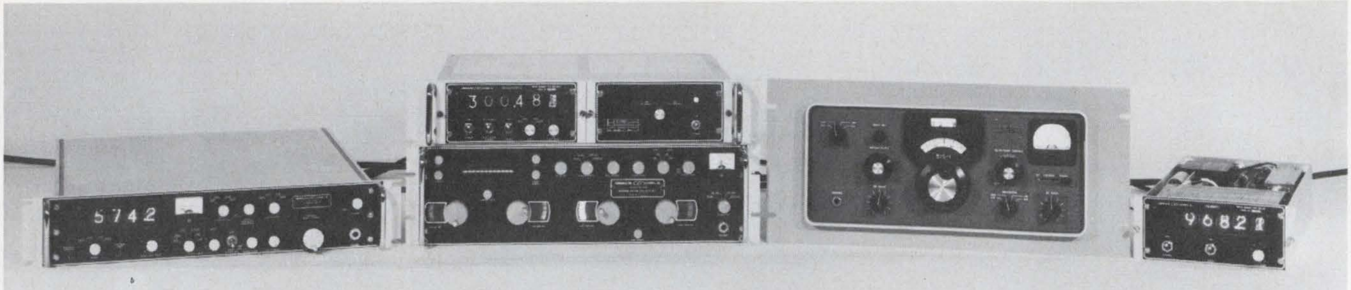
Its loop differs from the conventional afc loop in that the counter's time base, not the incoming signal, is used as a reference frequency. Also, the discriminator is replaced by a comparator unit that compares the last digit of the counter's readout with a preselected number (Fig. 2).

If the digits are not identical, the comparator will change the voltage fed back to the voltage-variable capacitor (varactor) in the local oscillator. Thus any drift in the LO frequency will change the last digit and cause the comparator to put out a correction voltage that will lock the local oscillator to the preselected digit.

Note that the incoming signal is not in the digital afc loop. Thus a major advantage of this technique is that it's not affected by the nature of the received signal. Of course, if the incoming signal is unstable, the receiver will not follow it. This may be a disadvantage in some applications.

Extending the range

The digital afc loop is characterized by three basic range parameters: a locking range, an acquisition range and a holding range. The locking range, or resolution of the system, is simply the maximum error that can exist without a correction being made. The smaller the locking



4. **Dafc really works.** The vlf receiver (left), made by Watkins-Johnson, has a built-in counter and digital afc circuit. The vhf/uhf unit (center), also by W-J, and the Collins hf receiver (right) employ external counters.

range, the tighter the frequency control. Clearly, the locking range of the system is set by the resolution of the counter.

The acquisition range is the maximum frequency error that the system can accurately sense and for which it can compensate. If the locking range is made very tight and the receiver is operated under severe environmental conditions—particularly high vibration—the local oscillator frequency may jump by an amount too large to be measured by the last digit of the display.

Add additional digits

In such a situation, additional digits must be added to the comparator. The locking and acquisition ranges are thus seen to be related: The locking range determines the required counter resolution, and the counter resolution and acquisition range determine the number of digits in the comparator.

The holding range is the total amount of local oscillator drift that the system can tolerate. It is determined by the maximum feedback voltage swing, the varactor sensitivity and the tightness of coupling of the varactor into the oscillator tank circuit.

One way to implement the digital afc scheme with simple hardware is illustrated in Fig. 3. A one-digit comparator is shown.

A sample of the local oscillator output is applied to the counter. The 10 signal lines from the last digit of the display are routed through switch S_1 to the up and down-control amplifiers. The switch is so wired that no signal gets through it if the displayed digit is the same as the selected digit. If the displayed digit is higher, the signal is routed to the down-control amplifier. If lower, it's routed to the up-control amplifier.

The up and down-control amplifiers charge capacitor C_1 in the positive and negative-going directions, respectively. Variable resistor R_1 is used to set the charging rate of the capacitor and hence the time lag of the loop. It is useful to have R_1 variable because a short time constant is needed when the selector switch is used for remote tuning, while a longer time constant is needed after the station is acquired. If the time constant is not increased after acquisition, the correction signal will be audible in the continuous-wave mode because the loop will be continually frequency-modulating the local oscillator.

The voltage on C_1 is applied to the tuning varactor through a MOSFET buffer. A high-impedance source follower configuration is used to prevent draining the charge off C_1.

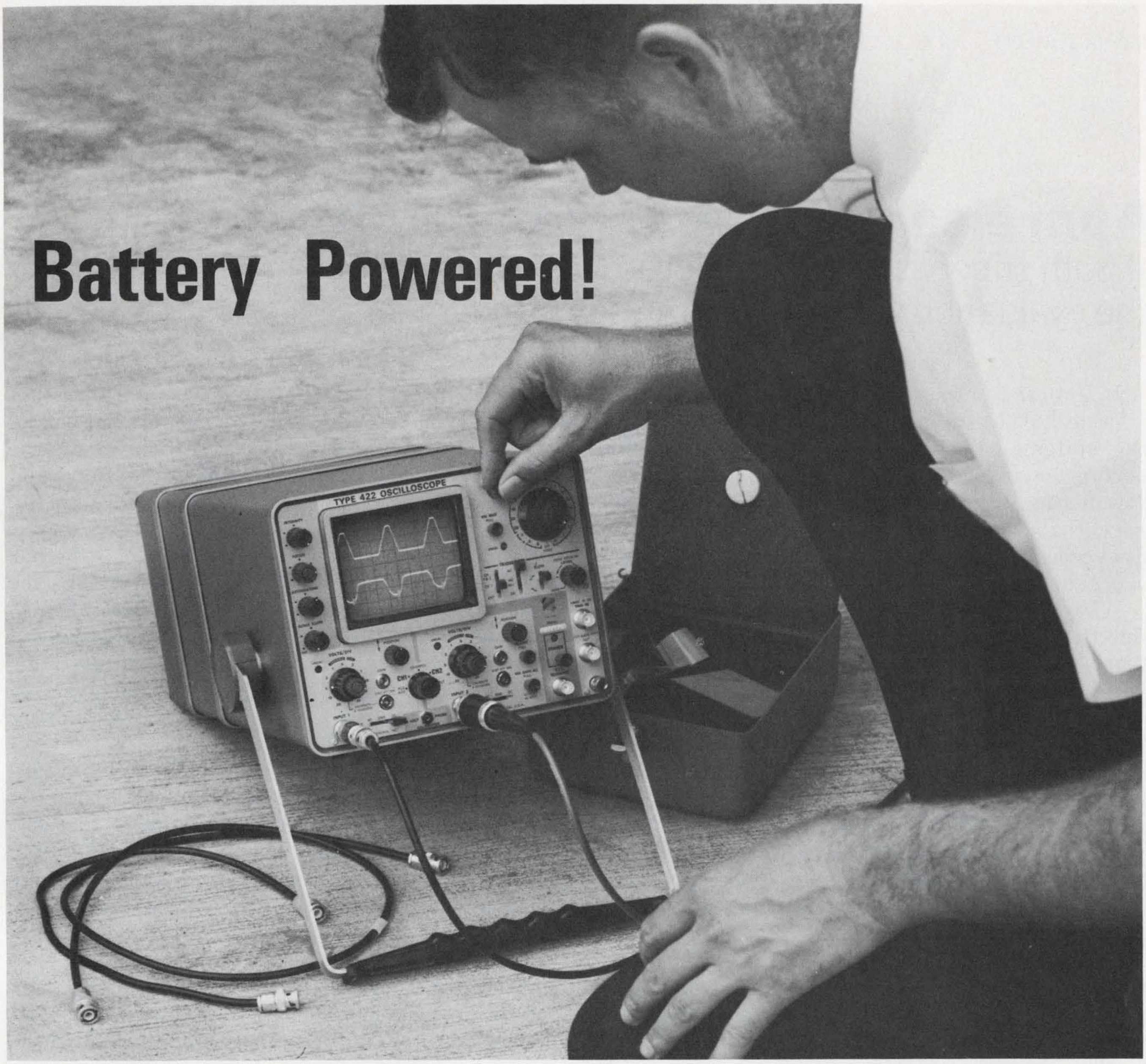
In a typical application, the output voltage from the buffer could vary from +4 V to +24 V, thus keeping the varactor reverse-biased. The varactor's capacitance varies inversely with the applied voltage; hence corrections are applied in the right direction.

For example, assume that the local oscillator has drifted down in frequency. The wiper on switch S_{1A} sends up-command pulses to the up-control amplifier, which, in turn, increases the voltage on C_1. This more positive voltage is sent through Q_1 to the varactor diode. The voltage decreases the capacitance across the local oscillator tank circuit, thereby increasing the frequency until the selector switch stops sending corrections.

Method is easy to use

Although mention was made earlier of the remote tuning application of the digital afc loop, it will probably be used most often to stabilize the receiver after a station has been manually tuned in. The procedure, then, is simplicity itself. Switch S_2 is turned off, thus applying a constant 10 V to the varactor. This biases the varactor to roughly the middle of its range. The desired signal is tuned in, and the last digit of its frequency is noted and set into switch S_1. Finally, the loop switch, S_2, is turned on and the loop is locked.

This technique has been used successfully in several applications. Examples of commercial receivers covering 1 kHz to 1 GHz are shown in Fig. 4. The vlf receiver has the counter and digital afc circuitry built in while the other two units use an external counter. ■■



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INFORMATION RETRIEVAL NUMBER 53

Appraisal programs can be effective

if both supervisor and employee learn the rules of the evaluation game before the day of judgment arrives.

In appraising the work of an actress in a play, a certain theater critic once wrote: "She was the epitome of eloquence and grace—a gifted performer indeed." Across town another critic saw it this way: "She gave the sort of performance that would have induced the audience in Shakespeare's day to shower the stage with an overabundance of well-ripened fruit."

Where appraisals are concerned, whether in the theater or in the engineering department, there will always be a certain amount of controversy, because the appraisers and those being appraised are, after all, only human.

However, much of the misunderstanding about appraisal systems can be eliminated simply by knowing why appraisals are necessary, how to conduct them, and what systems are used.

Pointing up the need to close the communication gap that exists between supervisor and employee is the result of a survey conducted recently at an electronics company.

In answer to the question, "How often does your supervisor conduct an appraisal review with you?" half of the employee respondents said never. When the respondents were questioned further, in an attempt to uncover the appraisal procedure that had been used, supervisors replied that they considered daily casual remarks made to the employee as part of a formal counseling process. The employees, however, considered these off-the-cuff remarks as being irrelevant. To them, a formal appraisal interview had never been held.

When employees were asked if they were satisfied with the appraisal system currently in use, 50% of them said they didn't know what system was in use. (For complete results of the survey, see tables 1 & 2 on opposite page.)

Why evaluations are made

You may ask, "Why do employees have to be appraised at all?" There are three main reasons:

- Employee's viewpoint: "An appraisal not only tells me how I'm doing on the job and what's expected of me in the future, but it gives me the opportunity to express my needs, ambitions and goals. It also gives me a chance to complain, criticize and gripe."
- Supervisor's viewpoint: "It tells me whether or not a man is right for his job, and helps me to select his successor if he's not. Appraisals also help me to distingiush between the 'livewires' and the 'short-circuits' on my staff, and gives me a better understanding of the job and goals of the department and a yardstick for measuring individual and group progress."
- Company president's viewpoint: "If we are to grow, we must determine whether or not our employees have the skills necessary to increase the quality and quantity of production. We should not only provide an opportunity for our people to practice these skills within the organization, but we should also motivate them to acquire these skills by setting goals that have as much meaning and value to the employee as they do to the company. The purpose of the appraisal interview is to inform our employees of these company goals."

Conducting a proper appraisal

The supervisor who wonders just how he should go about conducting an appraisal can be guided by the following five principles:

1. Assume that the employee knows more about himself than the boss does.
2. Understand that it is the employee who sets preplanned objectives with the help of the boss and not the other way around.
3. Realize that what is going to happen is more important than what has happened.
4. Put the accent on the employee's strengths, not his weaknesses.
5. Accept the idea that the boss should be a coach, not a psychoanalyst.

Once the supervisor is fully versed on the guidelines for evaluating an employee, his next logical step is to adopt a procedure for appraisal. Although the application of company-established

Robert Vijil, Jr., engineering instructor, Alabama A & M University.

Table 1. Employee survey

1. How often does your supervisor conduct an appraisal review with you?
   Never, 50% of respondents answered. The remaining answers varied from every six months to every two years.

2. Do you discuss salary at these reviews?
   The 50% who answered negatively to question No. 1 said no to this one. The remaining answers generally fell into a yes category.

3. Does your supervisor make definite recommendations for improvement in your work?
   Yes, said 80%, while 20% answered no.

4. What do you feel is accomplished by a performance review?
   The majority of respondents replied that a review would give them an insight into how their supervisors felt about them. They wanted to know where they stood.

5. Does your supervisor make a point of mentioning your good qualities?
   Yes, said 100%.

6. Are you satisfied with the review system currently in use?
   Half of them said they didn't know what it was. Only 10% expressed satisfaction with the present system.

7. Do you know what the salary evaluation procedure is?
   The answer was 100% no.

8. Do you have good rapport with your supervisor?
   Approximately 75% replied in the affirmative.

9. Do you know what is expected of you in your job?
   Most of the responses were affirmative, but almost all respondents said the understanding was not on a long-range basis.

10. Do you feel you can offer recommendations for improvement in the appraisal procedure?
    All responded yes—they should be held more often and at regularly scheduled intervals.

Table 2. Supervisory survey

1. How often do you hold performance reviews with your employees?
   Approximately 25% claimed to hold reviews every six months, 60% said annually, while 15% said never.

2. Do you discuss salary at these reviews?
   Most respondents answered in the affirmative. Some claimed that salary discussion was the only purpose in holding a review.

3. Do you make definite recommendations for performance improvement to the employee?
   The replies were a categorical yes.

4. Does your employee know the significance of an appraisal review?
   Yes, said 50%. Many supervisors considered this to be a poor question.

5. What do you try to accomplish during an appraisal review?
   To let the employee know where he stands, almost 100% responded.

6. Are you satisfied with the review system currently in use?
   Only 10% said they were satisfied.

7. Do your employees know what the salary-review procedure is?
   Some 80% answered negatively.

8. How often are you appraised and interviewed by your own supervisor?
   All but one answered never.

9. Do you have good rapport with your supervisor?
   Almost 100% answered in the affirmative.

10. Do you have good rapport with your employees?
    The reply was 100% affirmative.

PRODUCTIVITY	Always Above Average	Usually Below Average	Usually Average	Sometimes Above Average	**WORK OUTPUT**
EMOTIONAL STABILITY	Usually Excellent	Often Inadequate	Usually Adequate	Always Adequate	**POISE AND SELF CONTROL**
TECHNICAL ABILITY	Excellent	Adequate	Usually Above Average	Sometimes Inadequate	**KNOWLEDGE AND EXPERIENCE**

a

QUALITY OF WORK

Check most appropriate comment — considering accuracy, errors, waste, economy of material, neatness, etc.

☐ PERFECT	☐ EXCEPTIONALLY HIGH	☐ CONSISTENTLY HIGH
☐ ALWAYS SATISFACTORY	☐ SATISFACTORY	☐ USUALLY SATISFACTORY
☐ FREQUENTLY UNSATISFACTORY	☐ USUALLY UNSATISFACTORY	☐ ALWAYS UNSATISFACTORY

b

REACTION OF RATEE: Does he:	Definitely Agrees	Seems Inclined To Agree	Seems Doubtful	Definitely Disagrees	Non-Commital
Accept the delegation of responsibilities delineated in his position guide?					
Agree with the rightness of his position level?					

c

Appraisal forms vary from detailed (A) to more general (B). Some request ratee reaction (C).

evaluation procedures will naturally vary among supervisors, there are three elements common to all: setting standards; making judgments; and informing the employee.

Setting standards: Before a supervisor can evaluate an employee, both parties must understand what performance is expected from the subordinate. To determine that, the supervisor must know what the reasonable requirements are for the jobs under his direction. Each employee must know how the supervisor interprets these requirements. And these standards must be fair and attainable.

Making judgments: Many supervisors assume that their workers are doing all right unless they make some serious mistakes. A supervisor is not in a good position to appraise the job performance of employees unless he has all the facts.

The appraisal of an employee should represent the honest effort of a manager to collect sufficient relevant information about a particular application and evaluate it to the best of his ability.

Informing the employee: After the employee has been judged, the supervisor should tell him in a personal interview what he thinks of his performance.

Three methods used

In order to accomplish the objectives of an appraisal program, some of the major rating systems should be considered. Various methods used are:

- Chart or form, which lists a number of traits or personal characteristics.
- Rank-order, in which the supervisor places all employees under him in order from best to poorest.
- Forced distribution in which employees are rated on only two characteristics; job performance and promotability.

With this system a five-point scale is used. One end of the scale represents the poorest. The supervisor is requested to slot 10% of his employees to the best end of the scale, 20% to the next category, 40% to the middle bracket, 20% in the bracket next to the low end, and the remaining 10% to the lowest category.

Last things first

Evaluation periods vary: quarterly, semiannually, annually. Recent trends favor quarterly action. To evaluate performance at more frequent intervals can cause the supervisor to remember "last things first," thus creating a critical incident that may be out of proportion with the employee's true performance record. ■■

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THE 32 MODULES

FROM	TO	MODEL NUMBER
Rectangular	Polar	695
Polar	Rectangular	1618
Rectangular	Rotated Rectangular	689
Digital	Synchro	1670
	Resolver	1670
	DC (D/A)	1800
	Sin-Cos DC	1613
	AC (Multiplying D/A)	1690
Synchro	Digital	1623
	Linear DC	678
	Sin-Cos DC	655
	Linear AC	678 & 152
	Resolver (Buffer)	1620
	Synchro (Buffer)	1620
DC	AC (Modulator)	152
	Digital (A/D)	1500
	Sin-Cos DC	670
	Synchro	670 & 676
	Resolver	670 & 1614
Sin-Cos DC	Digital	A 1623
	Linear DC	A 678
	Synchro	676
	Resolver	1614
	Linear AC	A 678 & 152
AC	Linear DC (Demodulator)	840
	Digital	840 & 1500
	Sin-Cos DC	854 & 670
Resolver	Sin-Cos DC	697
	Linear DC	678
	Synchro (Buffer)	1620
	Digital	1623
Frequency	DC	567

AC TO DIGITAL
SYNCHRO TO DIGIT
POLAR TO RECTANG
SYNCHRO TO AC
SYNCHRO TO LINEAR
DIGITAL TO DC (D/A)
DC TO SIN-COS DC
DIGITAL TO RESOLVER

TRANSMAGNETICS, INC.
134-25 Northern Boulevard
Flushing, New York 11354
212-539-2750

Decrease driver turn-off time without sacrificing efficiency

Turn-off time for typical output stages in line drivers and MOS clock drivers may be greatly reduced without appreciably increasing power dissipation in the circuit.

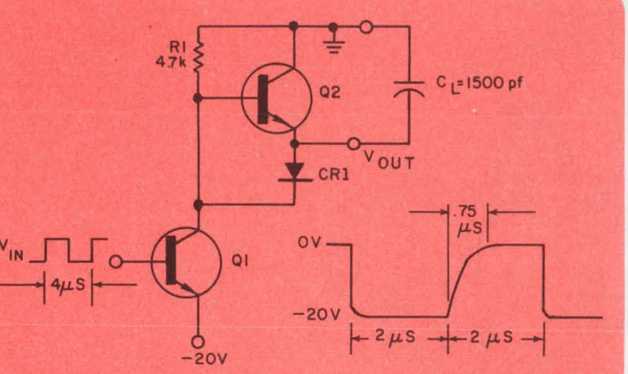
An ordinary output circuit driving a load capacitance of 1500 pF is shown in Fig. 1. The turn-on time of Q_1 is very fast if the saturation resistance is low. The turn-off time, however, is a function of R_1, the collector capacitance of Q_1 and the β of Q_2. Assuming a reasonable value for the β of Q_2 (30 nominal) and a collector capacitance for Q_1 of 20 pF, the turn-off time is essentially exponential with a time-constant of $T = (4.7\ K)(20+1500/30)\ pF = 330$ ns. The rise time is approximately 2.3 time constants or 760 ns.

As shown in Fig. 2 the turn-off time can be greatly reduced with the addition of only two small passive components. The turn-on time is still fast since the capacitance load on the output is increased only 10%. During turn-off, positive feedback is produced from the charge on C_1, which was stored during turn-on of Q_1. This raises the voltage at the junction of CR_2, C_1 and R_1 well above ground, thus providing a more positive voltage for the final value of the exponential rise time. In effect, the charge on C_1 is transferred to the equivalent capacitance at the base of Q_2. The result is a much faster time for the output to reach zero volts. This time is approximately 240 ns or less than one-third the previous rise time.

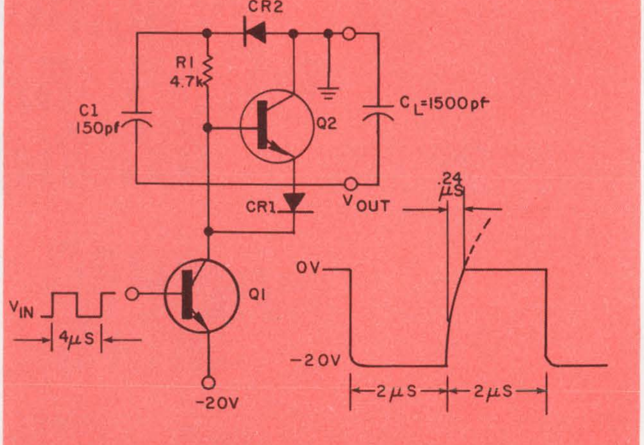
To achieve this rise time by decreasing R_1 to reduce the time constant would require a resistance of 1.5 kΩ producing an additional 180-mW dissipation during the time Q_1 is saturated. For one cycle, additional energy required is 0.36 microjoule. The energy stored in the 150-pF capacitor is only 0.03 microjoule. It can be seen that for a square-wave output of lower frequency, the difference in the efficiency of the two methods is even more pronounced.

L. R. Millsap, Member Technical Staff, Autonetics, Anaheim, Calif.

VOTE FOR 311



1. **Typical driver circuit** for a capacitive load has a rise time of approximately 0.75 μs.



2. **Improved driver circuit** with back biased diode CR_2 has a rise time of approximately 0.24 μs.

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We recently coined the word "inclusivity" as applied to the compatibility of system modules. To be truly flexible and versatile, modules must be as easy to apply as inserting a plug. Such modules must be compatible with one another, compatible with those made by all other manufacturers and compatible with the widest possible range of applications.

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The ANSCAN system features automatic ranging and zeroing, and accurately measures very small signals in the presence of very large noise. Channel access can be sequential or random. Data can be fed to most types of digital recorders or the ANSCAN system can interface directly with couplers, computers or other peripheral equipment.

ANSCAN SPECIFICATIONS

Analog Inputs:	100 channels in 10-channel increments
Conversion Accuracy: (Guaranteed, 0–50°C)	± .01% of full scale
Sample and Hold:	Aperture-time uncertainty <200 nsec
Data Output:	Output word 16 bits BCD, Sign, Address and Range or 13 bits binary Sign, Address and Range

The following control functions are local or programable

Sample Rate:	1, 10, 60, 100, 1000, 5000 samples/sec
Operating Modes:	Continuous, Single Scan, Single Channel, Remote Address
Channel Address:	Sequential or Random
Command Inputs:	Start, Stop, Reset, Channel Address, Address Load (remote start), Recorder Ready

For full information on Model 3700 or any of our systems modules, contact your local Beckman sales representative or the factory

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ELECTRONIC INSTRUMENTS DIVISION
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Major products include: voltage-to-binary converters, voltage-to-BCD converters, current-to-binary converters, current-to-BCD converters, frequency-to-BCD converters, events accumulator, binary-to-BCD converters, digital comparators, digital clocks, digital recorders, analog multiplexers, digital multiplexers, data formatter, teletype formatters, data processors.

Perform frequency scaling without rate multipliers

Do you need a circuit to multiply the frequency of a given square wave by a factor that is not an integer, while at the same time providing a symmetrical output signal? Burst generators and rate multipliers are not up to the task, but the method shown provides a convenient solution.

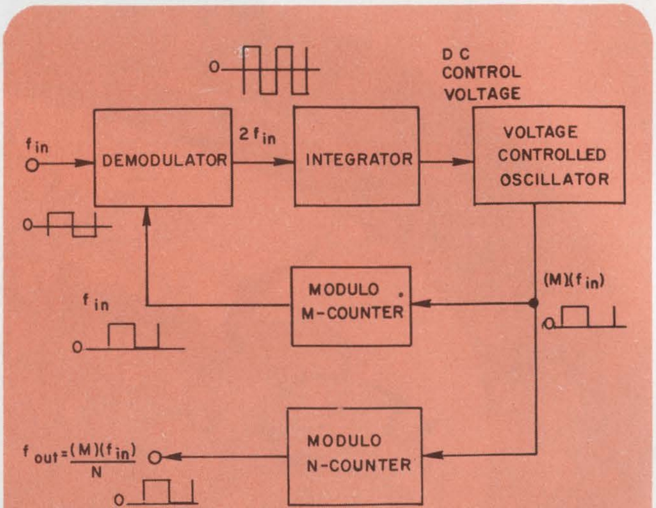
As long as input frequency f_{in} can be acquired by the phase-lock loop, the output of the phase-lock loop will be (M) (f_{in}). If a scale factor of K is required, then $M/N = K$. M and N are selected by first writing K in fractional notation. This ratio is then reduced to its simplest form.

A few examples will illustrate the technique:

Example 1 (K greater than 1)
Required: $f_{out} = 1.4\ f_{in}$
therefore $K = 1.4 = 14/10 = 7/5 = M/N$

Example 2 (K greater than 1)
Required: $f_{out} = 2.7\ f_{in}$
therefore $K = 2.7 = 27/10 = M/N$

Example 3 (K less than 1)



Frequency scaling is accomplished by this circuit arrangement for fractional multiples of f_{in}.

Required: $f_{out} = 0.6\ f_{in}$
therefore $K = 0.6 = 6/10 = 3/5 = M/N$

Irwin Cohen, Theta Instrument Corp., Bogota, N.J.

VOTE FOR 312

Single transformer provides positive and negative voltages

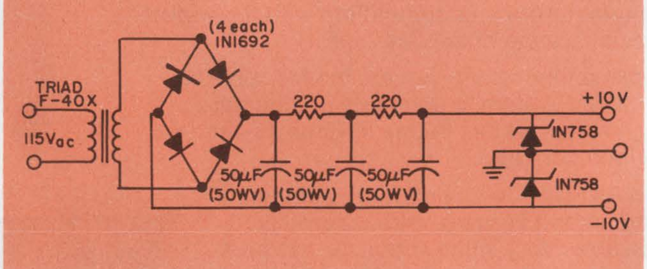
Circuits such as operational amplifiers require the use of both positive and negative voltages. The common technique is to use independent windings on a transformer; however, it is possible to use a single winding to furnish both voltages.

In the circuit shown the negative side of the power supply is not returned to ground. Thus, if two zeners are placed in series across the output, their common point can be grounded. In this way both positive and negative voltages are made available. For the circuit shown the ouputs are +10 and −10 volts. This is sufficient to operate most operational amplifiers. In addition, this power supply is safe against short circuits.

When unsymmetrical voltages are required, zeners of different voltage are used.

Saul Ritterman, Assistant Professor, Bronx Community College, Bronx, N.Y.

VOTE FOR 313



Single transformer winding furnishes plus and minus voltages by using the return side of the bridge instead of ground as negative terminal.

Our 1¼ oz. alarm will blast you with 80db of the most irritating noise in the world.

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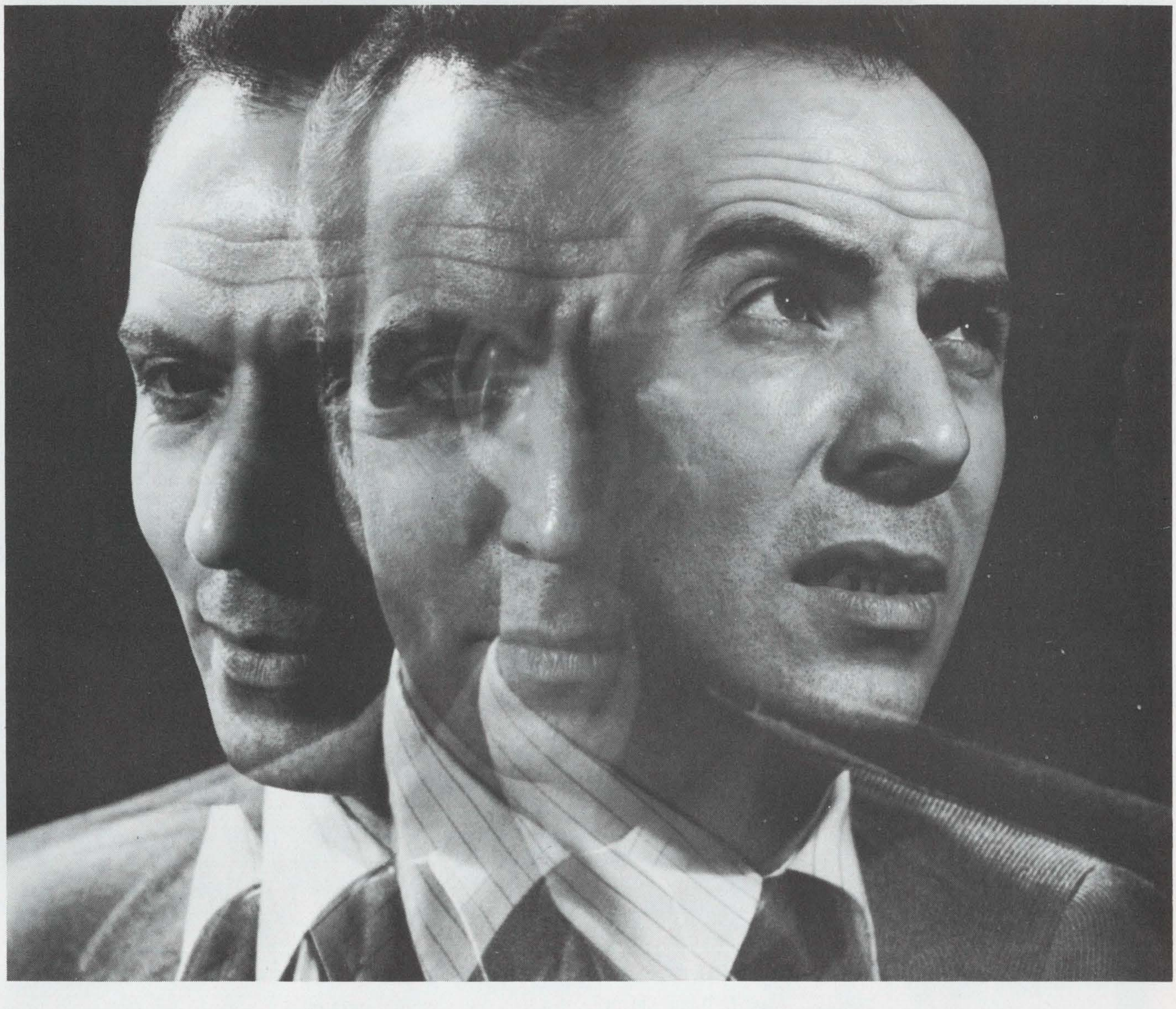


INFORMATION RETRIEVAL NUMBER 56

Hexidecimal display uses MSI package to drive Nixie readout

It is very inconvenient, time-consuming, and often a source of error to read out a group of hexidecimal characters in which each character is represented by four binary lamps. The circuit shown eliminates such problems and reads directly in hexidecimals.

The 9311 is an MSI one-of-sixteen decoder, which accepts four inputs and provides 16 mutually exclusive outputs. These 16 exclusive outputs represent 0 through F of the hexidecimal characters. The 16 outputs are decoded by four 8 × 5 diode matrices, which provide inputs for the drivers of the cathode segments of the readout.

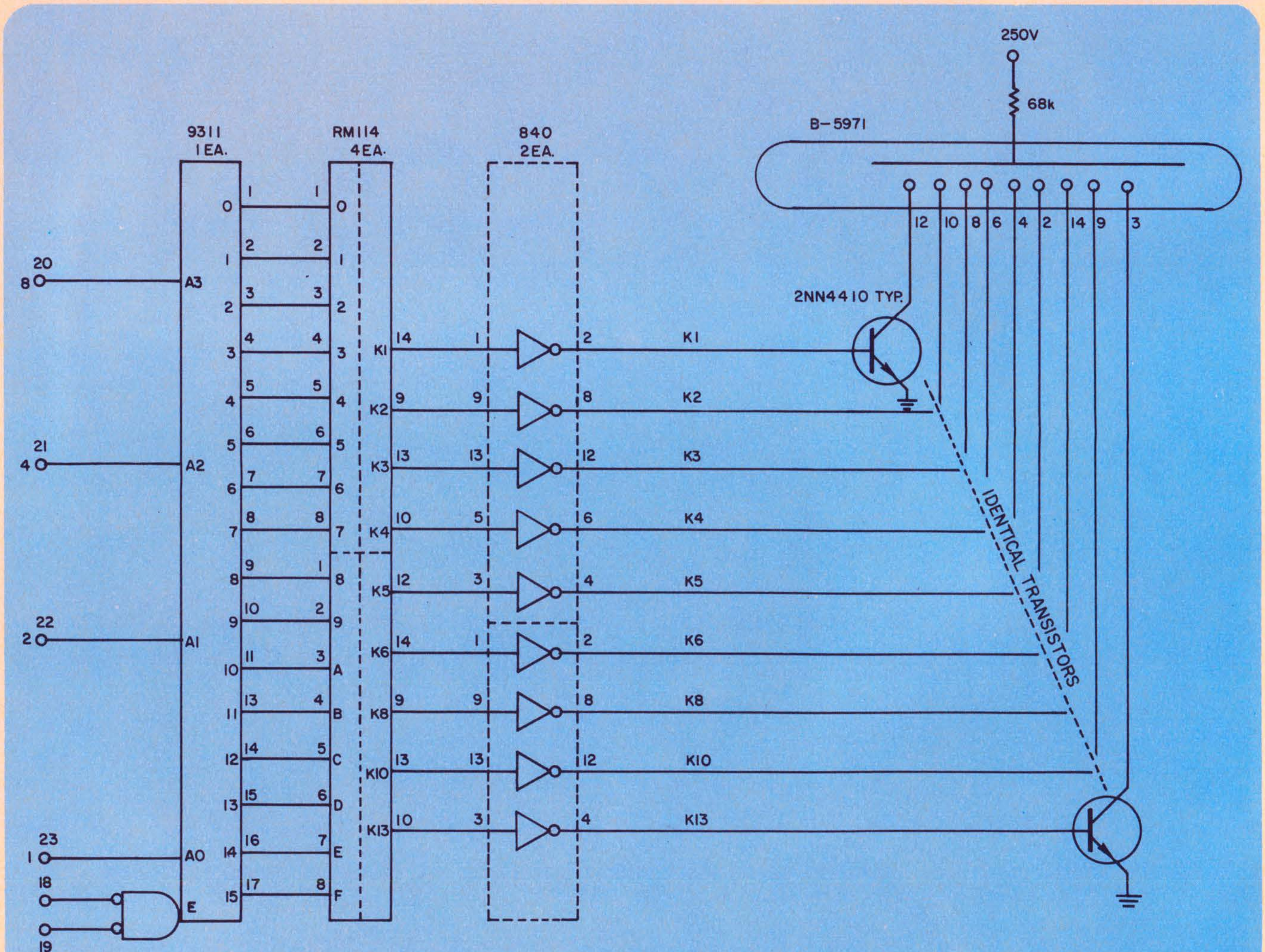
The hexidecimal alpha-numerical characters are formed by turning off or on the appropriate combination of cathode segments of the B-5971 alphanumeric Nixie tube. The circuit can be packaged on a 2 × 4-inch PC card with seven dual in line ICs and nine TO-92 transistors.

Vernon R. Clark, System Design Engineer, Systems Research Dept., Applied Automation Inc., Bartlesville, Okla.

VOTE FOR 314

DIODE MATRIX (4 EA.-RM114)

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
K1	1		1	1		1	1	1	1	1	1	1	1	1	1	1
K2	1		1	1	1			1	1	1	1	1		1		
K3	1			1	1	1	1	1	1	1	1	1		1		
K4	1		1	1		1	1		1	1		1	1	1	1	
K5	1		1				1		1		1		1		1	1
K6	1				1	1	1		1	1	1		1		1	1
K8		1										1		1		
K10			1	1	1	1	1		1	1	1	1				
K13			1		1	1	1		1	1	1				1	1



Display uses MSI to simplify reading hexidecimal characters.

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I
Triplett's Model 630-M Type 1 V-O-M

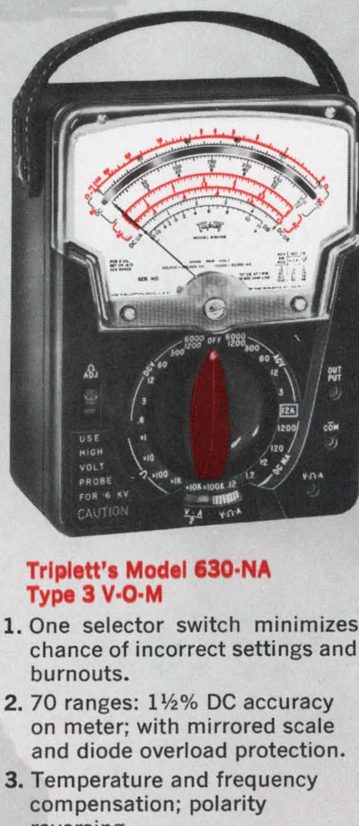
1. 1,000,000 Ohms per volt DC for greater accuracy on high resistance circuits. 20,000 ohms per volt AC.
2. 1μa Suspension Meter Movement. No pivots, bearings, or rolling friction. Extremely rugged. Greater sensitivity and repeatability.
3. 61 ranges, usable with frequencies through 100 kHz. Temperature compensated. 1½% DC accuracy, 3% AC in horizontal position.

$231.00

II
Triplett's Model 630-NS V-O-M

1. 200,000 Ohms per volt DC sensitivity for greater accuracy on high resistance circuits. 20,000 ohms per volt AC.
2. Suspension Meter Movement. No pivots, no bearings, no hairsprings; no rolling friction. Extremely rugged.
3. 62 ranges. Temperature and frequency compensated ±1½% DC Accuracy, ±3% AC.

$116.00



III
Triplett's Model 630-NA Type 3 V-O-M

1. One selector switch minimizes chance of incorrect settings and burnouts.
2. 70 ranges: 1½% DC accuracy on meter; with mirrored scale and diode overload protection.
3. Temperature and frequency compensation; polarity reversing.

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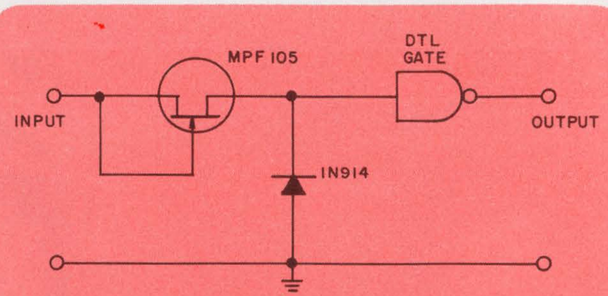
Inexpensive interface works with both DTL and EIA levels

In the development of some portable equipment it became necessary to design an interface that would allow the equipment to be used with standard DTL logic, as well as with the EIA levels used by the telephone system that has level shifts from −6 to +6 V.

The solution was to feed the input signal to the DTL logic through an FET connected as a constant-current logic diode and clamp the input at ground potential with a diode (see figure). The MPF 105 has a typical drain current of 9 mA with the gate connected to source. This protects the driving circuit from current overload in the negative direction.

When using standard DTL logic levels with a false level on the input to the interface, the gate voltage ranged from 0.3 V to 0.47 V over a small sample of FETs. If the equipment has to work in a high noise environment, some selection of the FET may be necessary in order to insure optimum performance. Tests run on the circuit both with and without the interface showed no change in rise time, fall time and propagation delay time for the circuit.



Simple circuit uses FET and diode to interface with both DTL and EIA (telephone) levels.

A. W. Hoecherl, Research Engineer, University of Utah, Salt Lake City, Utah.

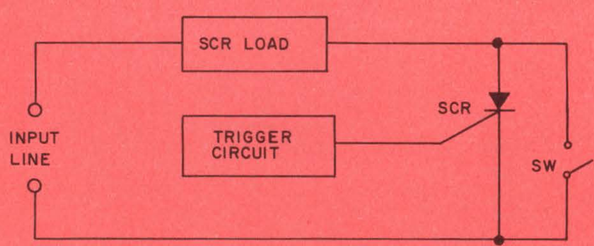
VOTE FOR 315

Improved SCR speed control achieves 100% motor regulation

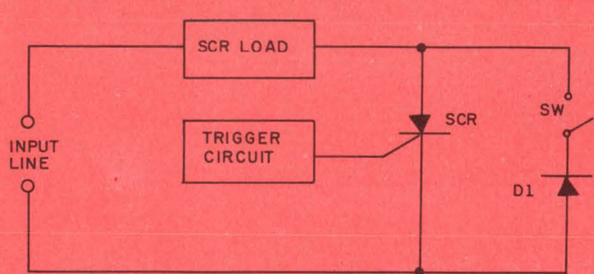
Most universal motor SCR speed controls regulate motor speeds from zero to approximately one-half of rated speed. For full power, a switch is used to short the SCR, effectively connecting the motor across the line input as shown in Fig. 1.

By adding a switch and a diode compatible with the SCR rating (Fig. 2), full speed control can be achieved.

Normal operation with the switch open achieves zero to 50% speed control, permitting full commutation of one-half cycle of the input line. When the switch is closed, the diode fully commutates the other half cycle of the input line while the SCR permits variable commutation of the opposite half cycle.



1. **Conventional SCR speed-control circuit** regulates speed from 0 to 50%.



2. **Improved SCR speed-control circuit** uses diode to achieve 100% speed control.

Richard V. Iwanski, Applications Project Engineer, Spacerays, Inc., Burlington, Mass.

VOTE FOR 316

IFD Winner for September 13, 1969
Robert Billon, Design Engineer, UNITEC, Grenoble, France. His Idea "Schmitt Trigger and Comparator Combine To Form Window Detector" has been voted the Most Valuable of Issue Award.
Vote for the Best Idea in this Issue.

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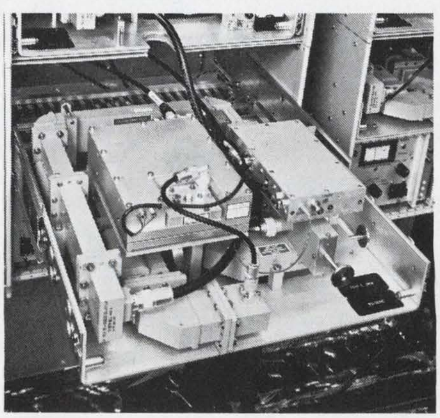
If you're sheltering a skeleton in the form of a worrisome packaging problem, why not unburden yourself to Jonathan the slidemakers? If you need to rack electronic chassis for accessibility, you may slide it, pivot it in behalf of service, or quickly-disconnect it for bench repairs. Whatever your requirement, the Jonathan Ultra-Thin full ball-bearing Type 110 Steel Chassis Slides (available in matched pairs beginning at \$6 the set) will most assuredly carry up to 200 lbs., while measuring only ⅜″ thin. Let Jonathan tuck your problem out of sight!



At Collins Radio Company our little lovelies are now part of a new independent subsystem design for its MW-109E (i-f heterodyne) and MW-108D (remodulating) series of microwave systems. (see photo) The new Collins design, also incorporated in auxiliary equipment, greatly improves system reliability and simplifies ordering, plant engineering, system expansion, station rearrangements and maintenance procedures.

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INFORMATION RETRIEVAL NUMBER 58

Product Source Directory

Signal Generators

This Product Source Directory, covering Signal Generators, is the fifth in a continuing series of product selection data that will list comparative specifications and prices for products frequently purchased by design engineers. All categories will be arranged according to some primary parameter so that items having similar functional capabilities can be instantly compared.

How to use the table

The tables in this section list the specifications for signal generators.

Unless otherwise noted in the tables, all signal generators have input requirements of 95-135 Vac single phase. The following abbreviations apply to all instruments listed.

ina—information not available.

n/a—not applicable.

An index of models by manufacturer is included at the end of each table.

For each table, the instruments are listed in ascending order of one major parameter. The column containing this parameter is color-coded white. Manufacturers are identified by abbreviation. The complete name of each manufacturer can be found in the following Master Cross Index.

Abbrev.	Company	Reader Service No.
AMI	Advanced Measurement Instruments 109 Dover St. Somerville, Mass. (617) 623-2008	**462**
Babcock	Babcock Electronics Corp. 3501 Harbor Blvd. Costa Mesa, Calif. 92626 (714) 540-1234	**463**
GR	General Radio Co. 22 Baker St. Concord, Mass. 01781 (617) 369-4400	**464**
H-P	Hewlett-Packard 1501 Page Mill Road Palo Alto, Calif. 94304 (415) 326-7000	Contact local sales office
Kay	Kay Electric Co. Maple Ave. Pine Brook, N.J. 07058 (201) 227-2000	**465**
Marconi	Marconi Instruments 111 Cedar Lane Englewood, N.J. 07631 (201) 567-0607	**466**
Measure	Measurements P.O. Box 180 Boonton, N.J. 07005 (201) 334-2131	**467**
Polarad	Polarad/Nelson Ross 5 Delaware Drive Lake Success, N.Y. 11040 (516) 328-1100	**468**
R-S	Rohde & Schwarz Sales Co. 111 Lexington Ave. Passaic, N.J. 07005 (201) 773-8010	**469**
Radiometer	Radiometer Electronics The London Company 811 Sharon Drive Westlake, Ohio	**470**
Sage	Sage Laboratories, Inc. Instrument Div. 14 Huron Drive Natick, Mass. 01760 (617) 653-0844	**471**
Sierra	Sierra Electronic Philco Corp. 3885 Bohannon Drive Menlo Park, Calif. 94025 (415) 322-7222	**472**
Singer/Gert	Gertsch Products Singer Instrument Division 3211 La Cienega Blvd. Los Angeles, Calif. 96016 (213) 870-2761	**473**
Singer	Singer Instrumentation Division 915 Pembroke St. Bridgeport, Conn. 06608 (203) 366-3201	**474**

	Manufacturer	Model	FREQUENCY Minimum MHz	Maximum MHz	Acc. %	Stab. ppm	OUTPUT Minimum µV	Maximum V	Modulation	Misc. Features	Price $
	Measure	65B	0.075	30	±0.5	ina	0.1	2.2	am	b	1075
	R-S	SMLR	0.1	30	±1	±50	1	3	am		1425
	R-S	SMAR	0.03	31	0.5	±30	0.01	10	am	g	5495
	R-S	SMDH	dc	50	$2/10^{-9}$	$1/10^{-9}$	0.1	2.5	am, fm	ah	10450
	Measure	82	0.08	50	±1.0	ina	0.1	1.0	am		985
SG 1	GR	1001-A	0.005	50	±1	ina	0.1	2	am		1450
	H-P	606A	0.05	65	±1	0.005%/10min	0.1	3	am	fjp	1540
	H-P	606B	0.05	65	±1	0.005%/10min	0.1	3	am, fm	fprs	1650
	Marconi	TF2002AS	0.01	72	1	30	0.1	1	am, fm	k	2940
	GR	1003	0.067	80	0.1	1/10min	0.1	6	am	df	2795
	R-S	SMSF	87	108	0.2	±50	0.1	0.3	fm		985
	Measure	188	86	110	±0.5	ina	0.1	0.1	fm		700
	Measure	189	86	110	±0.5	ina	0.1	0.1	fm	m	890
	H-P	211A	88	140	ina	ina	0.1	0.2	am		2900
	Sierra	470A-200	50	200	±1	0.005%/10min	50mW	50W	am	j	reg
SG 2	Radiometer	MS-27	0.3	240	0.002	0.005%	0.1	0.1	am, fm		1595
	H-P	202j	195	270	0.5	0.02%	0.1	0.2	am, fm		1595
	H-P	232A	329.3	335	0.0065	ina	1	0.2	am		3200
	Measure	180	2	400	±0.5	ina	0.1	0.1	am	k	760
	Measure	80	2	400	±0.5	ina	0.1	0.1	am		690
	Measure	95	50	400	±0.5	ina	0.1	0.1	fm		1980
	AMI	303A	215	420	0.5	±0.005%/10min	0.1	0.1	fm	j	3500
	H-P	608F	10	455	±1	0.005%/10min	0.1	0.5	am, fm	fqrs	1800
	Measure	801	25	470	±0.5	ina	0.1	0.1	fm		790
	Measure	80R	5	475	±0.5	ina	0.1	0.1	am		690
SG 3	Measure	180R	5	475	±0.5	ina	0.1	0.1	am	k	760
	H-P	608E	10	480	±0.5	0.005%/10min	0.1	1	am	fq	1640
	Singer/Gert	FM-9E	20	486	0.0001	1/mo	0.1	0.5mV	fm		1825
	Singer/Gert	FM-10	0.1	500	0.0001	1/yr	0.1	0.5mV	am, fm	a	2995
	GR	1026	9.5	500	0.05	50	0.1	10	am, pm	df	7150
	Sierra	470A-500	200	500	±1	0.005%/10min	50mW	70W	am	j	reg
	R-S	SMFA	1.39	510	±0.5	±30	0.3	1	am, fm		7260
	AMI	303H	380	520	ina	±0.005%	0.1	0.3	fm	j	2800
	Babcock	BSG-23A	215	550	0.005	ina	0.1	0.07	fm	b	reg
	AMI	303B	400	550	±0.01	ina	ina	ina	fm	j	2450
SG 4	Babcock	BSG-19A	406	550	0.005	ina	1.0	0.1	fm	jt	reg
	Babcock	BSG-17	406	550	0.005	ina	1.0	0.1	fm	b	reg
	AMI	303	225	800	0.5	±0.05%	0.1	0.1	fm	j	1800
	Measure	800	25	960	±0.5	ina	0.1	0.1	fm		790
	R-S	SDFA	30	970	0.5	±10	-110dBm	-6dBm	am, fm		4367
	Marconi	TF2006	4	1000	1	15	0.1	0.1	am, fm	k	6125
	Measure	840	400	1000	±0.5	ina	0.1	0.1	fm		790
	Measure	84TVR	400	1000	±0.5	ina	0.1	0.5	am		865
	Sierra	470A-1000	470	1000	±1	0.003%/10min	50mW	65W	am	j	reg
	Singer	SG-1001	0.061	1024	0.001	10	0.01	2.2	am, fm	ab	4640
SG 5	Singer	SG-1000	7.75	1024	0.001	10	0.01	2.2	am, fm	a	7790
	H-P	612A	450	1230	±1	0.005%/10min	0.1	0.5	am	fjq	1600
	Kay	1522A	1400	1599.9	0.002	2kHz	-120dBm	0dBm	fm, pm	n	4900
	R-S	SMAI	500	1800	±0.5	ina	-130dBm	+10dBm	am, fm, pm	a	4345
	Sierra	470A-1800	1000	1800	±1	0.003%/10min	50mW	40W	am	j	reg
	Sage	831-L-1	1000	2000	±0.1	1	80mW	150mW	am		6400
	Sage	851-L-1	1000	2000	±1	ina	n/a	100mW	am	c	2995
	Sage	841C-L-1	1000	2000	±0.1	1/wk	80mW	150mW	am	e	9195
	H-P	614A	800	2100	±1	0.005%/°C	0.1	0.223	am, fm, pm	cj	2400
	AMI	3000	1435	2310	0.01	0.001%/°C	-130dBm	-10dBm	am, fm	v	6960
SG 6	H-P	8614A	800	2400	±5MHz	0.005%/°C	-127dBm	+10dBm	am, fm, pm	cdj	2350
	H-P	8614B	800	2400	±0.5	0.005%/°C	n/a	15mW	am, fm, pm	cdj	1600
	Polarad	1605	950	2400	±0.5	0.0008%/V	-130dBm	0dBm	fm, pm	cj	2230
	Polarad	1105	950	2400	±0.5	0.0008%/V	-130dBm	0dBm	fm, pm	cij	1990
	Sierra	470A-2500	1800	2500	±1	0.003%/10min	100mW	25W	am	j	reg

a. Digital frequency readout.
b. Cavity tuned source.
c. Klystron signal source.
d. Phase Locked.
e. Backward wave oscillator.
f. External pulse modulation.
g. Can be synchronized to internal crystal or external crystal
h. Stability per day.
i. 0.0005%/°C
j. Internal, external modulation.
k. Solid state.

Signal Innovator

Singer has advanced the state-of-the-art with a signal generator so New it almost requires a new name.

The Model SG-1000 obsoletes every other signal generator within its frequency range . . . singly or in combination. Its performance is so superior that no other instrument available can equal or even approach it.

That's why we call it the Innovator.

Here's why you'll call it unbelievable . . .

■ Digital readout of frequency.

■ Broadband frequency coverage from 61kHz to 512MHz (to 1024MHz with a simple passive doubler) in a small 5¼″ high package.

■ Exceptional frequency accuracy and resolution . . . typically 0.005% . . . and no human readout errors.

■ Full modulation capability AM □ FM □ Pulse □ Video □ Internal 1,000Hz modulation □ . . . and combinations of the above.

■ Output levels from +20dBM to −146dBM.

■ An automatically leveled output . . . within ± 0.5dB over the entire frequency range.

■ Use it as a 2MHz counter for counting modulating signals or rep rates directly.

■ A spectrally pure output signal approaching that of a crystal . . . extremely low residual and incidental FM.

■ Total elimination of dial tracking errors.

■ The availability of BCD frequency output and a programmable attenuator to assure system integration.

This is only part of the SG-1000 story. A more complete technical description is available in Singer Application/Data Bulletin SG-10 upon request.

For additional information contact your local Singer Representative, or write or call —

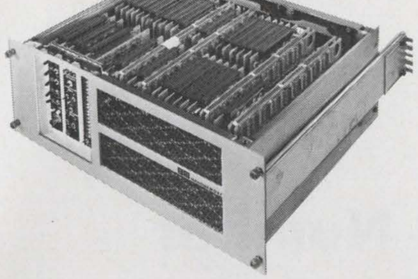
The Singer Company
Instrumentation Division
915 Pembroke Street
Bridgeport, Conn. 06608.
203-366-3201.
In Europe contact: Singer Sewing Machine Company, Instrumentation Division, P.O. Box 301, 8034 Zurich, Switzerland, Telephone: (051) 47 25 10
TWX 710-453-3483

SINGER
INSTRUMENTATION

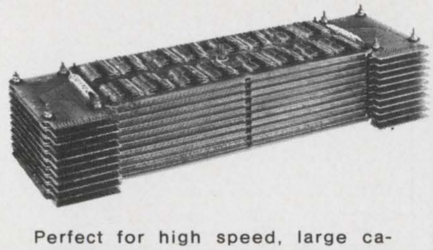
INFORMATION RETRIEVAL NUMBER 60

	Manufacturer	Model	FREQUENCY Minimum MHz	FREQUENCY Maximum MHz	Acc. %	Stab. ppm	OUTPUT Minimum µV	OUTPUT Maximum V	Modulation	Misc. Features	Price $
SG 7	Sage	851-S-51	2000	2500	±1	ina	n/a	100mW	am	c	2995
	Sage	814A-L-9	2000	2500	±0.1	0.05	n/a	100mW	am	c	5950
	Sage	814A-S-1	2500	3050	±0.1	0.05	n/a	75mW	am	c	4250
	Sage	851-S-52	2500	3600	±1	ina	n/a	100mW	am	c	2995
	Sage	814A-S-2	2950	3600	±0.01	0.05	n/a	80mW	am	c	4250
	Sage	831-S-1	2000	4000	±0.1	1	40mW	200mW	am	e	6400
	Sage	841B-S-1	2000	4000	±0.1	0.2	40mW	200mW	am	e	7950
	Sage	841C-S-1	2000	4000	±0.1	1/wk	40mW	200mW	am	e	9195
	H-P	616B	1800	4200	±1	0.005%/°C	0.1	0.223	am, fm, pm	cj	2400
	Sage	814A-S-31	3700	4300	±0.1	0.05	n/a	1000mW	am	c	8350
SG 8	H-P	8616B	1800	4500	±0.5	0.005%/°C	n/a	15mW	am, fm, pm	cdj	1600
	H-P	8616A	1800	4500	±10MHz	0.005%/°C	-127dBm	+10dBm	am, fm, pm	cdj	2350
	Polarad	1106	1950	4600	±0.5	0.0008%/V	-127dBm	+3dBm	fm, pm	cij	1990
	Polarad	1606	1950	4600	±0.5	0.0008%/V	-127dBm	+3dBm	fm, pm	cij	2230
	R-S	SMBI	1700	5000	±0.5	ina	-130dBm	+5dBm	fm, pm	a	4345
	Sage	851-C-51	5100	5900	±1	ina	n/a	100mW	am	c	2995
	Sage	814A-C-1A	5100	5900	±0.1	0.05	n/a	60mW	am	c	4250
	Sage	814A-C-10	5400	5900	±0.1	0.05	n/a	200mW	am	c	4500
	Sage	814A-C-31	5925	6525	±0.1	0.05	n/a	1W	am	c	ina
	Sage	851-C-52	5925	6525	±1	ina	n/a	200mW	am	c	2995
SG 9	R-S	SLRC	2300	7000	±1.5	ina	-100dBm	ina	square	f	5335
	Sage	851-C-53	6575	7125	±1	ina	n/a	200mW	am	c	2995
	H-P	618C	3800	7600	±1	0.006%/°C	0.1	0.223	am, fm, pm	cdj	2350
	Sage	841C-C-1	4000	8000	±0.1	1/wk	20mW	100mW	am	e	9195
	Sage	831-C-1	4000	8000	±0.1	1	20mW	100mW	am	e	6400
	Sage	841B-C-1	4000	8000	±0.1	0.2	20mW	100mW	am	e	7950
	Polarad	1107	3800	8200	±0.5	0.0008%/V	-127dBm	+3dBm	am, fm	cij	1990
	Polarad	1607	3800	8200	±0.5	0.0008%/V	-127dBm	+3dBm	fm, pm	cij	2230
	Sage	854-X-55	7500	8500	±1	0.2	n/a	200mW	am	cd	5995
SG 10	Sage	851-X-55	7500	8500	±1	ina	n/a	200mW	am	c	2995
	Sage	814A-X-5	7500	8500	±0.1	0.05	n/a	200mW	am	c	4700
	Sage	851-X-53	8500	10000	±1	ina	n/a	100mW	am	c	2995
	Sage	851-X-51	8500	10000	±1	ina	n/a	500mW	am	c	2995
	Sage	814A-X-21	8500	10000	±0.1	0.05	n/a	500mW	am	c	4150
	Sage	814A-X-2	9000	10000	±0.1	0.05	n/a	80mW	am	c	4250
	Sage	814A-X-21S	9600	10200	±0.1	0.05	n/a	500mW	am	c	4300
	Sage	814A-X-12	9800	10300	±0.1	0.05	n/a	200mW	am	c	4450
	Polarad	1608	6950	11000	±0.5	0.0008%/V	-127dBm	+3dBm	fm, pm	cij	2230
	H-P	620B	7000	11000	±1	0.006%/°C	0.1	0.223	am, fm, pm	cdj	2350
SG 11	Sage	851-X-52	9800	11200	±1	ina	n/a	200mW	am	c	2995
	Sage	814A-X-3	9800	11200	±0.1	0.05	n/a	500mW	am	c	4750
	Sage	814A-X3M	10600	11800	±0.1	0.05	n/a	100mW	am	c	4750
	Sage	841B-X-1	8000	12400	±0.1	0.2	50mW	350mW	am	e	7950
	Sage	831-X-1	8000	12400	±0.1	1	50mW	350mW	am	e	6400
	Sage	841C-X-1	8000	12400	±0.1	1/wk	50mW	350mW	am	e	9195
	R-S	SMCI	4800	12600	±0.5	ina	-130dBm	0dBm	fm, pm	a	4495
	Sage	851-K-51	12400	14500	±1	ina	n/a	100mW	am	c	2995
	Sage	814A-K-21	12800	14500	±0.1	0.5	n/a	100mW	am	c	4150
	H-P	626A	10000	15500	±1	0.005%/°C	-90dBm	+10dBm	am, fm, pm	cj	3900
SG 12	Polarad	1709	10000	15500	±1	0.0008%/V	-100dBm	0dBm	fm, pm	cij	3210
	Polarad	1809	10000	15500	±1	0.0008%/V	-100dBm	0dBm	fm, pm	cij	3450
	Sage	814A-K-22	15000	17300	±0.1	0.05	n/a	200mW	am	c	5150
	Sage	831-K-1	12400	18000	±0.1	1	40mW	200mW	am	e	6400
	Sage	841B-K-1	12400	18000	±0.1	0.2	40mW	200mW	am	e	7950
	Polarad	1810	15000	21000	±1	0.0008%/V	-100dBm	0dBm	fm, pm	cij	3450
	Polarad	1710	15000	21000	±1	0.0008%/V	-100dBm	0dBm	fm, pm	cij	3210
	H-P	628A	15000	21000	±1	0.005%/°C	-90dBm	+10dBm	am, fm, pm	cj	3900
	Sage	814A-K-24	23000	25000	±0.1	0.05	n/a	100mW	am	c	6950
	Sage	817A-K-35	34000	36000	±0.1	0.5	n/a	50mW	am	c	8200

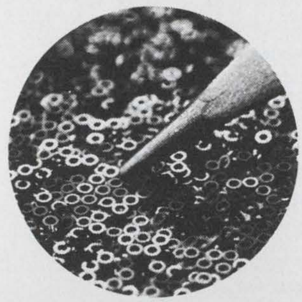
m. Provides 10.7 MHz output
n. Programmable.
p. Signal source, triodes & pentodes.
q. Signal Source - triodes
r. External frequency modulation.
s. Internal amplitude modulation
t. 20 IRIG channels.
u. 10 IRIG channels.
v. In two bands 1435-1540 MHz and 2200-2310 MHz.



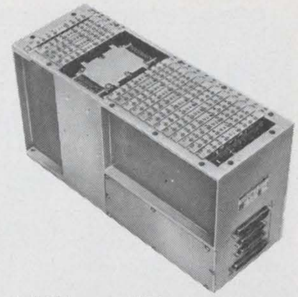
High speed commercial memory system — **NANOMEMORY 2600**. Full cycle time of 600 nanoseconds, and word capacities of 16K by 18 or 8K by 36. It's all done with a second-generation 2-1/2D drive system with efficient circuit and logic design, for reduced component count and high MTBF, and wide operating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



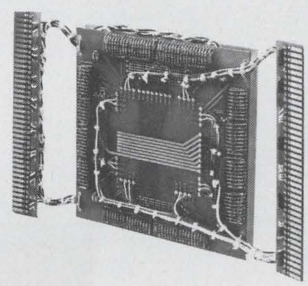
Perfect for high speed, large capacity mainframe memory systems... **NANOSTAK 3020**...technology breakthrough in 3W, 2-1/2D stacks. Stackable, compact size is an amazing 25% of competitive planar stacks and offers a significant advantage in form factor for system packaging. Extremely fast 650 nanosecond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



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



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



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

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

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

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telephone (213) 772-5201 TWX: 910-325-6213

INFORMATION RETRIEVAL NUMBER 61

Index by Model Number

Name	Model	Code
AMI	303A	SG3
Advanced	303	SG4
Measure-	303B	SG4
ment In-	303H	SG4
struments	3000	SG6
Babcock	BSG-17	SG4
Babcock	BSG-19A	SG4
Electronics	BSG-23A	SG4
Corp.		
GR	1001-A	SG1
General	1003	SG1
Radio Co.	1026	SG1
H-P	202J	SG2
Hewlett-Pack-	211A	SG2
ard Co.	232A	SG2
	606A	SG1
	606B	SG1
	608E	SG3
	608F	SG3
	612A	SG5
	614A	SG6
	616B	SG7
	618C	SG9
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	628A	SG12
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	8614B	SG6
	8616A	SG8
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Kay Electric		
Marconi	TF2002AS	SG1
Marconi In-	TF2006	SG5
struments		
Measure	65B	SG1
Measure-	80	SG2
ments	80R	SG3
	82	SG1
	84TVR	SG5
	95	SG3
	180	SG2
	180R	SG3
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	189	SG2
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	1809	SG12
	1810	SG12
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Schwarz	SMAI	SG5
	SMAR	SG1
	SMBI	SG8
	SMCI	SG11
	SMDH	SG1
	SMFA	SG4
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Radiometer		
Electronics		
Sage	814A-C-1A	SG8
Sage Labs,	814A-C-10	SG8
Inc.	814A-C-31	SG8
	814A-K-21	SG11
	814A-K-22	SG12
	814A-K-24	SG12
	814A-L-9	SG7
	814A-S-1	SG7
	814A-S-2	SG7
	814A-S-31	SG7
	814A-X-2	SG10
	814A-X-3	SG11
	814A-X-3M	SG11
	814A-X-5	SG10
	814A-X-12	SG10
	814A-X-21	SG10
	814A-X-21S	SG10
	817A-K-35	SG12
	831-C-1	SG9
	831-K-1	SG12
	831-L-1	SG6
	831-S-1	SG7
	831-X-1	SG11
	841B-C-1	SG9
	841B-K-1	SG12
	841B-S-1	SG7
	841B-X-1	SG11
	841C-C-1	SG9
	841C-L-1	SG6
	841C-S-1	SG7
	841C-X-1	SG11
	851-C-51	SG8
	851-C-52	SG8
	851-C-53	SG9
	851-K-51	SG11
	851-L-1	SG6
	851-S-51	SG7
	851-S-52	SG7
	851-X-51	SG10
	851-X-52	SG11
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Sierra Elec-	470A-500	SG4
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Philco	470A-2500	SG6
Corp.		
Singer/Gert	FM-9E	SG3
Gertsch	FM-10	SG3
Products,		
Singer	SG-1000	SG5
Singer In-	SG-1001	SG5
strumenta-		
tion Div.		

new mil-performance square cermet trimmers ...from CTS

Now . . . with CTS Cermet Multi-Turn Square Trimmers you get Characteristic C Mil-spec performance for all military applications. All new series 165 (style RJ24) and series 175 (style RJ22) meet tough Characteristic C of Mil-R-22097C. These same environmental characteristics are available . . . at lower cost . . . for commercial and industrial applications.

Both small ⅜"-square series 165 and compact ½"-square series 175 trimmers assure infinite resolution over a 20 ohm to 2.5 megohm range . . . and power rating of ½ watt @ 85°C. TC±150 ppm/°C for 2k ohms and above. −0 +175 ppm/°C from 50 ohms through 250 ohms and −0 +250 ppm/°C from 500 ohms through 1k ohm. All available at no extra cost.

Low cost*, proven quality, and top performance—combined with ***fast distributor delivery***—make CTS your best industrial trimmer choice. Can't use one of our standard series? Ask how we can solve specific application problems. Call or write for complete details to CTS of Berne, Inc., Berne, Indiana 46711. Phone (219) 589-3111.

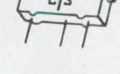
*Check these prices for 4-6 week production delivery. (Small quantities from stock)

	Series 165		Series 175	
Quantity	25-49 (each)	1000 (each)	25-49 (each)	1000 (each)
Commercial (±20% Tol.)	$4.55	$3.25	$4.20	$2.95
MIL-type (±10% Tol., Char. C)	5.30	3.80	5.10	3.65

CTS CORPORATION
Elkhart, Indiana

Other CTS Cermet Trimmers include:

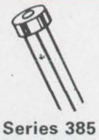
Series 185
1-¼" x .290" x .364" multi-turn



Series 190
¾" x .160" x .310" multi-turn

Series 340
¼" x ¼" square x .270" high—single-turn

Series 360
$\frac{7}{16}$" x $\frac{17}{64}$" x $\frac{25}{64}$" single-turn



Series 385
$\frac{11}{32}$" round x .225" high—single-turn

Series 660
⅜" round x ¼" high—single-turn

Series 630
½" round x $\frac{13}{32}$" high—single-turn

INFORMATION RETRIEVAL NUMBER 65

New Products

Miniature storage tube for $500 can hold an image for two weeks

Princeton Electronic Products, Inc., P.O. Box 101, New Brunswick, N.J. Phone: (201) 297-4448. P&A: $500; 4 wks.

Inexpensively store black-and-white images on an ordinary television set for two weeks? Nonsense?—No, reality!

It's all possible with a new miniature storage tube that sells for only $500 in small quantities and has a resolution of 800 television lines (640,000 bits). Key to the new unit's reduced price and size is its structured target, which is actually a monolithic silicon wafer. This structured silicon target allows use of a gun assembly which is identical to that employed in vidicon camera tubes.

Lithocon model 1M-800-HS actually acts as an electronic buffer memory. It can store a full-gray-scale image for 12 minutes with constant refreshing, and a black-and-white image for 30 minutes with power applied or for two weeks if the power is turned off or the tube removed from its socket.

Special sockets or cables are not necessary; the Lithocon will operate with standard vidicon hardware. In addition, its associated electronics only involves a dc power supply and a magnetically deflected yoke.

Operating voltage level is only 450 V, not in the order of kilovolts as with previous storage tubes. This means that high-voltage corona is no longer a problem and lower system operating temperatures are possible.

Besides a decisive cost advantage, the Lithocon permits broad applications flexibility because the display is separated from the storage system. Now the user can selectively edit the stored image, rather than erase the entire display and then repaint, as with previous systems.

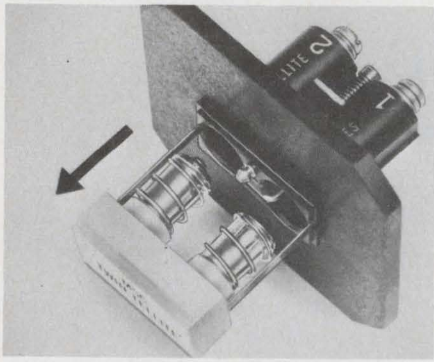
Other advantages include being able to zoom-in on any portion of the image for blow-up studies. Television monitors can also be time shared, thereby reducing required computer time.

The 1M-800-HS is the first product in a series of under-development silicon-target devices. In the near future, the 1M-1200-HS storage tube will offer a resolution of 1200 lines for only $1000.

Also available is the model 400 storage terminal, which contains the necessary electronics (except for display) and controls for the Lithocon. Cost is $3750; delivery is six to eight weeks.

CIRCLE NO. 250

Indicating pilot light uses only two lamps

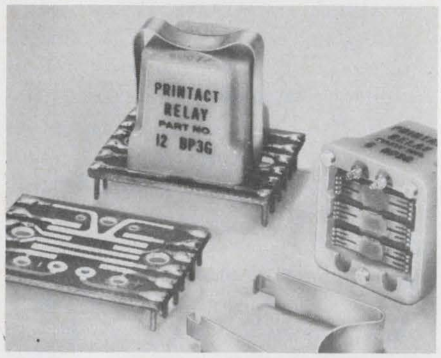


Master Specialties Co., 1640 Monrovia, Costa Mesa, Calif. Phone: (714) 642-2427.

Able to display as many as three lines of words in any one of six illuminated colors, a new indicating pilot light features two-lamp reliability. In addition, the 201 Twin-Tellite unit mounts in two drilled holes instead of square panel cutouts like previous devices. Its lens assembly can be pulled out and turned down for easy access to the lamps.

CIRCLE NO. 251

Modular 3-piece relays plug into PC boards

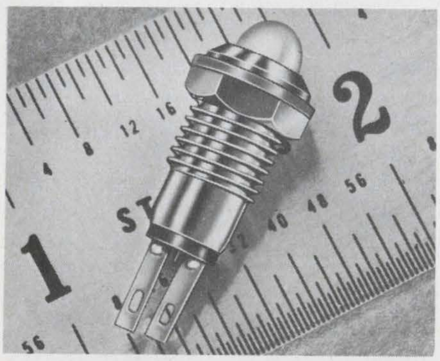


Executone Inc., Printact Relay Div., Austell Pl., Long Island City, N. Y. Phone: (212) 392-4800. P&A: $3.12 to $5.37; 4 to 6 wks.

Consisting of a header, a housing assembly and a clamp, a new series of latching and non-latching relays mount into PC boards with a plug-in bead pin header. This eliminates using sockets and allows replacement without soldering. These relays can be inserted and soldered to a PC board without the attached housing assembly.

CIRCLE NO. 252

Tiny lamp assembly replaces lamps easily

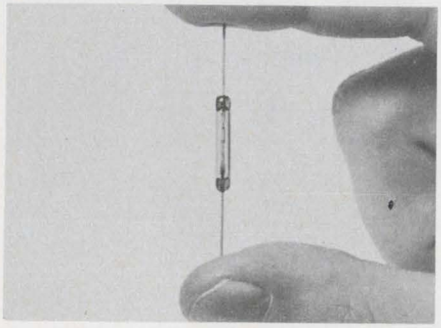


Alco Electronic Products, Inc., Box 1348, Lawrence, Mass. Phone: (617) 686-3887. P&A: $1.29; stock.

Easily serviced from the front, a new panel indicator lamp assembly features finger-tip lamp replacement. The Brite Glo assembly has a removable round dome lens and a supplied #680 incandescent T-1 lamp rated for 5 V at 60 mA. It mounts with a 9/32-32 nut. Lens colors are in red, green, blue, yellow or white.

CIRCLE NO. 253

Dry-reed rhodium switch withstands 600 V min

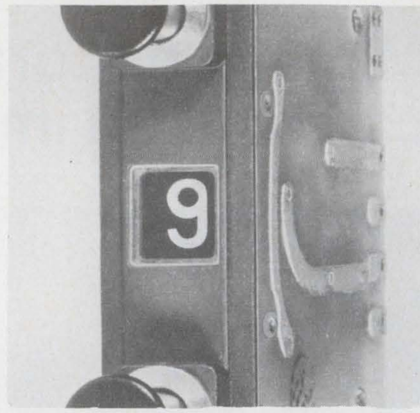


Hathaway Instruments Inc., 5250 E. Evans Ave., Denver, Colo. Phone: (303) 756-8301.

Developed for switching extremely high stand-off voltages, a new dry-reed rhodium switch has a minimum dielectric strength of 600 V. The switch has a contact rating of 1 A and power rating of 5 W. Insulation resistance is 10^6 Ω and initial contact resistance is 0.2 Ω. The switch is 0.8-in. long and 0.106 in. in dia.

CIRCLE NO. 254

Bidirectional switch works by push buttons

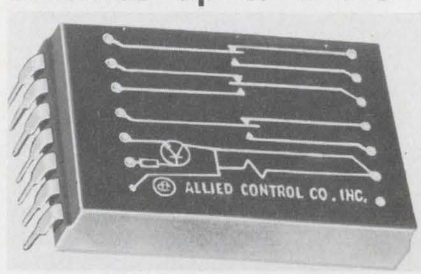


Janco Corp., 3111 Winona Ave., Burbank, Calif. Phone: (213) 845-7473.

By depressing one of two buttons on its front, a new bidirectional printed circuit rotary switch can change its position. It is available with 8, 10 or 12 positions with all standard codes. Ratings include 3 A at continuous duty; and make and break ratings are 0.125 A resistive at 28 V dc or 115 V ac, and 0.05 A inductive at 28 V dc. A viewing light is optional.

CIRCLE NO. 255

Tiny dry-reed relay switches up to 1 ms



Allied Control Co., Inc., Plantsville, Conn. Phone: (203) 628-9654.

Measuring only 0.0275-in. high and suitable for mounting on PC boards spaced as close as 0.5-in. apart, a new dry-reed relay switches at 1 ms. The Tri-R unit has contact ratings of 10 W resistive, 50 V dc or 0.5 A dc, power requirement of 75 mW/pole, and a life expectancy of 2×10^7 operations. It can incorporate other solid-state devices such as diodes, op amps and time-delay circuits in the same package.

CIRCLE NO. 256

...New Broadband MIC package

The TRW Gigahertz Family takes another step forward in power and frequency: a new compatible series of microwave transistors, operating at 3 GHz—the heart of S-band. The new family includes four devices with the highest available output power bandwidth and gain at 3 GHz:

PT6669	300 mW	6 dB gain
PT6618	1.0 Watt	5 dB gain
PT6635	2.5 Watts	4 dB gain
PT6636	5.0 Watts	3 dB gain

This new common base series is consistent with microwave integrated circuits and/or conventional stripline. The package is also specially designed for low parasitics. Like the rest of the Gigahertz Family, they operate from a 28 volt source.

For complete information and applications assistance, contact TRW Semiconductors Division, 14520 Aviation Blvd., Lawndale, California 90260. Phone: (213) 679-4561. TWX: 910-325-6206.

ACTUAL SIZE

TRW®

INFORMATION RETRIEVAL NUMBER 66

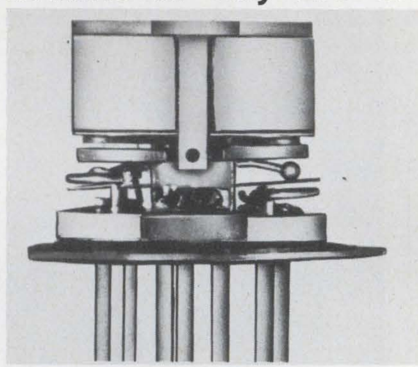
Compact fluidic relay simplifies interfacing

Corning Glass Works Fluidic Products Dept., Corning, N.Y. Phone: (607) 962-4444. P&A: $16 to $19.50; 2 wks.

A new fluidic time-delay relay eliminates the bulky resistor-capacitor networks and mechanical timing devices that were formerly required to set up time delays of 1 to 10 seconds or longer. The compact unit offers a repeatability of ±5% over its full adjustable time range, which can be expanded by adding capacitance.

CIRCLE NO. 257

Latching 4-pole relays actuate in only 1.5 ms



Teledyne Relays, 3155 W. El Segundo Blvd., Hawthorne, Calif. Phone: (213) 679-2205. P&A: under $20; stock.

Housed in a TO-5 case, a new line of four-pole magnetic latching relays actuate in 1.5 ms. Series 424 relays have 26.5-V dc reset coils and 0.1-V dc trip coils that will accept 80% of the required trip current without tripping. They are adjusted to trip between 80 and 120% of the nominal trip current.

CIRCLE NO. 258

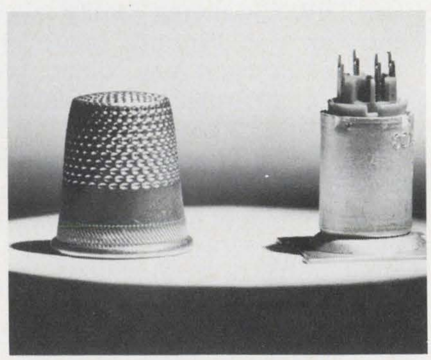
Annunciator system is 3 tiny modules

Rundel Components, Inc., 740 Broadway, Redwood City, Calif.

A miniature solid-state relay, mounted on a small pilot light, together with a small solid-state amplifier, form a complete annunciator system that gives off audible signals. The annunciator has standard sequence buttons and separate test and acknowledge buttons. The three units can be mounted together or separately to provide 10 annunciator points that can be powered by a single supply.

CIRCLE NO. 259

Pushbutton module brings down size

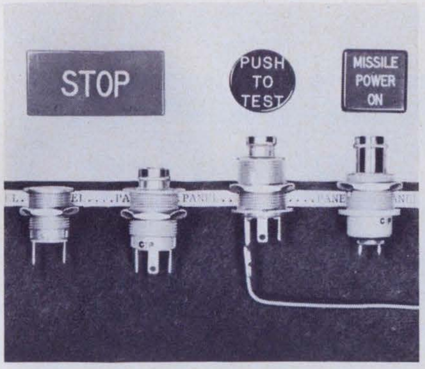


Cutler Hammer, Inc., Specialty Products Div., 4201 N. 27 St., Milwaukee, Wis. Phone: (414) 442-7800. P&A: $4.55 to $6.69; 8 to 10 wks.

Only the size of a thimble, a new pushbutton module can be snapped into place on illuminated pushbutton assemblies for efficient and inexpensive switching. The Diamin unit is interchangeable with snap-action low-travel limit switches, and is available with silver or gold contacts for different ratings.

CIRCLE NO. 260

Panel indicators widen selection

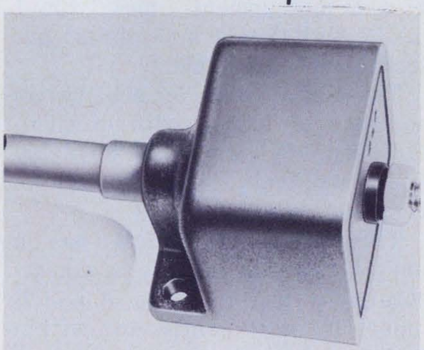


Clare-Pendar Co., P.O. Box 785, Post Falls, Idaho. Phone: (208) 773-4541.

Including standard and press-to-test models, a new line of panel indicators offers versatility of selection with front and rear-mounting styles. The new line offers front-removable single-light lenses in over a dozen shapes and a choice of nine colors, environmentally sealed indicator bases, and clip-on or solder-lug terminal connections.

CIRCLE NO. 261

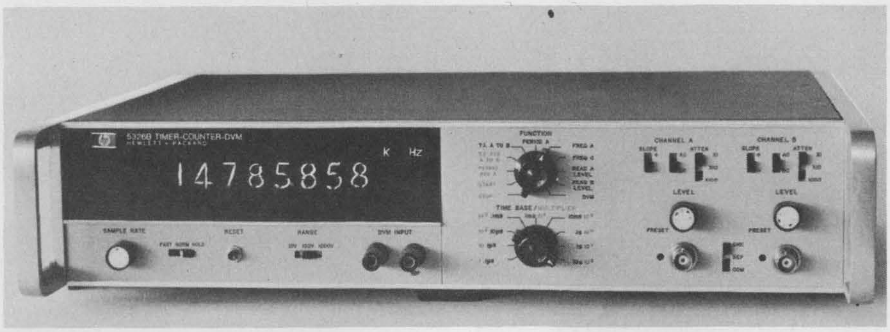
Fast rf limit switch actuates in 10 μs



Johnson Controls, Inc., 227 South St., Rochester, Mich. Phone: (313) 651-0218.

The model 7610 rf limit switch is a solid-state device that actuates in less than 10 μs on 110 V dc when there is enough capacitance between its antenna probe and a ground. It has no moving parts and is guaranteed for an unlimited number of actuations. It is available prewired with an inductive output of 1 A—10 A inrush and 1 A continuous.

CIRCLE NO. 262



Low-cost 50-MHz counter doubles as a seven-digit DVM

Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 326-7000. P&A: $1150 (A), $1450 (A/B); 4 wks.

Incorporating a 50-MHz electronic counter and a digital voltmeter in one instrument for under $2000 is one of the most versatile universal counters available.

The basic instrument is the model 5326A counter/timer. Adding an integrating digital voltmeter to the counter timer results in the model 5326A/B.

The model 5325A/B counter/DVM measures frequencies from 0 to 50 MHz of either periodic or random signals by period average measurements.

It has a dual-channel input, either ac or dc-coupled, and features level-controllable differential input amplifiers. A three-step attenuator changes the control-range maximum voltages in decades of ±2, ±20 and ±200 V.

Inputs to the two channels can be from either common or separate signals. This design results in high stability and sensitivity and an impedance of 1 MΩ shunted by 25 pF.

Time-interval averaging ranges from 15 ns to 1 s with a single-shot resolution of 100 ns. Since a measurement can be averaged over 10^8 intervals, resolutions down to 10 ps can be obtained.

The counter's gate time is selectable in nine decades from 0.1 μs to 10 s, with automatic display of the decimal point and units.

Periods are fully displayed with a seven-digit readout (eight digits optional), and an overflow lamp lights up on the front panel for counts in excess of the seven digits.

Time-interval measurements can be made from 0.1 μs to 10 s. A rear-panel connector furnishes 1-μs marker pulses from channel A and B for trigger-level display on an oscilloscope.

The 5326A/B offers dc voltage measurement in three decades of 10, 100 and 1000 volts. Auto-polarity and measurment times from 1 ms (2 digits) to 1 s (5 digits) are front-panel selectable.

The digital voltmeter achieves an accuracy of 0.05% with excellent linearity by the use of a highly linear and very stable voltage to frequency converter.

This seven-digit DVM has a unique function in that it can accurately measure channel A and B input trigger points to within 0.05% and display that value.

Consequently 50% points and 10% to 90% rise and fall-time points can be accurately set for time-interval measurements by using the internal meter functions.

The input impedance of the voltmeter ranges from 10 MΩ for the 1000-V range to greater than 1000 MΩ for the 10-V range.

Ac normal-mode rejection is greater than 60 dB for multiples of 10 Hz and integration time is 100 ms. The DVM suppresses the display of unwanted zeros.

CIRCLE NO. 263

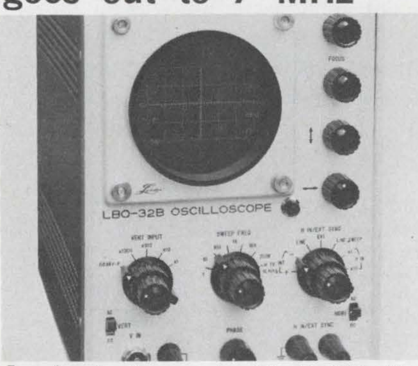
Inexpensive tester zeros-in on FETs

Sencore, Inc., 426 Westgate, Addison, Ill. Phone: (312) 543-7740. Price: $94.50.

Specifically designed to measure field-effect transistors, a new low-cost tester checks FETs as they should be checked—like cold vacuum tubes. Testers intended to measure transistors only cannot usually give a true performance indication for FETs. The new instrument, model FT155, is particularly designed to measure the new generation of field-effect transistors.

CIRCLE NO. 264

Three-in. oscilloscope goes out to 7 MHz



Leader Instruments, 37-27 27th St., Long Island City, N.Y. Phone: (212) 729-7411. P&A: $189.50; stock.

With sweep rates from 1 Hz to 200 kHz in six steps, a new 3-in. oscilloscope spans the frequency band of dc to 7 MHz. The model LBO-32B unit has easily balanced horizontal and vertical amplifiers allowing it to be used as a vector scope. It has an input sensitivity of 10 mV/cm and a calibration voltage of 0.03 V pk-pk at 60 Hz.

CIRCLE NO. 265

Computerized wiring tester performs 9000 checks/min

Automation Dynamics, div. of Resalab Inc., 35 Industrial Parkway, Northvale, N.J. Phone: (201) 768-9200. P&A: from \$37,500; from 120 days.

Delivering a complete diagnostic analysis of complex wiring systems, a new high-speed computerized test system can perform up to 9000 tests per minute. Checking for shorts, opens, leakage and impedance, model QC 448 represents the complete integration of a measuring system, a digital computer, and software. Primary applications are computer backplanes, aircraft harnesses, multi-layer printed circuit boards and multi-conductor cables.

The new system triples operating speed over conventional punched-tape-controlled circuit analyzers. This high-speed performance reduces testing costs and permits complete retesting after each error has been repaired. The retesting ensures that the rework has not introduced a new fault in previously tested circuits.

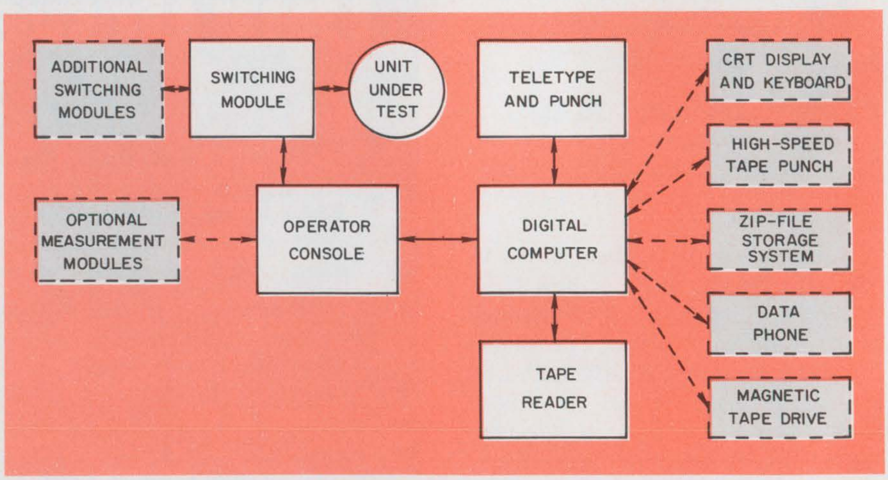
Model QC 448 employs Zip-Talk, a user-oriented conversational language, for both programming and diagnostic output data. The language uses the common terms of product descriptions, such as connector, pin number, or wire color.

Complete identification of faults, wiring errors, short-circuit paths, missing connections and components are automatically computed and displayed whenever a no-go condition exists. In addition, by using the computational capability of the digital computer, programming efforts can be reduced up to 50% over conventional paper-tape-controlled systems. A subroutine allows operation of the systems in a self-program mode.

The digital computer is a Hewlett-Packard model 2114B with a storage of 8192 words having 16-bit lengths. A photo-electric tape reader is used to load the programs into the computer. A model ASR 33 teletypewriter and punch acts as the output data logger.

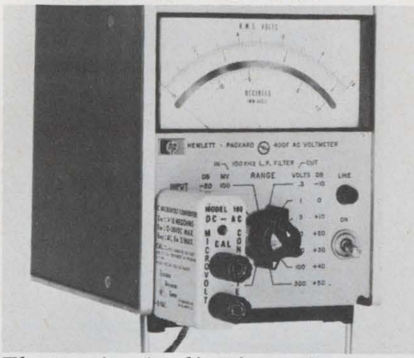
Optional measurement modules can expand the system's capability to dc and ac voltage, current and crosstalk. System capacity, which is normally 2500 terminations, can be increased to 100,000 test terminations. Optional peripheral equipment includes a high-speed punch, a CRT display, a magnetic tape drive, data-phone compatibility, and a Zip-File storage system.

CIRCLE NO. 266



Computerized test system checks out complex wiring at speeds of 9000 tests per minute. Its complete diagnostic analysis includes short, open, leakage and impedance checks. A full array of options meet special needs.

Ac to dc converter is accurate to 1%

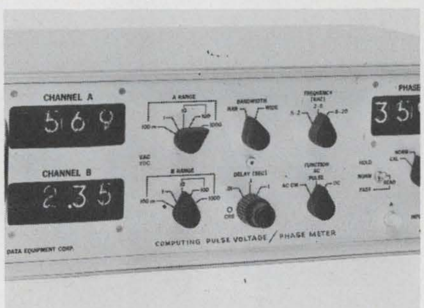


Electronic Applications Co., 2213 Edwards Ave., S. El Monte, Calif. Phone: (213) 442-3212. Price: under $50.

Transforming any ac millivoltmeter into a direct-reading dc microvoltmeter, a new low-cost microvolt dc converter accomplishes this at a 1% accuracy. The model 100's accuracy is limited only by the linearity of the ac millivoltmeter. It has a 1-μV resolution and features zero drift. Input impedance is 10 MΩ.

CIRCLE NO. 267

Voltmeter/phasemeter measures 1-ms pulses

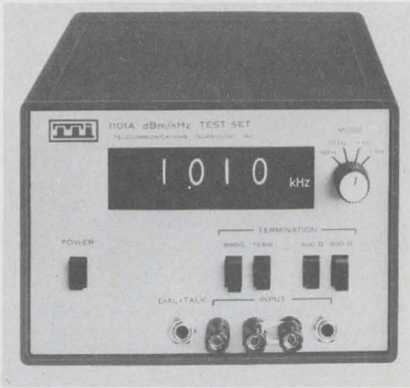


Ocean Data Equipment, 883 Waterman Ave., E. Providence, R. I. Phone: (401) 434-7780.

Measuring pulse or cw, a new two-channel ac digital voltmeter/phasemeter measures bursts of 1 ms. The model VIP-100 computing pulse meter responds from 500 to 20,000 Hz at 20 independent voltage readings per channel. It measures voltages from 10 mV to 1000 V at 100-μV resolutions and phase angles from 0 to 360 degrees at 0.1-degree resolutions.

CIRCLE NO. 268

DBm/kHz test set is one instrument

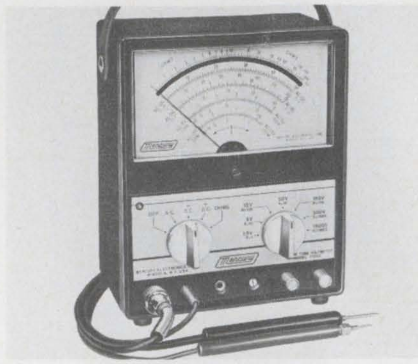


Telecommunications Technology Inc., 920 Commercial St., Palo Alto, Calif. Phone: (415) 326-9217. P&A: $1185; 60 days.

Sampling at 10 readings per second, a new dBm/kHz test set measures frequency and transmission levels in one instrument. The model 1101A has automatic ranging for digital readouts −50 to +10 dBm. It has frequency resolutions of 0.1, 1 and 10 Hz and a level resolution of 0.1 dB.

CIRCLE NO. 269

Mirror-scale VTVM widens ac response

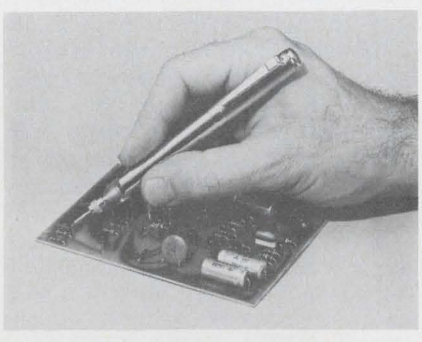


Singer Products Co., Inc., Electronics Div., 95 Broad St., New York. Phone: (212 944-8700. P&A: $39.95/kit, $49.95/wired; stock.

Available in both wired and kit form, a new vacuum-tube-voltmeter includes a wide frequency response for color-television service compatibility, fm multiplex and general-use applications. The model 1700C mirror-scale unit measures 0 to 1500 V ac and dc in seven ranges at a full-scale accuracy of ±5% and 0 to 1 GΩ in seven ranges.

CIRCLE NO. 271

Cordless signal source pulses a wide spectrum

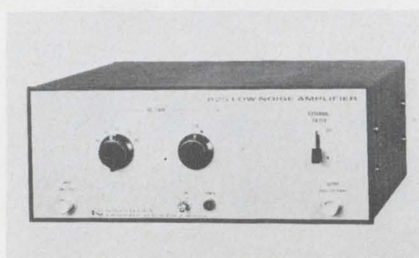


Don Bosco Electronics, Inc., 525 Broad St., Bridgeport, Conn.

Ideal for applications in DTL, TTL and RTL circuits, a new cordless pen-sized signal source generates and injects pulses over the audio, i-f and rf spectrums. Known as the "Mosquito," it operates on a single 1.5-V battery and weighs only 1 oz. It can be used to troubleshoot and test digital equipment, computers, telephone circuits, instruments and audio systems.

CIRCLE NO. 270

Gain-stable amplifier lowers noise to 25 nV



Keithley Instruments, Inc., 28775 Aurora Rd., Cleveland, Ohio. Phone: (216) 248-0400. Price: $400.

Providing a high degree of feedback over the operating range of 1 Hz to 1 MHz, a new low-noise amplifier exhibits a gain-stability of 0.5% per °C and noise of (shorted input) less than 25 nV rms per root Hz above 1 kHz and 100 nV per root Hz at 10 kHz. The model 825 has harmonic distortion of less than 0.05% and variable gain in five 10-db steps from 40 to 80 dB.

CIRCLE NO. 272

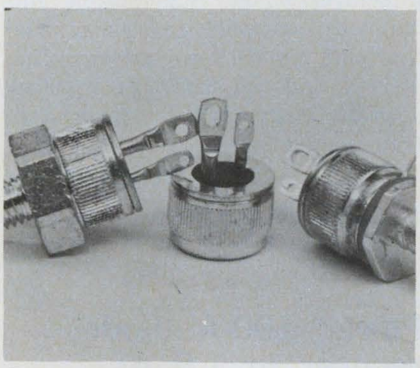
Power 1200-V SCR carries 1500 A

Power Semiconductors Inc., 90 Munson St., Devon, Conn.

Said to be the world's largest SCR, a new silicon controlled rectifier with a 48-mm pellet diameter is capable of supplying up to 1500 A at up to 1200 V. Called Astro-Pack, this high-power device eliminates the need for parelleling, thereby reducing the size and cost of the equipment into which it is designed. It can be supplied as a component or a heat-sink subassembly.

CIRCLE NO. 273

Metal-can triacs can handle 15 A

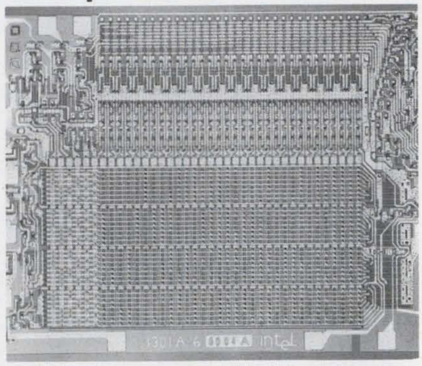


Texas Instruments Inc., Components Group, P.O. Box 5012, Dallas, Tex. Phone: (214) 238-2011. P&A: $1.70 to $4.15; stock.

Useful as a substitute for electromechanical relays and contactors, a new line of metal-can triacs feature current ratings as high as 15 A rms. Models 220, 230 and 240 can handle load currents of 6, 10, and 15 A, respectively, and offer voltage ratings of 200, 400 or 500 V. They are available in three package configurations.

CIRCLE NO. 274

LSI memory chip accepts 1024 bits

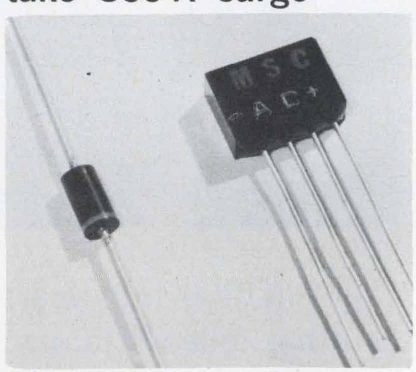


Intel Corp., 365 Middlefield Rd., Mountain View, Calif. Phone: (415) 969-1670. P&A: $120; 4 to 6 wks.

Providing random access in 60 ns maximum, a Schottky-process LSI bipolar read-only memory stores 1024 bits organized as 256 words by four bits. Model 3301 is fully decoded and has two chip-select leads that permit expansion to a 1024-word memory without the need for external decoding. Power dissipation is only 0.5 mW per bit.

CIRCLE NO. 275

Small rectifiers take 300-A surge



Microsemiconductor Corp., 11250 Playa Court, Culver City, Calif. Phone: (213) 391-8271. P&A: 23¢; stock to 2 wks.

Capable of handling 300-A surges at 100°C, series MHR 3-A silicon rectifiers offer peak inverse voltage ratings of 100 to 1000 V. These plastic devices meet or exceed the requirements of MIL-STD-202B, method 103A, and all other specifications of NEMA-EIA class A2. They are 0.2 in. in diameter × 0.38-in. long.

CIRCLE NO. 276

Fast-recovery diodes carry up to 750 mA

Electronic Devices, Inc., 21 Gray Oaks Ave., Yonkers, N.Y. Phone: (914) 965-440. Price: 26¢ typical.

Miniature axial-lead fast-recovery silicon rectifiers offer a recovery time of 250 ns and a forward current rating of 750 mA over the range of 50 to 1000 PIV. Series CB-F units, which measure 0.12 in. in diameter and 0.25 in. in length, are designed for use in high-density PC-board packages. Applications include computers, terminals, and test instruments.

CIRCLE NO. 277

IC memory drivers propagate in 60 ns

Texas Instruments Inc., Components Group, P.O. Box 5012, Dallas, Tex. Phone: (214) 238-2011. Price: $4.25 to $8.50.

Three new system interface IC memory drivers provide a typical average propagation delay time of 60 ns and a nominal output sink current of 400 mA. The SN75303 interfaces bipolar logic levels and magnetic memory systems; the SN75308 can be used as word-line driver; and the SN75324 replaces discrete high-current transistor-transformer circuits.

CIRCLE NO. 278

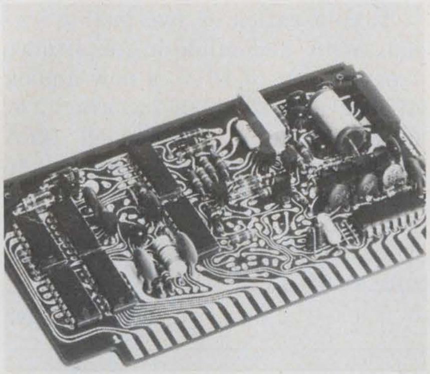
Power 100-A diodes recover in 1.5 μs

International Rectifier, Semiconductor Div., 233 Kansas St., El Segundo, Calif. Phone: (213) 678-6281. P&A: $25; stock.

Series 101KL and 101KLR fast-recovery diodes feature reverse recovery times of 1.5 and 2 μs with up to 100-A ratings at voltages from 400 to 1300 V. They are supplied in a DO-8 Rock-top package. Applications include inverters, phase-controlled SCR assemblies, and use as a free wheeling diode across an SCR bridge.

CIRCLE NO. 279

A/d 12-bit converter boasts $179.50 price



Analogic Corp., Audubon Rd., Wakefield, Mass. Phone: (617) 246-0300. P&A: $179.50; stock to 2 wks.

Digitizing analog signals to an accuracy of 0.05%, a new 12-bit a/d converter slashes 12-bit converter costs to $179.50. The model AN2612 has operating rates of 1000 conversions/s in eight-bit configurations and 100 conversions/s in 12-bit configurations. Temperature coefficient is 0.004%/°F.

CIRCLE NO. 280

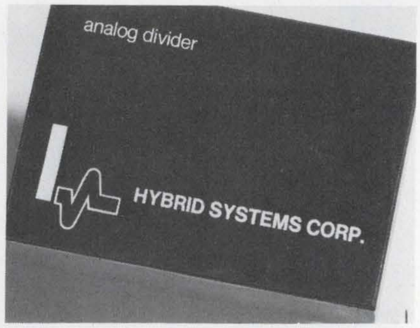
Dual power supplies give 100 mA/output

Phipps Precision Products, 7641 Densmore Ave., Van Nuys, Calif. Phone: (213) 785-3109. P&A: $41; stock.

Providing dual ±15-V dc or single 30-V dc outputs in modules, a new line of power supplies delivers up to 100 mA per output. Model 401 units operate from 115 V ac at an output-accuracy of ±0.05 V dc. They have a temperature coefficient of 0.02%/°C and no-load to full-load regulation of 0.005%.

CIRCLE NO. 281

Stable analog divider is accurate to 10 mV



Hybrid Systems Corp., 95 Terrace Hall Ave., Burlington, Mass. Phone: (617) 272-1522. P&A: $120; stock to 2 wks.

Taking ratios of two analog signals with denominator amplitudes from 50 mV to 10 V, a new analog divider displays an accuracy of 0.1% (10 mV). The model 106A encapsulated unit is linear to 0.05% and can take square roots to 0.1%. Gain vs temperature is 0.005%/°C and offset vs temperature is 50 μV/°C.

CIRCLE NO. 397

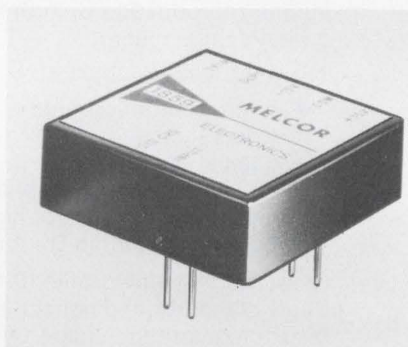
Voltage comparators drift just 0.05 mV/°C

California Electronic Mfg. Co., Inc., Box 555, Alamo, Calif. Phone: (415) 932-3911. P&A: $58 to $94; stock to 2 wks.

Improving trip point stability by voltage comparators drift only 10 to 1, a new series of precision 0.05 mV/°C. The series −01 Voltsensors have a hysteresis of 0.5 mV, and output rise and fall times of 1 μs. They are available in single and dual-set-point, and dual-set-point/dual-output types.

CIRCLE NO. 398

Differential op amp drifts only 0.5 μV/°C



Melcor Electronics Corp., 1750 New Hwy., Farmingdale, N.Y. Phone: (516) 694-5570. P&A: $64; stock.

Featuring a gain of 10^7 and an output of ±10 V at 5 mA, a new chopper-stabilized differential amplifier exhibits a voltage drift of 0.5 μV/°C and offset current drift of 1 pA/°C. Model 1859 operates over the temperature range of 0 to 66°C, has a small-signal response to 500 kHz, 20-kHz full-power, 5-μV of noise to 10 kHz and is powered by ±15 V dc at 20 mA.

CIRCLE NO. 282

Tiny synchro converter replaces bulky servos

Transmagnetics, 134-25 Northern Blvd., Flushing, N.Y. Phone: (212) 539-2750. P&A: $250; 4 to 6 wks.

Converting three-wire synchro inputs to dc sine-cosine ouputs, a new converter replaces less accurate and bulkier mechanical servos. The model 655MP4 has an accuracy of five minutes of arc, accepts 11.8 V rms (line-to-line) ±10%, and has an ac reference of 26 V rms (isolated) ±10% at 30 mA.

CIRCLE NO. 283

DATA PROCESSING

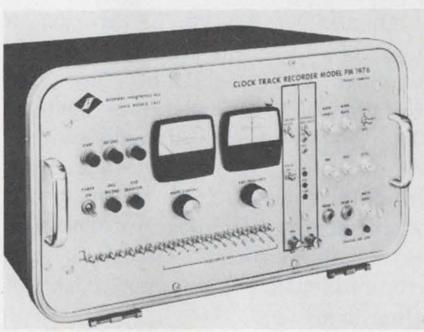
I/O data terminal prints 30 characters/s

Sperry Rand Corp., Univac Div., P.O. Box 3100, Philadelphia, Pa. Phone: (215) 646-9000. P&A: $3285; Spring, 1970.

Designed to be compatible with most computer systems, a new asynchronous input-output printer operates in a full or half-duplex mode at speeds of 10, 15, or 30 characters per second. The DCT-500 data communications terminal consists of an advanced 132-column printer mechanism, a control unit and a keyboard.

CIRCLE NO. 284

Fast clock recorder tracks disc memories



Pioneer Magnetics Inc., 1745 Berkeley St., Santa Monica, Calif. Phone: (213) 393-0136. Availability: stock.

In less than two minutes, a new rotating-memory clock recorder can automatically record clock tracks on disc or drum memories with undetectable closure error. Model PM 1976 can record frequencies from 10 Hz to 5 MHz with a bit capacity of 2 to 524,287 bits, readily selectable from front-panel switches. Set-up time is generally under 10 minutes.

CIRCLE NO. 285

Digital tape system programs cw and ccw

Ampex Corp., Computer Products Div., 9937 W. Jefferson Blvd., Culver City, Calif. Phone: (213) 836-5000. Price: from $2000.

Offering full computer compatibility and restriction-free programming, a complete digital tape memory system features bidirectional programming and read-after-write operation. The TMX uses 8-1/2-in. reels and has packing densities of 200, 556, and 800 bits/in. on standard 1/2-in. computer tape. Maximum tape speed is 12-1/2 in./s.

CIRCLE NO. 286

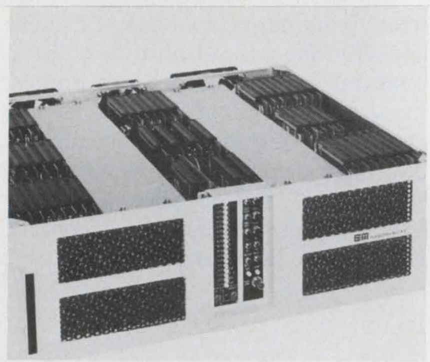
Portable coupler transmits 300 baud

Info-Max, 470 San Antonio Rd., Palo Alto, Calif. Phone: (415) 327-5470. P&A: $395; 30 days.

Featuring broad compatibility with data-terminal equipment and high immunity to external and line noise, a new compact portable acoustic coupler performs at a maximum data rate of 300 baud. It has switch-selectable half or full-duplex transmit/receive modes. Interface cables are available for Teletype 20-mA equipment and all RS-232-B equipment.

CIRCLE NO. 287

Reliable core memory has 650-ns cycle time

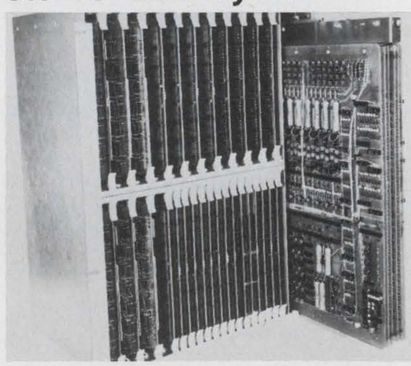


Electronic Memories, 12621 Chadron Ave., Hawthorne, Calif. Phone: (213) 772-5201. P&A: 3¢ to 5¢/bit; first quarter, 1970.

Nanomemory 3650 is a ferrite core memory system with a minimum mean time between failures of 2000 hours and a cycle time of 650 ns. It is available in capacities that range from 16k to 128k words by 8 bits to 76 bits per word. The drive circuitry of the new memory provides rise and fall times of approximately 50 ns.

CIRCLE NO. 288

Mass core memory stores 65k bytes



Interdata, 2 Crescent Place, Oceanport, N.J. Phone: (201) 229-4040. Price: from $25,000.

Organized as 32,768 words, a new 65k-byte mass core memory employs a 16 or 18-bit two-wire coincident-current 2-1/2-D system. The design uses multi-pole switches in the bit access system, and a unipolar readout from the memory. Applications include information retrieval, real-time functions and communications systems. Cycling time is 1.8 μs.

CIRCLE NO. 289

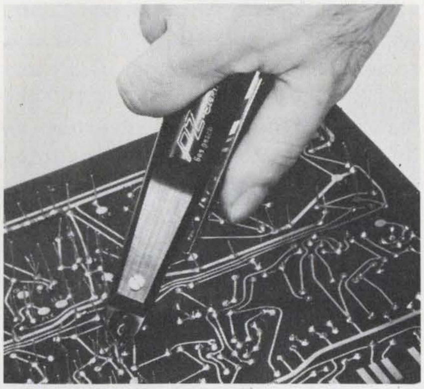
Inexpensive joystick is self-contained unit

Computek, Inc., 143 Albany St., Cambridge, Mass. Price: $1000.

Model JS low-cost joystick graphic-input accessory requires no mandatory options and can be used with any CRT display. It assures high resolution and linearity by using metal-film potentiometers that turn 360° with the full 5-in. travel of the joystick handle. Three pushbuttons on the joystick generate commands for lines, points, and end.

CIRCLE NO. 290

Pneumatic pliers swing through 90°

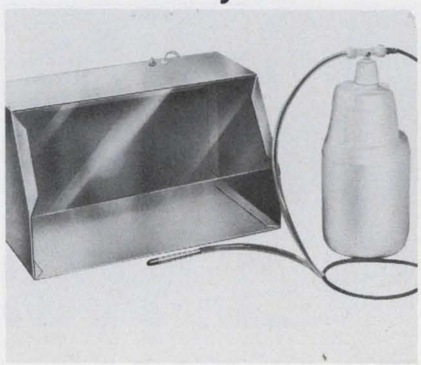


Hunter Associates, 182 Clairmont Terr., Orange, N.J. Phone: (201) 672-0423. P&A: $84.95 or $91.95; 3 to 4 wks.

A new lightweight compact pneumatic pliers has working heads that can be rotated through 90 degrees. The PZ Electronica is available with two interchangeable jaw inserts: one for cutting only, and the other for simultaneous cutting and crimping. The second jaw can be used to trim components and lock them in place on PC boards.

CIRCLE NO. 291

Abrasive clean pencil is full mini-system



Techni-Tool, Inc., 1218 Arch St., Philadelphia, Pa. Phone: (215) 566-4457.

Without requiring a large capital investment or expansive exhaust equipment, a new abrasive cleaning pencil comes complete and ready to operate. The unit consists of a pick-up assembly with cannister, a pencil and hoses, a cabinet with light and shield, a vacuum system, a foot valve, and a pressure regulator. The pencil can be used with wet or dry media.

CIRCLE NO. 292

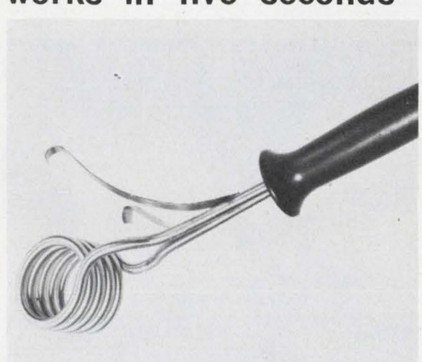
Motorized wire twister makes tiny harnesses

Storm Products Co., 2251 Federal Ave., Los Angeles, Calif.

The Mini-Twister motorized wire twister allows the fabrication of twisted pairs, triads and miniature wiring harnesses. Terminals, pins or lugs can be attached prior to twisting. Even AWG #30 and smaller computer wire can be automatically processed into twisted configurations. Costly hand-work operations such as untwisting of pairs and hand stripping can now be eliminated.

CIRCLE NO. 293

Circular tubing shrinker works in five seconds

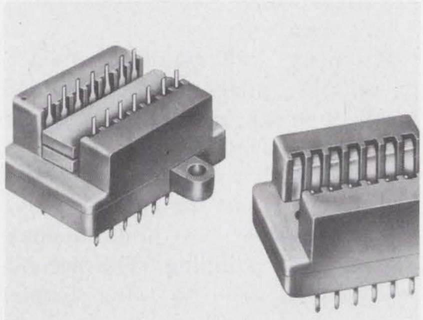


Russell Industries, Inc., 96 Station Plaza, Lynbrook, N.Y. Phone: (516) 887-9000. Price: $17.95.

Labeled as Heat Tunnel, a new lightweight portable hand tool can shrink tubing in as little as five to seven seconds to 50% of its original diameter. The unit has a weight of less than one pound. It is a general-purpose product that is designed for industrial, experimental and hobbyist use in electronic, marine, electrical, automotive and home applications.

CIRCLE NO. 294

DIP test sockets invert device leads

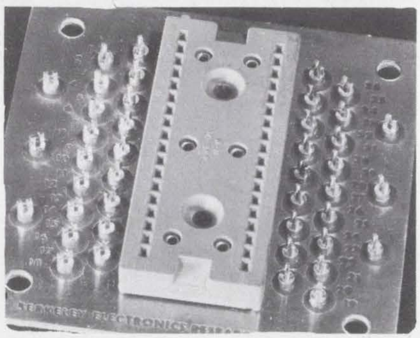


Barnes Corp., 24 N. Lansdowne Ave., Lansdowne, Pa. Phone (215) 622-1525. P&A: $1.58 to $2.95; 3 wks.

Designed for high-speed hand testing of dual-in-line devices, series 121-0102 inverted DIP test sockets accept devices with the leads up. This allows test probes to be connected to the top of mounted devices while all the leads are excited. Even with inexact alignment, DIP devices can be inserted quickly and easily.

CIRCLE NO. 295

Modular IC test cards bring out device pins

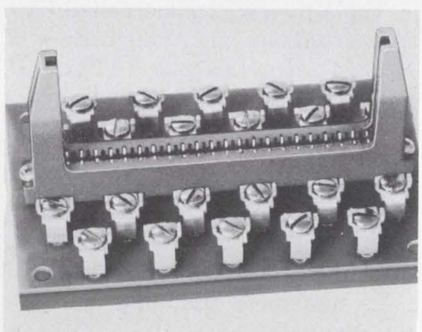


Berkeley Electronics Research Co., P.O. Box 1021, Berkeley, Calif. Price: $9.50 to $13.50

CmII test module cards contain an integrated circuit socket in all popular configurations, including those with 24 and 36 pins. Each pin is brought out to a numbered terminal; other terminals are available as tie points. There is a ground plane around each terminal for easy access to ground, and for preventing oscillations and ground loops. Auxiliary brackets are also available.

CIRCLE NO. 296

Connector interface mates with PC cards

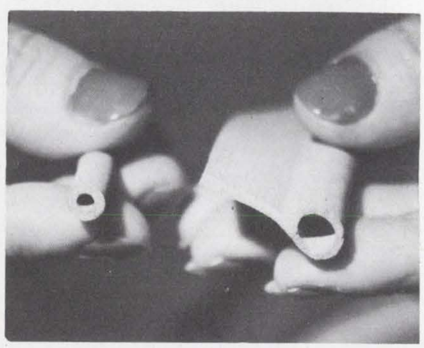


Farmer Electric Products Co., Inc., Tech Circle, Natick, Mass. Phone: (617) 653-8850. P&A: $12; stock.

Bridging the gap between printed circuit technology and factory control panel installations, the model 22 edge connector interface socket allows the insertion of a 22-pin printed circuit board into a panel-mounted connector with screw terminals. This eliminates soldering, wire-wrap connections and cumbersome PC mounting panels.

CIRCLE NO. 297

Hollow rfi gaskets seal out environment



Chomerics, Inc., 77 Dragon Court Woburn, Mass. Phone: (617) 935-4850.

Molded from electrically conductive silicone elastomers, new hollow strip gaskets provide both rfi and environmental protection. Because of their hollow core, these gaskets can be compressed as much as 75% without compression set, and with extremely low closure forces. Shielding effectiveness is said to be high even when deflection is small. Various cross-sections are available.

CIRCLE NO. 298

Resistive cermet paste stabilizes to 100 ppm

Conshohocken Chemicals, Inc., Consh-Ohm Div., Box 244, Flourtown, Pa. Phone: (215) 836-5700. Price: $50 to $90 per troy oz.

Resistive cermet pastes in the very low ranges, with stable and reproducible temperature coefficients to much less than 100 ppm are now available. Series CC200 thick-film pastes meet all military specification requirements. They fire at 565 to 610°C and offer, in process, range and temperature coefficient adjustments.

CIRCLE NO. 299

Masking latex coating strips away easily

Baer Bros. Paint & Varnish Co., Inc., Box 217, Rye, N.Y. Phone: (914) 698-0358.

A strippable latex coating which provides a rapid masking or protective coating for plastics, wood and metals, dries in 30 minutes, then peels off quickly and easily. Known as #6-27A, it will cover approximately 450 square feet per gallon, bringing its cost to less than 1¢ per foot. It is available in 55-gallon drums, five-gallon pails and one-gallon cans.

CIRCLE NO. 340

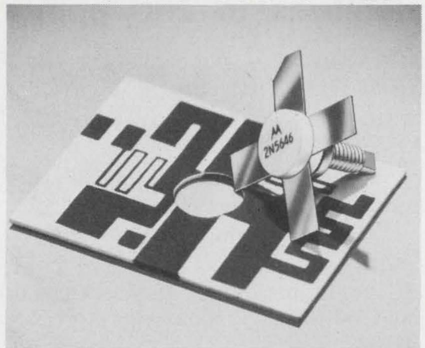
Solder creams match thick films

Alpha Metals, Inc., 56 Water St., Jersey City, N.J. Phone: (201) 434-6778.

A new line of solder creams, which are homogeneous combinations of finely powdered solder and flux, can be used on any solderable metallic or thick-film surface. These new formulations can be replaced by spraying, screening, masking, automatic dispensing, roller transfer, or by hand. They are available in curable and non-curable forms.

CIRCLE NO. 341

Rf 470-MHz transistors belt out a dozen watts

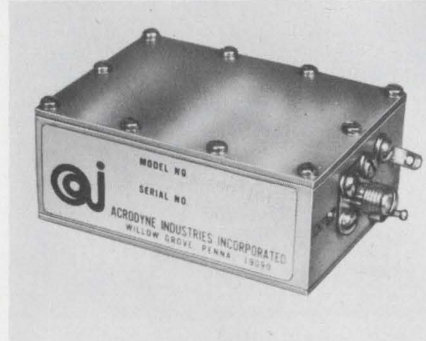


Motorola Semiconductor Products, Inc., Box 20924, Phoenix, Ariz. Phone: (602) 273-3466. P&A: $8.30 to $22.50; stock.

Operating with a 12.5-V power supply, a new chain of balanced-emitter rf power transistors supply 12 W from 450 to 470 MHz. The 2N5644 through 2N5646 units need no dc-to-dc converter and are used as power amplifiers in mobile transmitters. They are supplied in 3/8-in. ceramic stripline opposed-emitter packages.

CIRCLE NO. 342

Uhf power amplifier shows 2 W at 0.2 GHz

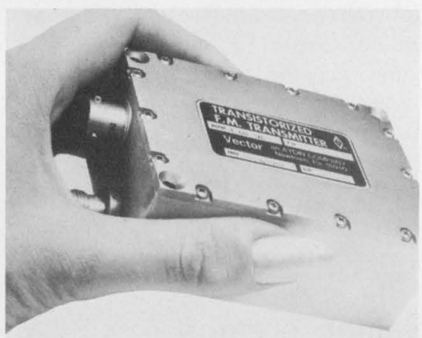


Acrodyne Industries, Inc. 666 Davisville Rd., Willow Grove, Pa. Phone: (215) 657-1800.

Spanning the frequency range of 500 to 2000 MHz is a new compact solid-state uhf power amplifier with an output of 2 W. The model A-2004/L is used for class-C operations with a 3-dB bandwidth of 150 MHz. Its power gain is rated from 7 to 13 dB and it is powered by +28 V dc. Dc-to-rf efficiency is 35%, and the amplifier measures 2-3/4 × 2-1/4 × 1 in.

CIRCLE NO. 344

S-band transmitter provides 2-W power



Vector, an Aydin Co., Box 328, Newton, Pa. Phone: (215) 968-4271.

Operating in the S band, a new miniature transmitter supplies a minimum output of 2 W. The model T-102S incorporates an integral circulator for operation into any load including open and short circuits. Its frequency response is dc to 2 MHz with a ±2 MHz carrier deviation, and stability is ±0.003%. Harmonic distortion is 1% at ±500 kHz. It measures less than 12 cubic in.

CIRCLE NO. 343

Low-noise amplifier spans 0.5 to 1 GHz

Optimax, Inc., 258 Main St., Ambler, Pa.

Without compromising noise figure, a new high-power, high-gain linear amplifier covers the frequency range of 500 to 1000 MHz. The model A52D2-M is capable of producing an output of +22 dBm with a noise figure of 5.5 dB. It has a gain of ±0.5 dB and its input-to-output VSWR (voltage standing wave ratio) is a maximum 1:7.1. This allows class A amplification at no loss of parameters.

CIRCLE NO. 345

Tiny radar altimeter weighs just 21 oz

General Dynamics, Electronics Division, San Diego, Calif.

Capable of measuring altitudes to 2000 ft, a new IC radar altimeter weighs 21 oz and measures only 3-1/2 × 2-1/2 × 1-1/2 in. (including antenna). This analog-readout device displays from 0 to 5 V and works at a minimum altitude of 20 ft. Its accuracy is within 2 ft and 3% of altitude and it uses fm and cw transmissions in the K frequency band. A slot array antenna is an integral part of the unit.

CIRCLE NO. 346

Power transistors go out to 1 GHz

TRW Semiconductors Inc., 14520 Aviation Blvd., Lawndale, Calif. Phone: (213) 679-4561. Price: $24 or $48 per 100.

Offering significant performance advantages over two older types (2N4330 and 2N4331) which they will replace, two new transistors, 2N5764 (3 W) and 2N5765 (5 W), perform to 1 GHz. They will withstand severe mismatches under any load or phase conditions with a gain-increase of 6 dB and an efficiency increase of 40% over the older ones.

CIRCLE NO. 347

YIG-tuned receiver covers 10 to 40 GHz

Electro/Data, Inc., 1621 Jupiter Garland, Tex. Phone: (214) 341-2100. P&A: $2995; 45 to 60 days.

With a single sweep, a new plug-in YIG-tuned panoramic receiver covers 10 to 40 GHz. The model PN1014 can plug into Textronix 560 and letter-series oscilloscopes. It uses an electronically swept yttrium-iron-garnet bandpass filter, which has a decade-tuning range, as a preselector, followed by a sensitive crystal detector and a low-noise video amplifier.

CIRCLE NO. 348

GaAs impatt diodes lower a-m/fm noise

Raytheon Co. Micro State Electronics Operation, 152 Floral Ave., Murray Hill, N.J.

A new line of gallium-arsenide avalanche impatt diodes offers minimum a-m and fm noise. These high-power X and Ku-band diodes are designed to give higher dc to rf efficiencies for high power cw levels, with regulated dc inputs, compared to other solid state microwave devices and include matched characteristics for interchangeability and parallel operation.

CIRCLE NO. 349

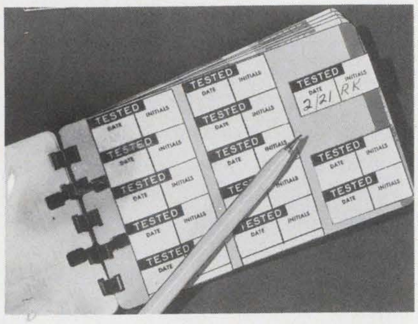
Ku-band Gunn diodes supply noiseless 36 mW

Varian Solid State Microwave Operation, 611 Hansen Way, Palo Alto, Calif. Phone: (415) 326-4000.

When inserted properly in a tunable microwave cavity, two new series of low-voltage gallium-arsenide Gunn-effect diodes deliver a typical output of 9 mW (series VSU-9206) or 36 mW (series VSU-9202) from 12.4 to 15 GHz. Output for both series is said to be noise free. Maximum threshold bias current is 750 mA dc for the VSU-9202 units and 500 mA for the VSU-9206 ones.

CIRCLE NO. 350

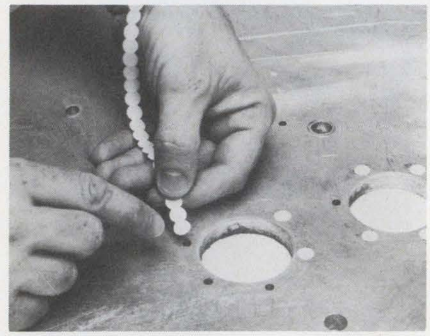
Evaluation Samples



Portable labels

Porta-Packs are new pocket-size books containing self-sticking write-on labels for fast on-the-spot marking. Now available as a free evaluation sample, these new products make it easy to handle and carry a full supply of labels at all times. The labels accept written information to indicate inspection, testing, calibration, numbering, inventory, coding or identification. Various sizes and assortments are available. W. H. Brady Co.

CIRCLE NO. 351



Masking dots

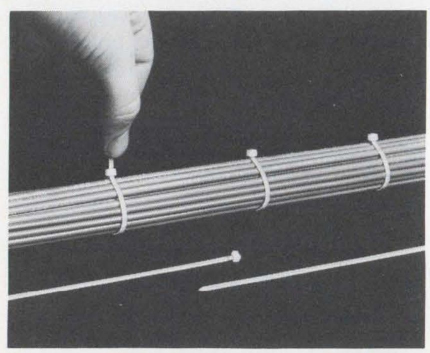
Masking discs, called "Kwiky Dots," a practical idea for cutting masking time over holes and orificies, are offered as a free sample. To use, simply strip off a short string of dots and place the first one over the area to be masked. With the index finger of the other hand, press into position and hold as you gently pull to detach the rest of the strip. The dots easily separate from the strip and you are ready for the next one. By-Buk Co.

CIRCLE NO. 353

Foam tapes

Two new folders contain actual samples of Arnofoam tapes, along with details on the tapes' specifications and potential applications. Made of polyurethane or plasticized vinyl, Arnofoam is offered in four basic types with thicknesses ranging from 1/32 to 1/2 inches. The tapes come in widths from 1/4 to 36 inches. Suggested applications include cushioning, insulating and protection. Arno Adhesive Tapes, Inc.

CIRCLE NO. 352



Long cable tie

Extra long to accommodate harnesses up to 0.25 inches in diameter, a new Sta-Rap cable tie, the SST1.5M, offers a loop tensile strength of 18 pounds minimum. The unit meets the requirements of military standards MS-3367-4, -17821-4, and -18034-4. It is all nylon and can be installed either by hand or with a tool. Now a free evaluation sample, this new tie is available in 11 colors, including natural white. Panduit Corp.

CIRCLE NO. 354

Design Aids

Transformer wallet card

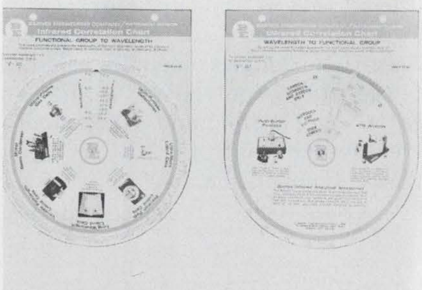
Putting a selection guide in a nutshell, a handy wallet-size plastic card contains reference tables to determine rated line amperes for single-phase dry-type transformers. The units range in power from 1 to 500 kVA with voltages of 120, 240, 480 and 600 V. Three-phase transformers are rated at 3 to 2000 kVA for 208, 240, 480 and 600 V. Federal Pacific Electric Co.

CIRCLE NO. 355

Elastomer guide

Condensing basic data on 17 Vibrathane liquid prepolymers is this new urethane elastomers selection guide. Listed are both polyester and polyether types. Product applications include belting, pads, rollers, draft gear, seals, wheels, diagrams, heel lifts and coatings. Also described are durometer hardness values and special characteristics of the discussed types. Uniroyal Chemical.

CIRCLE NO. 356



IR/wavelength chart

A new circular chart correlates infrared wavelengths to chemical compounds. Simply set the cursor to any given wavelength, and one side automatically identifies most compounds producing absorption at that wavelength. It also includes the formula to convert wavelengths to wavenumbers. The other side of the chart presents wavelengths of the main absorption bands of 61 classes of chemical compounds. It is available at a nominal cost of $3.00 per unit. Barnes Engineering Co.

CIRCLE NO. 357

Application Notes

MOS/LSI design

An MOS/LSI guide enables anyone with a reasonable knowledge of MOS fundamentals to design his own MOS/LSI circuits. It includes electrical characteristics, process parameters and implementation guidelines for MOS devices. Included are tables for item definitions, values and dimensions. Other tables show undesirable and allowable design situations and suggested device input protection. A discussion follows on quality acceptance and masks. Cartesian, Inc.

CIRCLE NO. 358

Magnetic testing

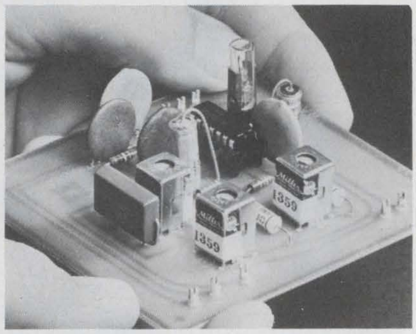
The use of magnetic test methods and instrumentation is described in the latest issue of the "Motorgram" (Vol. 49, No. 5). Outlined are various procedures and equipment requirements for evaluating the magnetic properties of electrical steels used in motors and transformers. The issue also contains a case study of a portable recorder that uses several precision fractional-horsepower motors. Bodine Electric Co.

CIRCLE NO. 359

Printed circuit design

A short course on printed circuit design is contained in a booklet entitled "Printed Circuit Design and Documentation." It describes a system in which a printed circuit designer can communicate circuit requirements from the board fabricator to the responsible engineer for modifications. Included in this booklet is a printed circuit layout guide and specification sheet in tabular form, template diagrams and illustrated masking processes. High Altitude Products Co.

CIRCLE NO. 360



IC stereo decorder

A six-page construction article describes a monolithic integrated circuit fm stereo decoder system. Designed around an integrated circuit, the decoder provides excellent channel separation across the entire audio range. It incorporates series coils to help assure optimum channel separation characteristics. J. W. Miller Co.

CIRCLE NO. 361

Chemical machining

The engineering parameters that must be considered in designing for photofabrication or photo chemical machining are thoroughly detailed in a 13-page design manual. Besides a concise description of the process itself, the manual talks of problems and their solutions, metal properties, and dimensions. Fotofabrication Corp.

CIRCLE NO. 362

Thin-film measurement

An eight-page article describes two new interference objectives for measuring thin-film thickness and surface roughness. These objectives can be used with almost any standard microscope. The booklet is amply illustrated with diagrams of the equipment and photographs of various surfaces. Hacker Instruments Inc.

CIRCLE NO. 363

Thermal drifts

Reprints of a recent article entitled "Minimizing Self-Heating Drift in Power Supplies" are available. It discusses the commonly overlooked factor of thermal feedback created by heat generated in the power supply itself. Load-induced and line-induced thermal drifts are considered as direct results of variation in internal temperatures of the power supply following a change in power dissipated by the supply. Application of a compensated amplifier, which exhibits freedom from thermal transients and has a steady-state temperature coefficient approaching zero, is described. Deltron, Inc.

CIRCLE NO. 364

Zero-voltage switch

Primarily used as a trigger circuit for thyristors, the model CA3059 zero-voltage switch is a multi-stage monolithic circuit. A 12-page application note shows the use of this IC in thyristor power switching and control circuits. Specific examples include various temperature controllers, a differential comparator, and a transient-free switch controller. RCA Electronic Components.

CIRCLE NO. 365

Cryogenic metals

The advantages of low-temperature processing in various metallurgical applications is described in a new booklet entitled "Metals Respond to Ultralow Temperatures." It covers many phases of low-temperature treatment including austenitic transformation, shrink assembly, as well as advantages which may be anticipated. This information will be of interest to production supervisors, design engineers, and pilot plant operations. Cincinnati Sub-Zero Products, Inc.

CIRCLE NO. 366

Time control for all data systems

Durant Calendar clock with electric readout

The Durant 59005 Digital Clock gives you a wide choice of models which supply visual and electrical readout in combinations of hours, minutes, seconds, tenths of minutes and thousandths of hours. And, if you wish, day of the month and calendar year.

Simple connections, made on the back panel, provide remote electrical readout. For visual readout, a signal holds all figures motionless; time pulses generated during readout are stored and recorded later.

Durant's 59005 Digital Clock has several mountings available. Operates on 115 or 230 volt AC, 50-60 cycle, or from your own system's time base generator. For full information, write for catalog 90-J, 622 North Cass Street, Milwaukee, Wisconsin 53201.

DURANT®
MANUFACTURING COMPANY
COUNT / CONTROL INSTRUMENTS
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In Europe: Durant (Europa) N.V. Barneveld, Netherlands

INFORMATION RETRIEVAL NUMBER 89

ELECTRICAL COMPAC E2B

Life Tests:

Electrical impulse E2B counters, running at 600 counts per minute under laboratory conditions, have achieved the following—

50,000,000 counts—DC units;
15,000,000 counts—AC units;
Testing still in progress.

Accuracy: Complete reliability under variable test conditions.

Figures: 6-digits, black on white.

Voltages: 115 V. AC; 230 V. AC; 24 V. AC; and 24 V. DC. (4 watts)

Drive: New patented reciprocating Delrin verge.

Mounting: Base or panel mount.

Face Size: 1.72" W x 1.19" H x 2.34" D. (Net wt. 5 oz.)

Recognition: Meets U.L. and C.S.A. standards.

Delivery: Most voltages *available from stock.*

Price: $1.85 in OEM quantities.

Covered by Patent No. 3,470,361

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INFORMATION RETRIEVAL NUMBER 90

SCR series Power Supplies

for high power applications

- Smallest volume per watt
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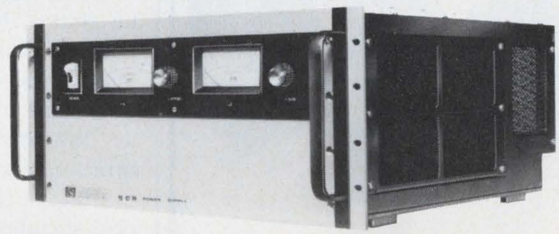
- Constant voltage/constant current
- 0.1% constant current regulation
- High efficiency
- Remote programming/mhogramming
- Plug-in circuit boards



Low output ripple plus constant voltage and current makes the SCR Series ideal for a wide range of industrial uses — including CW and pulse lasers, capacitor forming, electro plating, battery charging, focusing coils for accelerators, aging racks for semiconductors, electronic memory systems and cryogenic magnet applications. The SCR Series includes standard models with DC outputs of 0-500V, 5-500 amps, regulating at 0.1% for both constant voltage and constant current, with a price range from $995 to $1700. Four new 10 KW models which use only 12¼" of rack space. Rated at 0-20V, 0-40V, 0-50V and 0-100V priced from $2500 to $2900.

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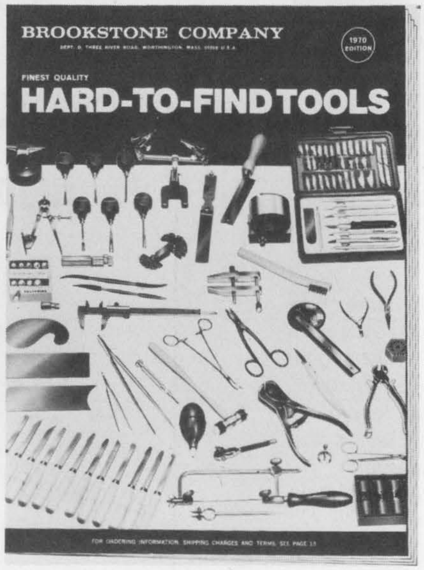
INFORMATION RETRIEVAL NUMBER 91

New Literature



Hard-to-find tools

Useful hard-to-find tools can now be found in a 24-page, fully illustrated catalog. It contains precise and detailed descriptions and applications of each unique tool such as tungsten carbide saw blades, miniature riffler files, torch lamps, miniature screws, nuts, bolts, washers, stainless steel pliers and hard-chromed needle files. Also included are wood working tools, electronic tools, jewelers' tools, diamond pencil and glass cutters, unusual solders, rust removers, hard-wire cutters and glass drills. Scores of other versatile hand tools and small power tools are also shown. Brookstone Company.

CIRCLE NO. 367

Time sharing

"Time Sharing and You" is the title of a free booklet now being offered. Designed as an aid to the understanding of the computer time sharing concept, the booklet aims to explain how and why time sharing developed, how it works and also provides a glimpse of its future. The booklet is offered because of a belief that a wider understanding of computer time sharing is necessary and desirable. Call-A-Computer.

CIRCLE NO. 368

Motors

An expanded and redesigned catalog includes stock motors and speed controls. In 20 pages it provides data on more than 325 stock fractional motors and gearmotors ranging from 1/2000 to 1/4 hp, as well as SCR-adjustable speed/torque drive systems. Included are 14 new gearmotors and enlarged photographs, dimension drawings and increased type size for easier reading. The line of motor speed controls listed include both chassis and enclosed types. Also listed is a selection of new optional and accessory parts available for use with both types of controls. Bodine Electric Co.

CIRCLE NO. 369

Engineering tools

Special purpose slide rules, calculators, kits, books, precision measuring tools and other information aids are described in a 32-page catalog. Besides the many items with broad engineering and management appeal, products for specific fields such as mechanical, electronic, reliability and fluids are covered with special emphasis on quality control and inspection. Info Inc.

CIRCLE NO. 370

Computer time

Computer time marketing is the subject of a 36-page quarterly magazine called "Computer Time Report." It analyzes and reports computer and market trends and developments. Listed are computer availabilities in major cities across the nation along with prices and special features. Also listed are large scale computers available coast to coast with configurations and prices. Included are suggestions for buyers and sellers on services in demand and for efficient use of time. Time Brokers, Inc.

CIRCLE NO. 371

Power conversion

Features, specifications, modifications and mounting dimensions of miniature and subminiature power conversion equipment are described in a four-page condensed catalog. It covers ac-dc, miniature solid-state dc-dc and subminiature three-watt dc-dc converters. Also discussed are dc-sine-wave inverters, dc-dc high voltage regulated power supplies, miniature power transformers, inductors, current limiters and filters. Basic pricing information is included. Arnold Magnetics Corp.

CIRCLE NO. 372

Instrument journal

The December 1969 issue of the Hewlett-Packard Journal is now available. It contains articles on wideband network analysis with a network analyzer that operates from 100 kHz to 110 MHz and high-impedance probing with a 500-MHz probe. Hewlett-Packard.

CIRCLE NO. 373

Power supplies

A new 12-page catalog detailing a selection guide for all types of modular power supplies is now available. The catalog shows both commercial and off-the-shelf military types of power supplies. Powertec Division of Airtronics.

CIRCLE NO. 374

Modular components

Solid state modules for a large line of electronic components are shown and discussed in a short-form catalog. Included are such devices as telemetering systems, a/d and d/a converters, oscillators, pulse generators, frequency mixers, phase detectors and amplifiers. Also described are isolators, transducers, voltage-controlled oscillators, discriminators, choppers, relays, coils and transformers. Solid State Electronics Corp.

CIRCLE NO. 375

Flatpack ICs

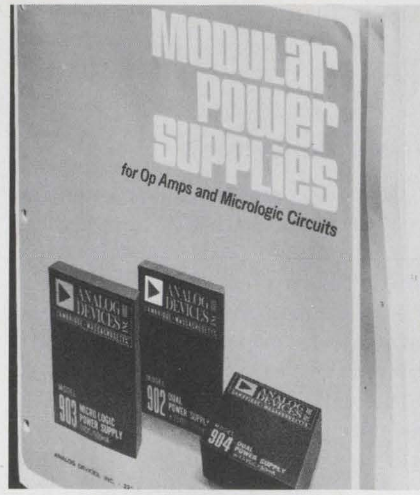
Flatpack hermetic packages for housing integrated and hybrid circuits are fully described in a new short-form catalog. The publication details the 62 hermetically sealed packages and lists the packages by size. It includes such information as the number of leads, part numbers, base materials and minimum bonding pad areas. Detailed drawings and dimensions of 23 basic package types with the lids and solder preforms are clearly shown. Sprague Electric Co.

CIRCLE NO. 376

Switches and displays

Lower-cost lighted matrix displays and switches are described in a new 46-page catalog. Described are matrix display/switching systems, four-lamp and single-lamp push-button switches for individual mounting, power and rotary switches and miniature indicator lights. Also presented are product series features, performance and environmental specifications dimensioned views, schematic diagrams, legend availability and arrangements, and outlined drawings and exploded views. Stacoswitch.

CIRCLE NO. 377



Modular power supplies

Specifications and applications on eight modular dc sources are described in a 12-page catalog. Included are bi-polar operational amplifier supplies and single-polarity micrologic circuit supplies. Also shown are highly stable dual-polarity units that develop precision reference voltages for a/d and d/a converters. Analog Devices, Inc.

CIRCLE NO. 378

Coaxial transistors

The design, construction and performance of microstrip circuits using coaxial transistors is discussed in a six-page brochure. Two circuits are described: a 1.5-GHz amplifier which can provide 1.5 watts of output power with an 8-dB power gain at 50% collector efficiency; and a 2-GHz amplifier which can provide 1.2 watts of output power with a 6-dB power gain at 40% collector efficiency. RCA Electronic Components.

CIRCLE NO. 379

Precision instruments

A score of precision laboratory instruments and components is contained in a 12-page catalog. Included are such instruments as potentiometers, bridges, dividers, detectors, voltage and resistance standards, ac/dc consoles and precision resistors. Julie Research Laboratories, Inc.

CIRCLE NO. 380

SCRs

Critical ratings and characteristics as well as photos and outline drawings of a complete line of silicon controlled rectifiers (SCRs) are contained in a 16-page catalog. Rectifiers listed range in current values from 16 to 470 A and voltage ratings from 25 to 1300 V. Also included are high-dv/dt and di/dt types. A complete listing of symbols and definitions of terms used in SCR data sheets are shown. National Electronics, Inc., a Varian subsidiary.

CIRCLE NO. 381

Instruments

A condensed 24-page publication describes a complete line of electronic test and measuring instruments. Products and systems described include oscillographs, X-Y and magnetic tape recorders, signal-conditioning equipment, digital multimeters, transducers, biomedical and recording instrumentation, and rfi/emi surveillance and analysis equipment. Honeywell Test Instrument Div.

CIRCLE NO. 382

Audio switches

A line of multi-channel go/no-go audio switches are thoroughly discussed in a 22-page manual. It illustrates these switches as used in audio systems with a technical discussion of their operational characteristics and shows block diagrams and circuit representations. Specifications and illustrations are also included. Gosh Instruments, Inc.

CIRCLE NO. 383

Crystals

A customer product and information source on single crystals is contained in a new 76-page booklet. It includes product listings and information pertinent to each crystal such as growth method, structure and purity. Illustrated on each page is a breakout of the element from the periodic table. Alfa Crystals, Ventron Materials Div.

CIRCLE NO. 384

Fans

Precision cooling devices consisting of a complete line of fans for electronic and other applications are included in a new 16-page "airmovers" catalog. Included are complete descriptions, electrical specifications and outline drawing with mechanical dimensions. Boxer, propeller and blower fans are shown. IMC Magnetics Corp. New Hampshire Division.

CIRCLE NO. 390

Film trimming

An abrasive-jet machining technique which permits trimming thick-film resistors, as well as thin-film and capacitance trimmers, is detailed in a 38-page bulletin. Four abrasive systems are covered with price and specification lists, as well as on-the-job photos. Included in the manual are a laboratory unit for prototype work and research and design, semi-automatic systems with or without an indexing table, and a fully automatic system. Also included is a description of a probe designed for testing of microcircuits. S. S. White Div., Pennwalt Corp.

CIRCLE NO. 391

Connectors

An expanded series of multiple coax connectors for rack-and-panel/cable applications is fully described in a 52-page catalog. It includes completely updated specifications, plus application and dimensional data for nearly 350 items of a coax connector series. Included is information about standard, miniature and subminiature crimp-type connectors for use with coaxial cable, shielded wire and twisted pairs. Connector blocks with 2 to 156 contact positions, and a full array of accessory hardware such as jackscrews, hoods and clamps, are described. AMP Inc.

CIRCLE NO. 392

Resistors

Up-dated technical information on vitreous enamel resistors is now available in two new bulletins. One bulletin covers a family of tab-type resistors in wattage ratings from 8 to 210 W. The other describes axial-lead type resistors in wattage ratings from 1 through 11 W. Both bulletins contain complete listings of standard resistance values and the maximum permissible current for each resistance rating, as well as complete performance specifications for the resistors. Sprague Electric Co.

CIRCLE NO. 393

Fluidics

A complete family of fluidic industrial control modules and associated mounting manifolds are described in a 28-page illustrated booklet. A two-page introduction to fluidics and a two-page explanation of basic fluidic technology are followed by five pages of component descriptions. A fold-out chart gives symbols and truth tables for the various elements and their corresponding symbols in other technologies. Corning Glass Works.

CIRCLE NO. 394

Filters and modulators

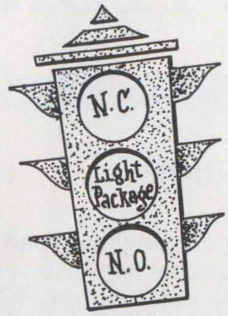
Passive and active electronic filters and modualtors are discussed in a 12-page brochure. It describes and illustrates high-pass, low-pass, rejection and bandpass filters and lumped constant delay lines. Included are discussions and specifications. KDI Navcor West.

CIRCLE NO. 395

IC amplifier array

Applications of an array of four identical amplifiers on a single monolithic silicon chip are described in an eight-page brochure. Each amplifier in the array has a typical open-loop gain of 58 dB and an input impedance of 90 kΩ. The arrays are in a 16-lead dual-in-line package. RCA Electronic Components.

CIRCLE NO. 396



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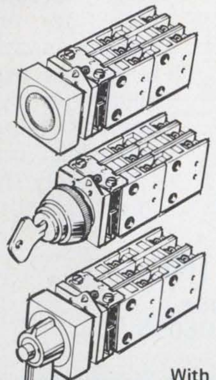

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A leader in inertial navigation systems, such as the F14 and S3A programs, announces openings for circuit design specialists. BSEE's with 5-10 years experience in either platform electronic and control systems, power conversion or signal processing.

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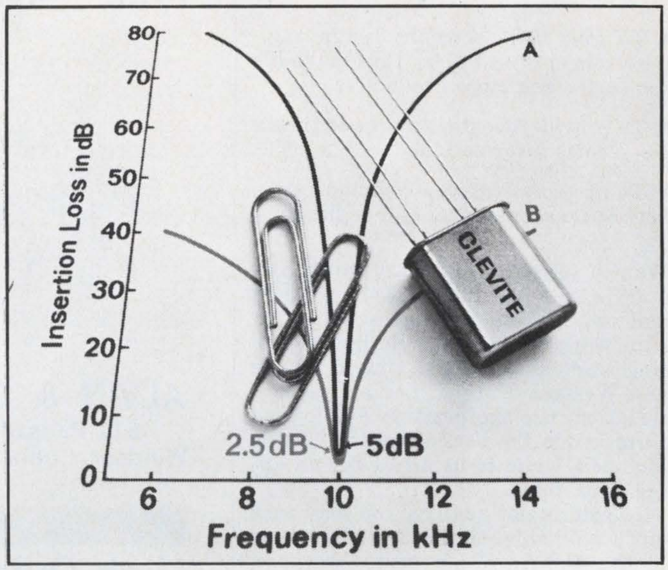
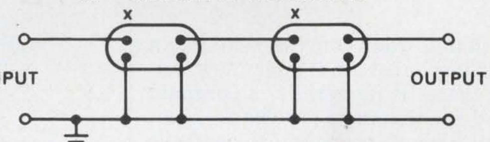
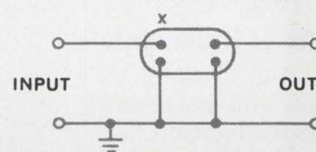


A—CASCADE OF 2 LF FILTERS



B—SINGLE LF FILTER



New Clevite ceramic bandpass filter puts big performance into ¼ oz.

Clevite low frequency (LF) ceramic filters—from 9 to 50 kHz—are about one-tenth the size and weight of comparable conventional types—have narrower bandwidths, lower insertion loss and greater stability. This means you can pack more channels into a given portion of the spectrum with less sacrifice in volume and weight. They're fixed tuned, so you have no installation adjustments, simpler assembly and inspections.

Typical characteristics: 1% min. 3 dB pass bandwidth, 20 dB/3 dB bandwidth ratio not exceeding 13, and passband insertion loss less than 5 dB. Stopband attenuation exceeds 30 dB from dc to above 100 kHz. For even better selectivity they can easily be cascaded without worrying about matching or big insertion losses.

All this performance comes in a miniature HC-6/U can that weighs just ¼ ounce (it's shown here actual size). They're hermetically sealed, immune to environments . . . there's no need for magnetic shielding. And LF filters are independent of the power source, so there's no current drain.

New Clevite LF filters are ideal for low frequency communications receivers, control circuits, selective calling systems, underwater sound systems and military/navigation systems. Write today for full specs and technical data. Piezoelectric Division, Gould Inc., 232 Forbes Road, Bedford, Ohio 44146, U.S.A. Or: Brush Clevite Company, Ltd., Southampton, England.

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INFORMATION RETRIEVAL NUMBER 98

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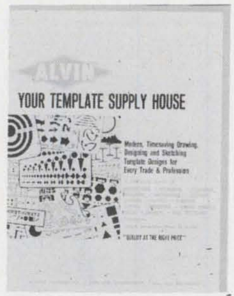
Free — New Alvin Template Catalog



A must for every electronic engineer and draftsman! The comprehensive 36 page Alvin catalog clearly illustrates and describes over 400 templates for practically every use. This template catalog is categorized in sections and shows the templates used for each field, ie, electrical and electronic symbol templates, mechanical engineering templates and many others. Alvin's precision made, time-saving templates cover completely the needs of draftsmen and engineers in all categories. Send for free catalog now.

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High Output/Reliability DC Airmovers

Illustrated bulletin NT6 describes IMC's new line of high output DC Boxer fans.
Eight models deliver up to 120 cfm, accept DC inputs from 12 to 38 Volts. Units are available with ball or sleeve bearings . . . both patented designs rated at 10 or more years life. Integral solid-state inverter mates precisely with the quality proven Boxer (4-11/16-in. sq. by 1-1/2-in. deep). Mounts easily, inside or outside equipment enclosures. Requires no extra connections or fasteners.
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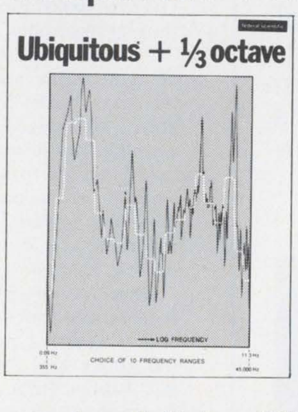

Only the Ubiquitous® Spectrum Analyzer makes possible 500-point real-time spectra of noise plus simultaneous 1/3-octave for very little more. For high speed analysis of noise, vibration and other low-frequency random data, and for detection of low-level periodic signals buried in noise. All you add is the new Option 150A Broadband Adapter — at less than 1/2 the price of a separate 1/3-octave analyzer, less than ¼ the cost of a computer approach. Additional features include: wide coverage, from 0.1 Hz to 40,000 Hz; high accuracy and repeatability through digital integration; preferred center frequencies and filter shapes; ½-octave and octave analysis also included; CRT or X-Y plotting in log or linear scales.

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Manufacturers

Advertisements of booklets, brochures, catalogs and data sheets. To order use Reader-ServiceCard.
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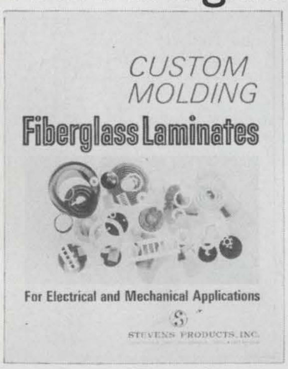
Free: Fiberglass Laminated Insulator Brochure



Four page brochure presents procedures and applications for **Custom Molded** fiberglass laminated electrical insulation components. Specially molded glass epoxy and silicone insulators solve problems better than fabrications from sheet stock, tapes, paste-ups, or coatings in tough Aerospace, Marine, and Commercial applications. Thicknesses from .003" offer strength and shock resistance. Prototype tooling from $60.00. Standard line of tubing for coil and **potting forms** also available. Write for literature and samples.

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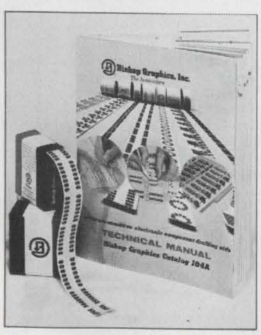
1970 Electronic Components Drafting Aids Catalog



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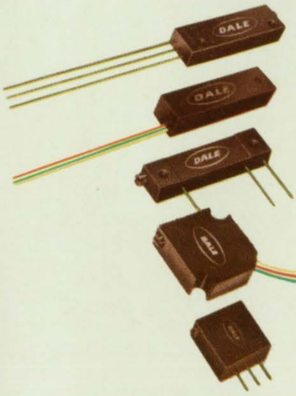
MILITARY GRADE T-POTS



600 Series: Mil. Equiv. RT-10; 10Ω to 100KΩ, $\pm$5%; 1 watt at 70°C, derated to 0 at 175°C; .18 H x .32 W x 1.00 L.

1200 Series: Mil. Equiv. RT-11; 10Ω to 100KΩ, $\pm$5%; 1 watt at 70°C, derated to 0 at 175°C; .28 H x .31 W x 1.25 L.

1600 Series: Mil. Equiv. RT-12; 10Ω to 100KΩ, $\pm$5%; 1 watt at 70°C, derated to 0 at 175°C; .19 H x .32 W x 1.25 L.

5000 Series: Mil. Equiv. RT-22; 10Ω to 50KΩ, $\pm$5%; 1 watt at 70°C, derated to 0 at 175°C; .19 or .22 H x .50 W x .50 L.

5800 Series: Mil. Equiv. RT-24; 10Ω to 50KΩ, $\pm$5%; 1 watt at 70°C, derated to 0 at 175°C; .145 or .150 H x .375 W x .375 L.

COMMERCIAL GRADE ECONO-TRIM T-POTS

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2300 Series: Sealed/Unsealed; 10Ω to 50KΩ, $\pm$10%; 0.5 watt at 25°C, derated to 0 at 105°C; .36 H x .28 W x 1.00 L.

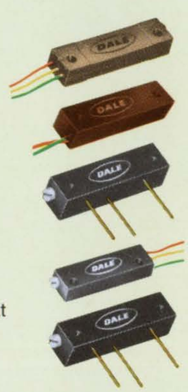
2400 Series: Sealed/Unsealed; 10Ω to 50KΩ, $\pm$10%; 1 watt at 40°C, derated to 0 at 125°C; .31 H x .16 W x .75 L.

FILM ELEMENT

8300 Series: Sealed/Unsealed; 10Ω to 2 Meg., $\pm$10% 100Ω thru 500K, $\pm$20% all other values; .75 watt at 25°C, derated to 0 at 105°C; .36 H x .28 W x 1.00 L.

8400 Series: Sealed/Unsealed; 10Ω to 2 Meg., $\pm$10% 100Ω thru 500K, $\pm$20% all other values; .75 watt at 25°C, derated to 0 at 125°C; .31 H x .16 W x .75 L.

INDUSTRIAL GRADE T-POTS



WIREWOUND ELEMENT

100, 200, 300 Series: 10Ω to 100KΩ.
100 Series: $\pm$5%; 0.8 watt at 70°C, derated to 0 at 135°C.
200 Series: $\pm$10%; 0.5 watt at 70°C, derated to 0 at 105°C.
300 Series: $\pm$15%; .25 watt at 70°C, derated to 0 at 85°C.
Dimensions: .22 H x .31 W x 1.25 L (also 1.32 L for 100, 200).

1100 Series: 10Ω to 100KΩ, $\pm$10%; 1 watt at 70°C, derated to 0 at 175°C; .28 H x .31 W x 1.25 L.

2100 Series: Industrial counterpart RT-11; 10Ω to 100KΩ, $\pm$10%; 1 watt at 70°C, derated to 0 at 125°C; .28 H x .31 W x 1.25 L.

2200 Series: Industrial counterpart RT-10; 10Ω to 100KΩ, $\pm$10%; 1 watt at 70°C, derated to 0 at 125°C; .18 H x .32 W x 1.00 L.

FILM ELEMENT

8100 Series: Industrial counterpart RJ-11; 10Ω to 2 Meg., $\pm$10% 100Ω to 500K, $\pm$20% other values; .75 watt at 70°C, derated to 0 at 125°C; .28 H x .31 W x 1.25 L.

Call 402-564-3131 for complete information or write for Catalog B

DALE®

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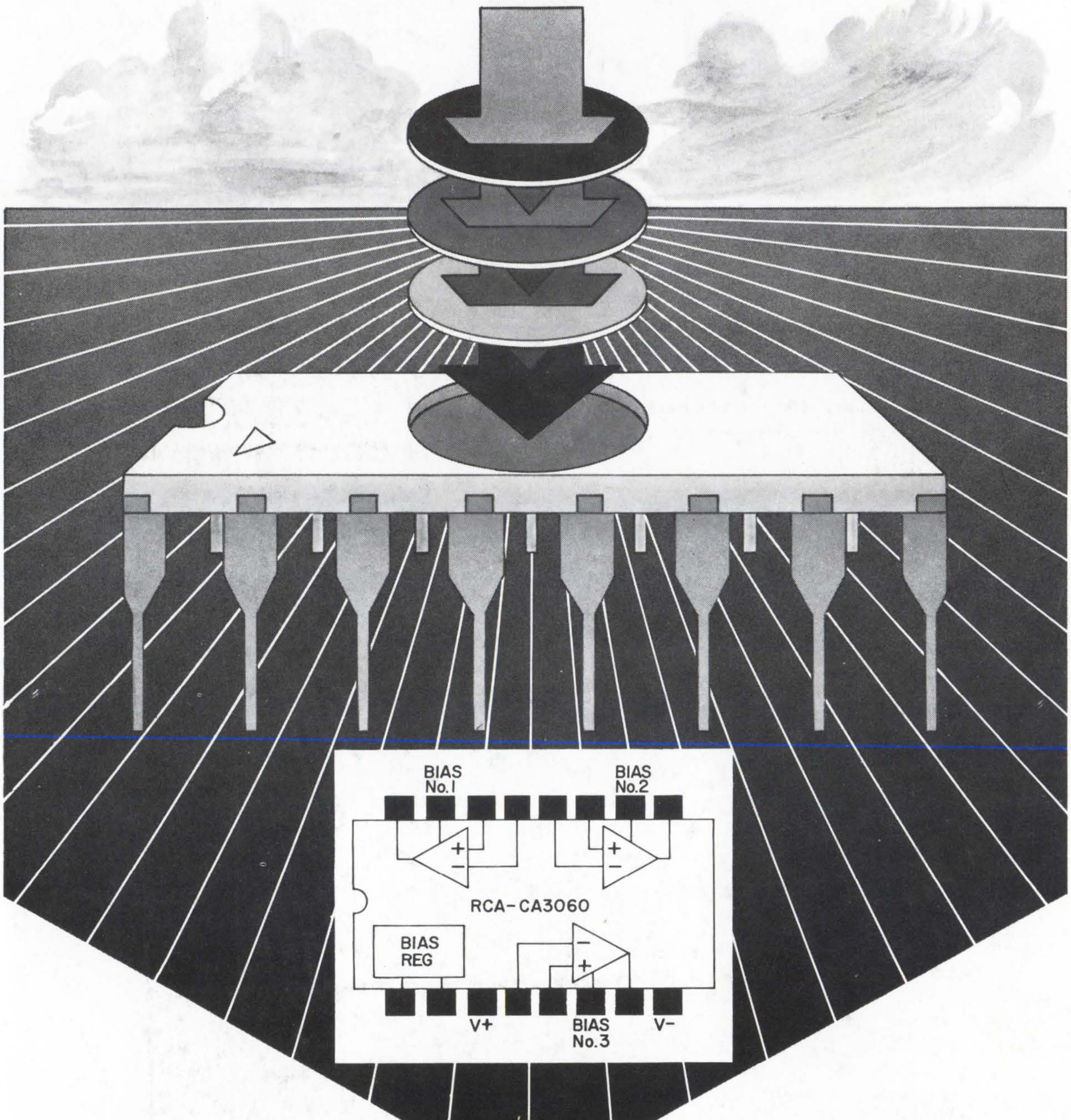
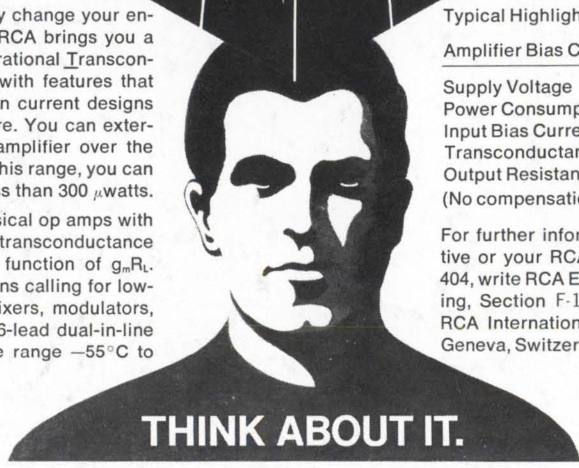
INFORMATION RETRIEVAL NUMBER 106

OTA–NEW DIMENSION IN OP AMPS FOR THE CREATIVE DESIGNER



Here's the IC design breakthrough that may change your entire approach to op amps. In the CA3060, RCA brings you a monolithic array of three independent Operational Transconductance Amplifiers and a bias regulator with features that will send you back to the drawing board on current designs and start a new chain of ideas for the future. You can externally adjust the supply current for each amplifier over the range from 10 μA to 1 mA. At the low end of this range, you can have three amplifiers working for you on less than 300 μwatts.

The CA3060 has the characteristics of classical op amps with the added feature of externally variable transconductance (g_m). Hence, open-loop voltage gain is a function of g_mR_L. Think about it and look into it for applications calling for low-power op amps, active filters, gyrators, mixers, modulators, or multipliers. Price \$5.95 (1000 units) in 16-lead dual-in-line ceramic package (full military temperature range −55°C to +125°C).



Typical Highlight Parameters (Per Amplifier)

Amplifier Bias Current	1 μA	100 μA
Supply Voltage	±2 to ±6 V	±2 to ±6 V
Power Consumption	$\leq$ 100 μW	$\leq$ 10 mW
Input Bias Current	33 nA	2500 nA
Transconductance (g_m)	380 μmho	35 mmho
Output Resistance	200 MΩ	2 MΩ

(No compensation required in many applications)

For further information, contact your local RCA Representative or your RCA Distributor. For technical bulletin, File No. 404, write RCA Electronic Components, Commercial Engineering, Section F-1-2/CA 24, Harrison, N. J., 07029. In Europe: RCA International Marketing, S. A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

RCA Integrated Circuits